

# A Spatial Future Materializes

An ARtillery Intelligence Briefing



20  
23  
Edition

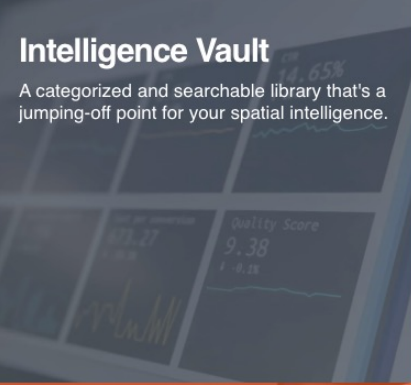



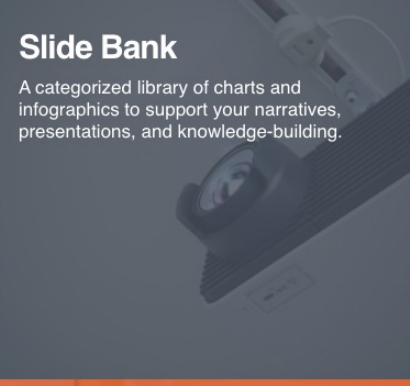
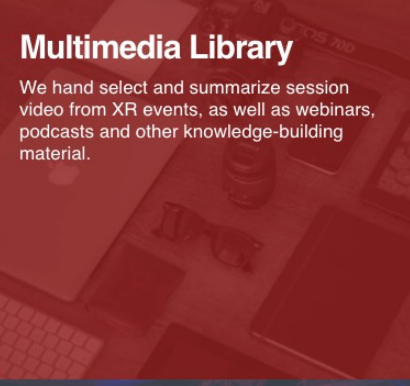
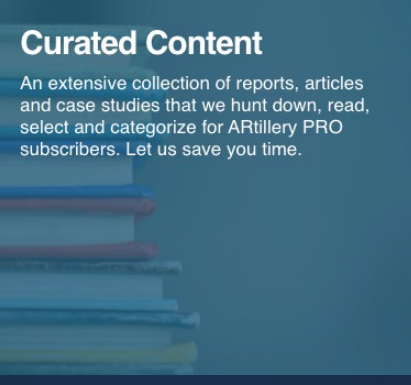
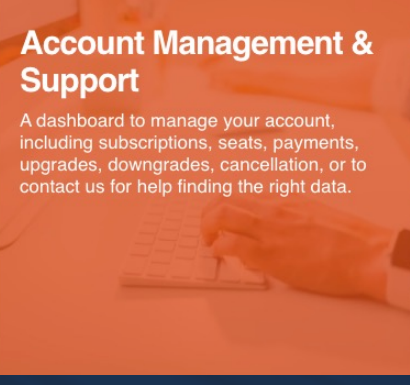
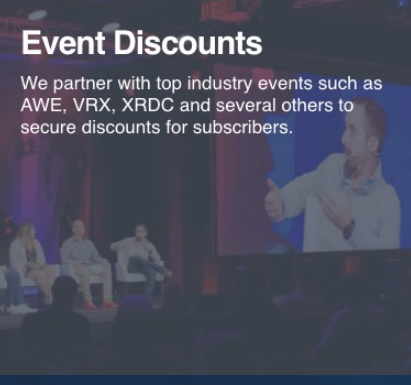
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# Executive Summary

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# Executive Summary

## Reset Expectations

Spatial computing – including AR, VR, and other immersive tech – continues to alter the ways that we work, play, and live. But there have been ups and downs, characteristic of hype cycles. The pendulum has swung toward over-investment, then toward market correction – leaving us now in a middle ground of reset expectations and moderate growth.

Beyond that macro view, the spatial spectrum holds greater nuance in the varied growth curves of its subsectors. Those seeing the most traction include AR brand marketing and consumer VR. Meta continues to advance the latter with massive investments, loss-leader pricing, and a steady pipeline of new hardware.

## The M-Word

Driving this investment is Meta's vision for the metaverse. Disproving our previous prediction, "metaverse mania" didn't die down... In fact, it gained steam, though that now appears to be slowing. Regardless, "steam" is perhaps the right term, as metaverse punditry continues to be mostly vapor. It has immense potential as an interconnected 3D web...

but is more about unfocused future-gazing than real consumer products or revenue-generating businesses.

Stepping back, what is the metaverse? By some definitions, you're *in* the internet instead of *on* the internet. This manifests in 3D virtual spaces that host time-synchronized interaction between place-shifted participants. Today's metaverse-like fiefdoms include multiplayer games like Fortnite and Roblox. They're not THE Metaverse (uppercase M), because they exist as silos that aren't interoperable.

Image Source: Meta



***“The pendulum has swung toward over-investment, then market correction – leaving us now in a middle ground of reset expectations and moderate growth.”***



# Executive Summary



## The Metavearth

But it's not just about 3D gaming. Beyond common metaverse connotations for online 3D experiences, there's a second track. We're talking about a potential physical-world metaverse. The idea is that geo-anchored data can trigger devices to evoke digital content, including AR, where and when it's relevant.

This metavearth, as we call it, is built on a multi-dimensional data mesh that activates digital content. Think of it sort of like Google's search index but for the physical world. This metaverse track is potentially more valuable than its online 3D counterpart. It's also truer to the Greek root meta, which means "beyond." We're talking here about digital content that evokes meaning *beyond* a given entity's physical state.

## Building Blocks

But enough about the metaverse. While its theoretical endpoints are pursued, its building blocks are creating standalone value today. That brings us back to VR and AR, which happen to map to these online and "real-world" metaverse tracks. With both technologies, we continue to see traction and value through the work of Snap, Meta, Google, and others.

Beyond user-facing products, a spatial tech stack lies beneath. This involves a cast of supporting parts. We're talking processing muscle (Qualcomm), experience creation (Adobe), and developer platforms (Niantic). These are the engines of AR and VR growth.

So how is all of this coming together? Where are we in spatial computing's lifecycle? And where are there gaps in the value chain that signal opportunity for AR and VR players? We dive into these questions and others through numbers and narratives. The goal, as always, is to empower you with a knowledge edge.

Image Source: Magic Leap



***“While metaverse theoretical endpoints are being pursued and discussed ad nauseum, its building blocks in AR and VR are developing and creating standalone value today.”***

# Introduction

# The Pendulum

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# Executive Summary



## Practical Realities

When looking at spatial computing (AR and VR) the term hype cycle is often invoked. This is a useful way to contextualize where these technologies sit in their lifecycles. Often, there's a period of over-investment, followed by market correction, then moderate growth.

Like a pendulum, these markets swung toward over-investment and herd mentality that peaked around 2016. Then, technical and practical realities caught up with AR and VR... so they retracted. They swung toward market correction that peaked in 2020, after which a reborn industry grew at a more sober pace.

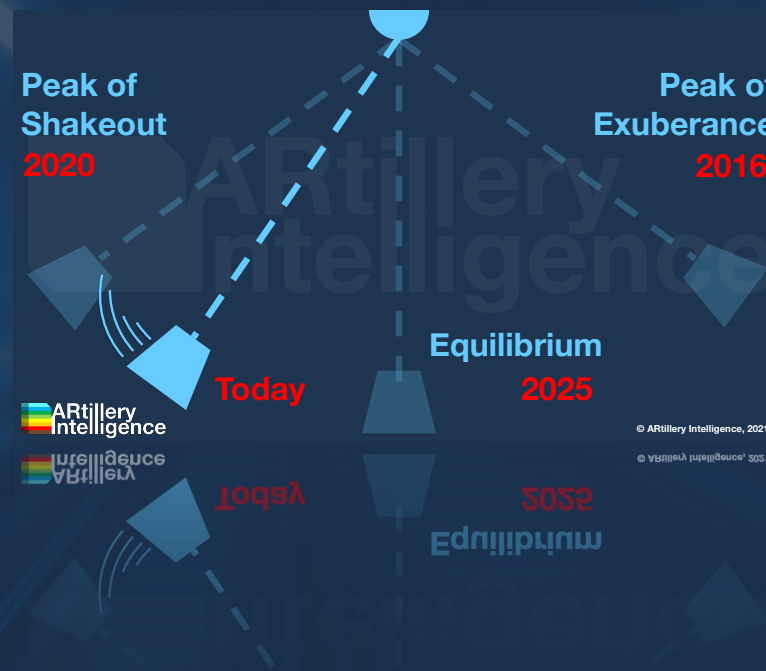
## Pattern Recognition

We've seen such cycles before – most notably, the dot com boom/bust. “Irrational exuberance” was followed by retraction and scorched earth. Then, sprouting from those ashes were companies like Google, and revolutions like social media and the smartphone.

That post-correction state is where we now sit in spatial computing's lifecycle. It's not the revolutionary shift touted circa-2016, but it will create value in

measured ways and in specific areas. XR may not revolutionize everything, but will elevate many things.

Beyond AR and VR, which sit at different lifecycle stages, all the above applies to the m-word... the metaverse. It too has a lifecycle, that will follow these patterns. So where are we in that journey with AR, VR, and the metaverse, respectively? Let's dive into the status and momentum of each, starting with AR...



***“Like a pendulum, these markets swung toward over-investment and herd mentality... then a correction, after which a reborn industry grew at a more sober pace.”***

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# Part I

# Mobile AR



# Smartphone Scale

## Here Today

To pick up where the previous section left off, the metaverse's key ingredients are being built. But unlike the metaverse itself, these building blocks exist today. Most promising among them is AR, which is being applied to enterprise productivity, brand marketing, gaming, and utilities such as visual search.

To pause for definitions, we consider AR to be any technology that digitally enhances a human experience. That includes immersive product try-ons, geo-located mobile gaming (e.g., Pokémon Go), and line-of-sight annotations that support industrial work.

The form factor can also be mobile or head-worn. The latter is AR's fully-actualized modality, which we'll cover later. The former conversely isn't as natural to real-world augmentation but it scales today.

## By the Numbers

To put some numbers behind that claim, of the roughly **3.6 billion** global smartphones today, **3.2 billion** are compatible with at least one form of AR, including rudimentary web AR.

This ubiquity is not only a pathway to scale, but a stepping stone: mobile AR acclimates the world so that AR glasses can hit the ground running. This goes for consumers as well as developers learning to *think spatially*.

Lastly, smartphones won't just be a means to an end, but a key piece of the AR glasses formula. By handling and hosting CPU, GPU, and 5G & edge connectivity, smartphones enable early-generation AR glasses to be lighter, cheaper, and more powerful. This will involve a progression of wired to wireless tethers whereby your smartphone serves as the processing muscle of your smart glasses.

Image Source: Snap



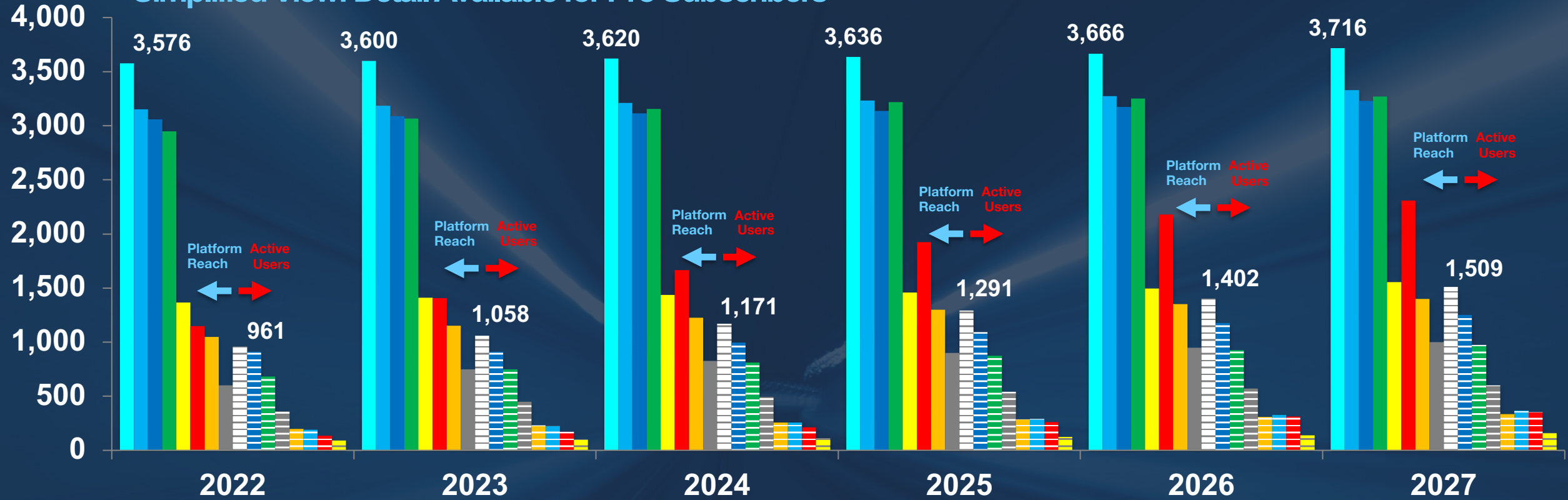
***“This ubiquity is not only a pathway to scale, but a stepping stone: mobile AR acclimates the world so that AR glasses can hit the ground running.”***

# Mobile AR Global Penetration

Millions  
of Units

AR-Compatible Devices & Active Users, Across Platforms\*

Simplified View: Detail Available for Pro Subscribers



\*Excludes platforms endemic to China.  
\*\*Includes iPad  
\*\*\*Google, Pinterest & Snap (de-duped)  
\*\*\*\* Includes Facebook & Instagram

- Smartphones (of any type)
- Web AR (Devices)
- Visual Search (Devices)\*\*\*
- Meta AR (Devices)\*\*\*\*
- ARkit (Devices)\*\*
- ARCore (Devices)
- TikTok (Devices)
- Snap Lenses (Devices)
- Total AR Active (de-duped)
- Visual Search (Active)\*\*\*
- Meta AR (Active)\*\*\*\*
- Snap Lenses (Active)
- TikTok AR (Active)
- Web AR (Active)
- ARCore (Active)\*
- ARkit (Active)\*\*





# Building Blocks

## Depth and Breadth

Mobile AR doesn't just tap into sheer scale but a wide variety of platforms. In other words, it's not just about the volume of AR-ready smartphones but the creation and delivery channels to reach all those devices.

To name a few, there are native app development kits for iOS (ARKit) and Android (ARCore). These SDKs have democratized and scaled AR app creation to trusted and ubiquitous mobile operating systems.

## Naming Names

Apps like Instagram and Snapchat have meanwhile gained traction for AR lenses that enhance multimedia sharing. They've correspondingly built free developer platforms to boost lens creation and engagement.

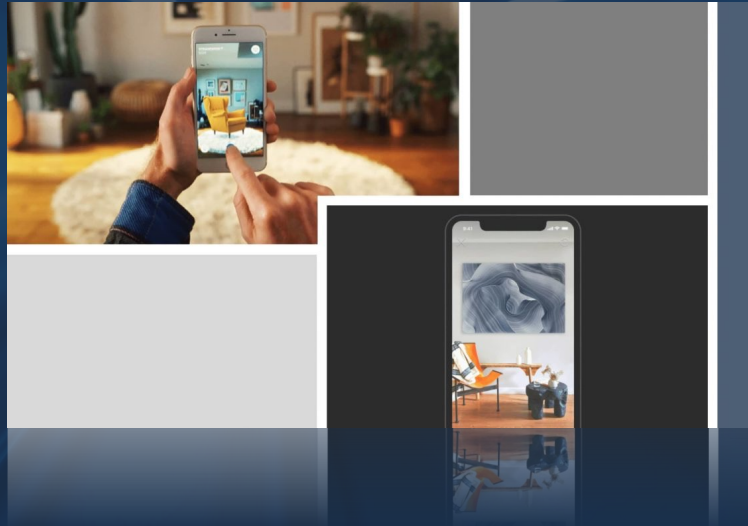
Then there's web AR\*, including developer platforms like 8th Wall and Zappar. Web AR operates within the mobile browser, and its advantages include less friction to launch AR experiences (no downloads), and amplified reach (mobile browser ubiquity).

Software is also developing from Niantic's Lightship, and enterprise-gearred platforms such as Microsoft

Mesh and PTC Vuforia. We also see innovators elsewhere in the tech stack launching AR developer platforms. For example, Qualcomm's Spaces SDK lets developers build a range of AR experiences.

By doing so, Qualcomm has doubled down on its position as the gold standard in chips that power AR and VR devices. With a developer platform, it can now also realize the business and technological advantages of vertical integration. This enables it to develop tighter integration of software & silicon. And like many of the above platforms, it will be a worthwhile AR accelerant and enabler to watch.

Image Source: IKEA, Saatchi Art



***“Mobile AR doesn’t just tap into sheer scale but variety. It’s not just about the volume of AR-ready smartphones but the delivery channels to reach all those devices.”***

# Immersive Marketing

## Branded Experiences

In addition to enabling tech and AR creation tools, some of the players noted previously are beginning to establish and standardize AR revenue models. For example, one of the most popular forms of consumer AR so far has been AR lenses that are distributed through social channels like Snapchat and Instagram.

These lenses lend themselves to brand sponsorship and paid distribution – a business model propelled by several factors. Not only is advertising the primary business model of the above social players, but AR lenses are naturally conducive to branded experiences.

## Faces & Spaces

For example, branded AR lenses in channels like Instagram and Snapchat let consumers visualize products on “faces & spaces.” This involves paid distribution through these apps’ content discovery mechanisms and social graphs. Beyond paid amplification, brands can also self-distribute AR marketing experiences through their own apps.

In total, AR marketing represents one of the leading AR revenue sub-sectors today, with spending estimated to reach **\$4.73 billion** in 2023 according to ARtillery Intelligence’s [Global Mobile AR Forecast](#) (login required). Consisting of experience creation software, paid ad placement, and agency services, this total is projected to grow to **\$14.5 billion** by 2027.

Image Source: Amazon



***“AR marketing represents one of the leading revenue sub-sectors today, with spending estimated to reach \$4.73 billion in 2023 and \$14.5 billion by 2027.”***

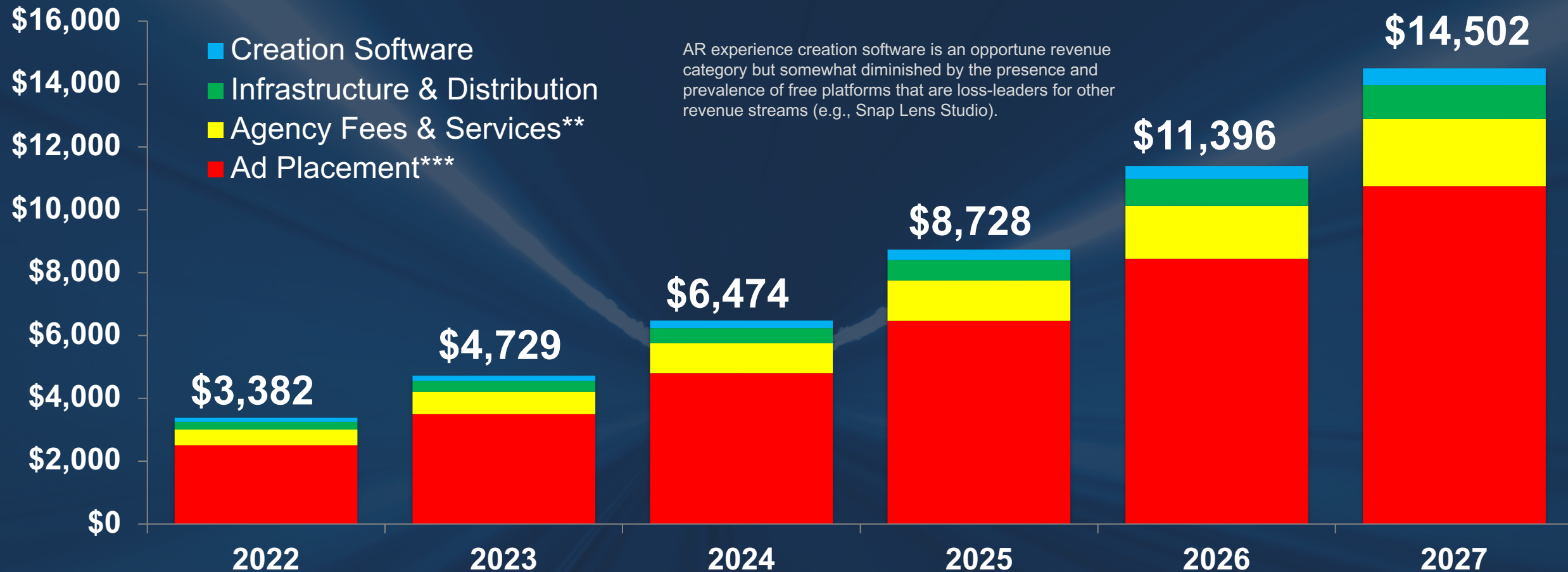


# Mobile AR Marketing Spend

Estimated spending on AR Brand Marketing\*

U.S. \$Millions

Simplified View: Detail Available for Pro Subscribers



# Shoppable & Transactional

## Follow the Eyeballs

So what's driving all that AR marketing revenue? First, users are demonstrating high engagement with AR lenses to enhance already-popular activities including media-sharing and enhanced selfies. Second, advertisers are attracted to those eyeballs.

More specific to AR's advantages, advertisers are drawn to its ability to let them flex creative muscles and transcend 2D media where they've been confined for years. There's also a strong business case shown in ongoing [campaign performance metrics](#).

## The Camera Company

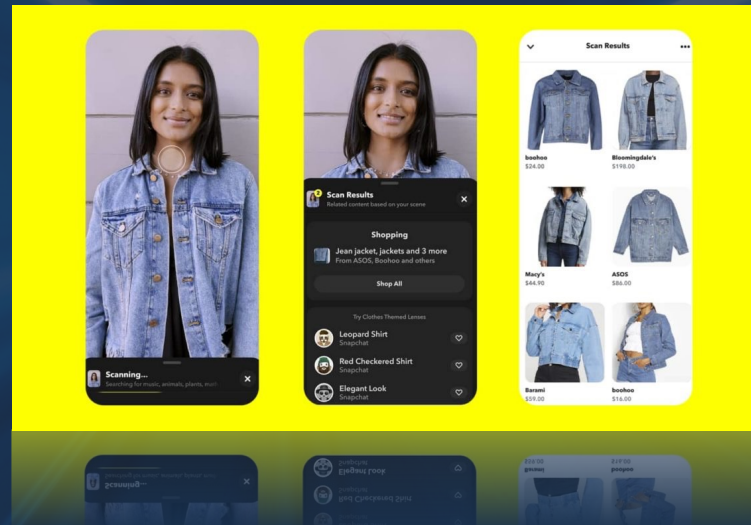
As for who's doing what to tap into that advertiser demand, Snap is a clear leader\*, due mostly to its dedicated focus on AR, and alignment with its "camera-company" mission. Meta also looms large with greater global scale through Facebook and Instagram.

One reason that AR finds fertile ground with these apps is because they've cultivated shopping use

cases. For example, Instagram has become a go-to place for product discovery. And as it increasingly becomes shoppable and transactional, AR can add value through product visualization and try-ons.

Meanwhile, joining the mix is mobile AR's wild card: TikTok. Its global scale makes its AR efforts consequential, including its new developer tool, Effect House. Though early, it could be formative in new use cases that align with TikTok's co-creation culture (e.g., Duets). This will be a factor to watch closely.

Image Source: Snap



***“Joining the mix is mobile AR’s wild card: TikTok. Its global scale makes its AR efforts consequential, including its new developer tool, Effect House.”***



# Visual Search



## Search What You See

Beyond social lenses, a greater opportunity exists with visual search.\* It lets users point their phones at objects to identify them through informational overlays. This carries strong intent signaling – the same factor that makes web search so lucrative.

Google calls this “search what you see.” It brings the on-demand utility of web search and puts a visual spin on it. In that way, visual search inherits the value of web search, while finding unique and native value that flows from its visual and proximity-based use case.

For example, use cases showing early promise include shopping, education, and local discovery. Users can discover new restaurants through their phone’s camera, which can be more natural than typing or tapping text into Google Maps.

## Killer App Ingredients

For all these potential use cases, common attributes include broad appeal and high frequency... again, just like web search. These factors give visual search a large addressable market in quantity of users and volume of usage – both ingredients for killer apps.

These use cases have another common attribute: shopping. The endgame is monetizable visual searches for shoppable items. Actively holding up one’s phone to identify real-world items flows naturally into transactional outcomes or brand marketing.

Amplifying these benefits is another big factor: generation Z. It has a high affinity for the camera as a way to interface with the world. And this will only grow

as gen Z collectively gains purchasing power and phases into the adult consumer population. This makes visual search a strong future-proofing move.

***“Visual search lets users point their phones at objects to identify them. This carries strong intent signaling – the same factor that makes web search so lucrative.”***



# The Knowledge Graph



## Highly Motivated

Speaking of future proofing, Google is primed for visual search. Its knowledge graph – built from 20+ years as the world’s search engine – engenders a training set for AI image recognition, including products (Google Shopping) general interest (Google Images), and storefronts (Street View).

Google is also highly motivated to lead the way in visual search. Along with voice search, it helps the company boost query volume, which correlates to revenue. That motivation translates to investment, which will accelerate visual search development.

## Not Alone

But Google isn’t alone. Pinterest Lens and Snap Scan are keen on visual search. And each player’s approach traces back to its core products and company goals. To that end, Google will work toward “all the world’s information,” while Pinterest works with food & style, and Snap prioritizes fun & fashion.

As these players drive things forward, ARtillery Intelligence projects that visual search will grow from **\$119 million** in 2022 to **\$5.96 billion** in 2027. Though it’s under monetized today, it will grow to a leading share of mobile AR ad revenue by 2027.

Why is it under-monetized? It’s not as established as other AR ad formats such as social lenses. Visual search players are still experimenting with the right UX design and consumer traction before they flip the monetization switch. But it’s well on its way, as Google alone sees 10 billion visual searches per month.



***“Google’s knowledge graph engenders a training set for AI image recognition, including products, general interest, and local storefronts.”***



# Visual Search Breakdown

U.S. \$Millions

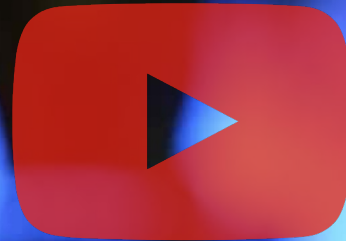
Visual Search Estimated Ad Placement\*, by Network

Simplified View: Detail Available for Pro Subscribers



# Video Companion

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## ARtillery Briefs, Episode 65

Mobile AR Revenue Outlook



# Part II

# Headworn AR

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# AR Glasses: The Endgame

## Fully Actualized

Moving from mobile to headworn, though AR glasses haven't arrived en masse, they represent a fully-actualized AR modality that will unlock the technology's true potential.

In fairness, AR glasses have arrived considering enterprise deployments (see next section). There, AR glasses' style crimes aren't the same issue as they are in consumer markets. Though there are form-factor issues such as comfort and heat in industrial settings, enterprise AR has the early lead in spending.

Notably, consumer/enterprise spending shares could flip (see figures on the next page) as AR glasses gradually gain style and "wearability." Consumer markets are generally larger than enterprise markets due to population sizes... but enterprise spending often leads in early days of emerging tech.

## By the Numbers

To quantify that, ARtillery Intelligence projects AR glasses spending to grow from **\$2.32 billion** in 2022 to **\$35.27 billion** in 2027. Enterprise spending is **94**

**percent** of that total today, but will retract to **83 percent** by 2027 and continue to decline from there until consumer/enterprise trendlines intersect.

But that sequence could take several years, not just due to requisite technical advancements, but also cultural acceptance. As seen in the Google Glass era, consumer acceptance and comfort for face-worn hardware (with a camera, no less) is a critical gating factor. And this cultural barrier won't be crossed quickly nor easily.

Image Source: Microsoft



***“Though AR glasses haven’t arrived en masse, they represent a fully-actualized AR modality that will unlock the technology’s true potential.”***

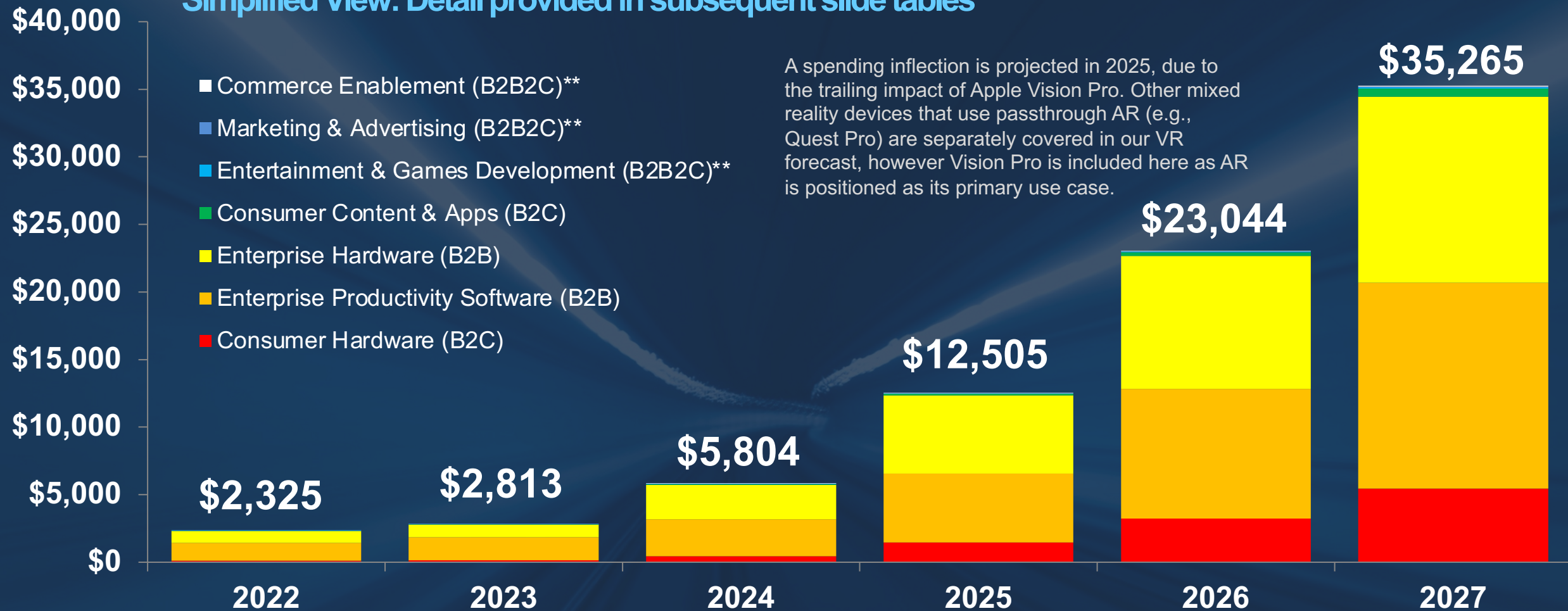


# Headworn AR Revenue Estimates

Consumer & Enterprise AR Glasses Revenues, by Source\*

U.S. \$Millions

Simplified View: Detail provided in subsequent slide tables



# AR, Hard at Work



## Institutional Knowledge

While consumer AR challenges are being worked out, smart glasses have found less resistance in the enterprise. As noted, the technology's style crimes are less of an issue, and AR has clearer ROI and adoption drivers. That includes operational efficiencies that are brought by line-of-sight visualization.

This represents a sort of enterprise metaverse. Led by tools such as PTC Vuforia, Scope AR, and Microsoft Mesh, remote collaboration, and industrial support can be enabled. This will importantly span enterprise verticals and environments – everything from corporate settings to industrial factory floors.

In key functions like industrial assembly and maintenance, AR can expedite task completion and reduce errors by lessening cognitive load from “mentally mapping” 2D instructions to 3D space. There are several macro benefits too, such as distribution and retention of institutional knowledge.

Drilling down on the latter, it's all about mitigating knowledge loss from seasoned personnel retiring. Because baby boomers are retiring at a greater pace, not to mention the Covid-era “great resignation,” it's getting harder to retain institutional knowledge – an expensive problem for industrial enterprises.



***“In key functions like industrial assembly and maintenance, AR can expedite task completion and lessen cognitive load from ‘mentally mapping’ 2D instructions to 3D space.”***



# AR, Hard at Work (cont'd)



## Pilot Purgatory

For all the reasons on the previous page, ARtillery Intelligence has estimated that AR spending on enterprise productivity will grow from **\$6.55 billion** in 2022 to **\$35.86 billion** in 2027, a **40.5 percent** compound annual growth rate. This includes head-worn AR (hardware and software spending) and mobile & tablet-based AR (software spending).

But even though AR boasts these advantages, it's easier said than done to execute. Practical and logistical barriers stand in the way – such as organizational inertia, politics, change management, and fear of new technology among key stakeholders.

For example, the biggest stumbling block for enterprise AR is the dreaded “pilot purgatory.” This is when AR is adopted at the pilot stage but never progresses to full deployment. It's the biggest pain point in industrial AR, and there are many reasons for it...most of them cultural.

An ARtillery Intelligence report in 2022 featured several case studies, including tactics for avoiding

pilot purgatory. An upcoming report will advance the narrative with a fresh batch of case studies that represent the latest challenges and strategies in enterprise AR. These case-study-driven reports will be an annual exercise, currently in Volume 2.



***“Practical and logistical barriers stand in AR’s way – such as organizational inertia, politics, change management, and fear of new technology.”***

# The Comeback Kid

## Second Coming

While sticking with the theme of enterprise AR, one of the most notable events of late has been the return of Magic Leap... this time with an enterprise focus. To maximize its impact, it backed up this pivot with a second swing at AR glasses: Magic Leap 2 (ML2).

The \$3,299 device features upgraded optics and display. The field of view (FOV) is 2x that of ML1, while its architecture achieves 12x more efficient light distribution. It also features 2,000 nits of brightness with 2x image quality and 2-3x color uniformity,

These upgrades broaden the device's use cases, including multiple colleagues collaborating on virtual content from different angles. Physicians can get full-body patient views. And front-line industrial workers can gain a more complete sense of large and complex machinery that they're servicing.

## Common Challenges

As for brightness, 2000 nits is substantial, but not enough to compete with direct sunlight. ML2's signature dimming feature addresses this by

reducing incoming light so that graphics achieve higher contrast – a common issue in AR glasses.

Another common challenge with AR glasses is the vergence accommodation conflict. This happens when wearing AR glasses and your eyes naturally focus on real objects. But virtual objects that aren't rendered at the correct distance appear out of focus.

Magic Leap 1 previously addressed this issue by using two focal planes... but that added to the device's bulk and weight. ML2 conversely starts over with a series of factors including eye tracking with two interior cameras. These translate pupil dilation to accurate image rendering and focal matching.

Image Source: Magic Leap



***“Multiple colleagues can collaborate on virtual content. Physicians can get full-body patient views. And industrial workers can gain a more complete sense of complex machinery.”***



# The Comeback Kid (cont'd)

## Stereo Sound

Beyond visuals, one of ML2's biggest selling points is spatial audio. It simulates spatial positioning so that sounds are perceived at deliberate distances and directions. It achieves this by directing sound waves to each ear in a way that utilizes the human ear's ability to triangulate audio signals... a.k.a. stereo.

For example, something requiring attention to your right sounds like it's coming from that direction. This comes in handy in a variety of enterprise use cases. Virtual meetings can mimic physical spaces like a conference room, with realistic sound fields. And industrial applications can divert users' attention where and when it's needed.

## Market-Share Gains

Coming full circle to Magic Leap's turnaround, ML2 sits at the center. And several other components of that road map influence the device's design. For example, OpenXR and WebXR support – not to mention an Android-based OS – ease adoption barriers for developers.

But another aspect of Magic Leap's positioning falls outside of ML2...or anything deliberate for that matter.

Its resurgence happens as headwinds challenge its chief competitor: Microsoft. The last year has seen some erosion to its enterprise AR dominance.

That involves a few factors including turbulence in its landmark U.S. Army contract, internal disagreement about HoloLens 2's strategic importance, and the high-profile departure of HoloLens creator Alex Kipman. These factors have set Microsoft's AR ambitions back a bit.

Without disparaging Microsoft or piling on the grief, we mention this only to say that the timing is opportune



for a HoloLens 2 competitor. That, plus new leadership with competency in enterprise sales, clears the path for Magic Leap's potential market-share gains. Now it's all about execution.

***“ML2 directs sound waves to each ear in a way that utilizes the human ear’s ability to triangulate audio signals... a.k.a., stereo.”***



# Apple of My Eye

## Halo Effect

Moving on to consumer AR glasses, there's one company that has the potential to jumpstart the market: Apple. Indeed, many AR proponents are banking on this outcome, as it could accelerate the AR market through Apple's signature "halo effect."

Part of this story was finally revealed when Apple launched Vision Pro. But the device should be seen as a first step towards Apple's spatial computing long game. That starts with a VR-like form factor with passthrough AR. But Apple's hope is to evolve towards all-day AR-centric smart glasses.

Apple's motivation here is to vault its core hardware business in the face of a maturing smartphone market. It could accomplish this by both boosting and succeeding the aging iPhone. The former happens as it creates reliance on the iPhone for compute and connectivity. The phone gains importance – and user incentive to upgrade – if it powers your smart glasses.

## Ecosystem Approach

An iPhone succession plan is meanwhile accomplished through a suite of wearables that

replaces the suite of iThings at the center of our computing lives. That could mean line-of-sight graphics through AR glasses, which accompany spatial audio from your AirPods, and biometrics from your Apple Watch.

This theory fits Apple's signature multi-device ecosystem approach. It will emphasize that the whole is greater than the sum of its parts so you should own several devices (sound familiar?). In this way, AR glasses will be a key puzzle piece in Apple's much-vaunted wearables road map. But this evolutionary path from Vision Pro to an all-day AR wearable could take several years.

Image Source: Apple



***“Part of the story was finally revealed when Apple launched Vision Pro. But the device should be seen as a first step towards Apple’s spatial computing long game.”***



# AR Glasses Unit Estimates

Millions of Units

AR Glasses Annual Unit Sales\* by Brand

Simplified View: Detail provided in subsequent slide tables



# Causing a Spectacle

## Head Start

Beyond Apple, there are several players chasing the AR glasses market. But in the interest of time, we'll drill down on one more representative example: Snap Spectacles, which we recently had the chance to test.

Backing up, consumer AR glasses are an elusive species. Prominent players like Microsoft and Magic Leap have pivoted to enterprise, while consumer-grade AR glasses like Nreal Light have been difficult to get until recently. Venerable AR glasses specialists like Vuzix sit somewhere in between.

There's also an emerging and broadly-defined crop of "smart glasses," which could be a sizable category in the long term. These are defined by smart features like cameras and speakers, a la Ray-Ban Stories, but don't have optical systems to display visual content.

Snap Spectacles occupied this smart-glasses territory for several generations until its latest version launched with full-blown AR capabilities. But there's one drawback: they're not for sale. Instead, they're meant for Snap lens creators to gain creative footing. Snap wants to get a head start on that process.

## Design Tradeoffs

Upon unboxing, Spectacles' most striking quality is its build quality. The glasses feel solid and sturdy but aren't onerously heavy at 134 grams – a key attribute for anything face-worn. Spring-loaded arms adjust to head size while buttons and touch panels are intuitive.

True to Snap's persona, the glasses are also halfway stylish. This is notable, given design tradeoffs endemic to AR glasses. Every UX enhancement carries a cost, usually heat and bulk – neither of which are onerous with Spectacles. They output 2000 nits of brightness.



So where's the tradeoff? The battery life is low at 30 minutes. But again, this device is purpose-built for developers. When it makes its way to consumer markets, battery life will presumably be addressed.

***"Snap Spectacles occupied this smart-glasses territory for several generations until its latest version launched with full-blown AR capabilities."***



# Causing a Spectacle (cont'd)

## Wild Card

As for Spectacles' potential use cases, they're seen in lens creators' work so far. A solar system lens signals the potential for education by letting you walk around orbital bodies with anchored and positionally-tracked graphics, care of Snap's Spatial Engine.

Another opportune category is meditative lenses, such as "Metascapes" and "The Door." For the latter, animations direct hand gestures that unlock calming sequences – demonstrating the Spatial Engine's hand-tracking capability.

Beyond lenses, Spectacles' killer app may be its Scan feature. Already prominent in Snapchat's mobile app, it lets you tap a physical button on the device's frame to activate. It identified simple objects in our tests, including bushes, trees, and benches.

In fact, visual search could be a killer app, as explored earlier, especially in its transition from handheld to headworn. Identifying objects is both practical and monetizable, including making the world sharable and shoppable. This could be AR's wild card.

## World Facing

That same evolution is apparent in Snapchat's mobile AR expansion from front-facing lenses (selfies) to rear-facing lenses to augment the broader canvas of the physical world. These developments are all related because with AR glasses, *all* lenses are world-facing.

The payoff could be sizable given a wider range of use cases in that broader canvas. This fuels Snap's growth as a business, as the addressable market of sponsored lenses extends from face fodder to things that fit in the physical world –from cars to couches.

Image Source: Snap



Back to the hardware, though Spectacles are developer-first, they foreshadow the design of an eventual consumer model. If that's the case, Spectacles' future – just like its optics – is bright.

***“Identifying objects through AR glasses is both practical and monetizable, including making the world sharable and shoppable.”***



*shoppable,”  
sharable and  
making the world*

# The Spatial Stack

## Purpose-Built

Beyond AR hardware, there's an entire tech stack forming. Like other computing categories, AR glasses need hardware, software, silicon, and all points between. In fact, the need for integrated systems is even greater, given AR's technical complexity.

One company that's integral to this stack is Qualcomm. Mentioned earlier for its work with the Snapdragon Spaces developer platform, it's also a key accelerant in AR glasses and VR headsets. Its XR2 chip powers many of the top headsets in both classes.

In the AR glasses realm specifically, Qualcomm recently raised the stakes by launching a dedicated chipset. The Snapdragon AR2 is purpose-built for AR glasses. It does this through distributed processing so that AR glasses can share the load with a proximate host (smartphone or computing puck).

## Heavy Lifting

The result is that glasses can handle positional tracking and computer vision, while the host device does the heavy lifting for running apps and graphics

processing (GPU). This not only spreads things out but lets each piece of hardware play to its strengths.

Split processing also alleviates a key challenge: AR glasses design is a game of tradeoffs between UX and wearability. With a host device, AR glasses can shed heat and bulk. After all, they're worn on your face.

Beyond AR2's merits and specifications, it signals a key moment for AR. Among other things, it represents Qualcomm's confidence that the category will be large enough to support its own purpose-built processors. And it's putting its money where its mouth is.

Image Source: Qualcomm



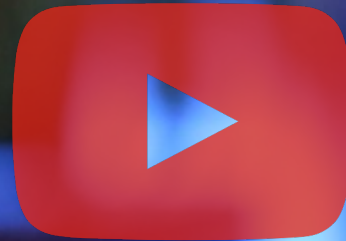
***“The AR2 chip represents Qualcomm’s confidence that AR will be large enough to support its own purpose-built processors. And it’s putting its money where its mouth is.”***



# Video Companion

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 ARtillery  
Intelligence



**ARtillery Briefs, Episode 64**

Headworn AR Revenue Outlook

# Part III

# VR

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# Spatial Cousin

## Slow & Steady

This report so far has focused mostly on AR. But what about its spatial cousin, VR? The short version is that it's a promising technology in entertainment, gaming, and some enterprise functions. But mainstream consumer traction continues to be challenged.

We estimated in our global VR forecast\* that revenue will grow from **\$8.3 billion** in 2021 to **\$28.8 billion** in 2026, a **28.29 percent** CAGR. It includes consumer spending (**\$9.81 billion** in 2023) and enterprise spending (**\$5.99 billion** in 2023).

Consumer spending is driven by gaming's lead as a VR use case. VR conversely has valuable but relatively-narrow use in enterprise settings due to its degree of sensory immersion that compromises factors like safety, social presence, and ergonomics. But VR does certainly show promise as an immersive training and design collaboration tool.

## Network Effect

In all cases, VR's biggest accelerant is Meta's ongoing investments. Though its flagship Quest 2 saw a price

increase in 2022, it remains competitive at sub-\$500 levels. This is a central piece in Meta's longer-term strategy to reach network effect in VR by gaining early market share through loss-leader pricing.

But it's not just about Meta. As we'll examine later in this section, other notable players include Valve Index in PC VR, PSVR 2 in console VR, and Pico 4 in standalone VR.

Image Source: HTC

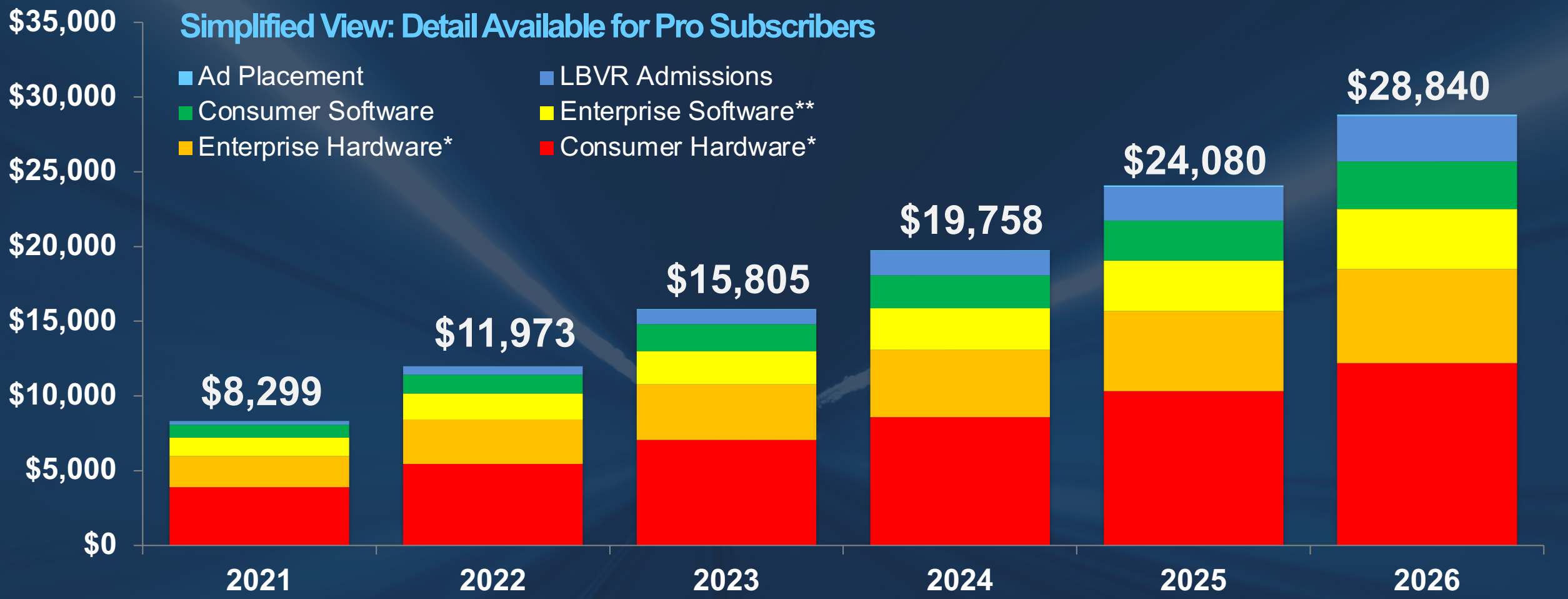


***“Quest headsets are a central piece in Meta’s longer-term strategy to reach network effect in VR by gaining early market share through loss-leader pricing.”***

# Global VR Revenue Overview

U.S. \$Millions

Consumer & Enterprise VR Revenue Estimates, by Category\*



\*Includes Tier-1 console and PC VR (e.g., PSVR), Tier-2 standalone VR (e.g., Meta Quest) and Tier-3 personal entertainment devices (e.g., VIVE Flow).  
\*\*Includes B2B2C, such as software licenses for LBVR facilities and developer tools for VR experience creation.



## The Magic Number

Going deeper into Meta, one of its central goals is to reach 10 million in-market VR units. This is the magic number where there's critical mass to attract content developers en masse. The thought is that an eight-figure installed base presents financial incentive for developers to catalyze an ecosystem.

In other words, as those financially-motivated developers flock to a given platform like osmosis, it results in greater content libraries that attract more users, which in turn attract more developers. It's a classic flywheel effect. Or as Mark Zuckerberg has stated:

*The big question is what is it going to take for it to be profitable for all developers to build these large efforts for VR? To get to that level, we think that we need about 10 million people on a given platform. That's the threshold where the number of people using and buying VR content makes it sustainable and profitable for all kinds of developers. And once we get across this threshold, we think that the content and the ecosystem are just going to explode.*

*Importantly, this threshold isn't 10 million people across all different types of VR. Because if you build a game for Rift, it doesn't necessarily work on Go or PlayStation VR. So we need 10 million people on [one] platform.*

Keep in mind that this defines the installed base of in-market units, which is different than period unit sales. So when will Meta reach 10 million? It already has... According to March 2023 reporting by the Verge, using leaked internal communications, Meta has sold 20 million Quest headsets in the device's lifetime.

Image Source: Meta

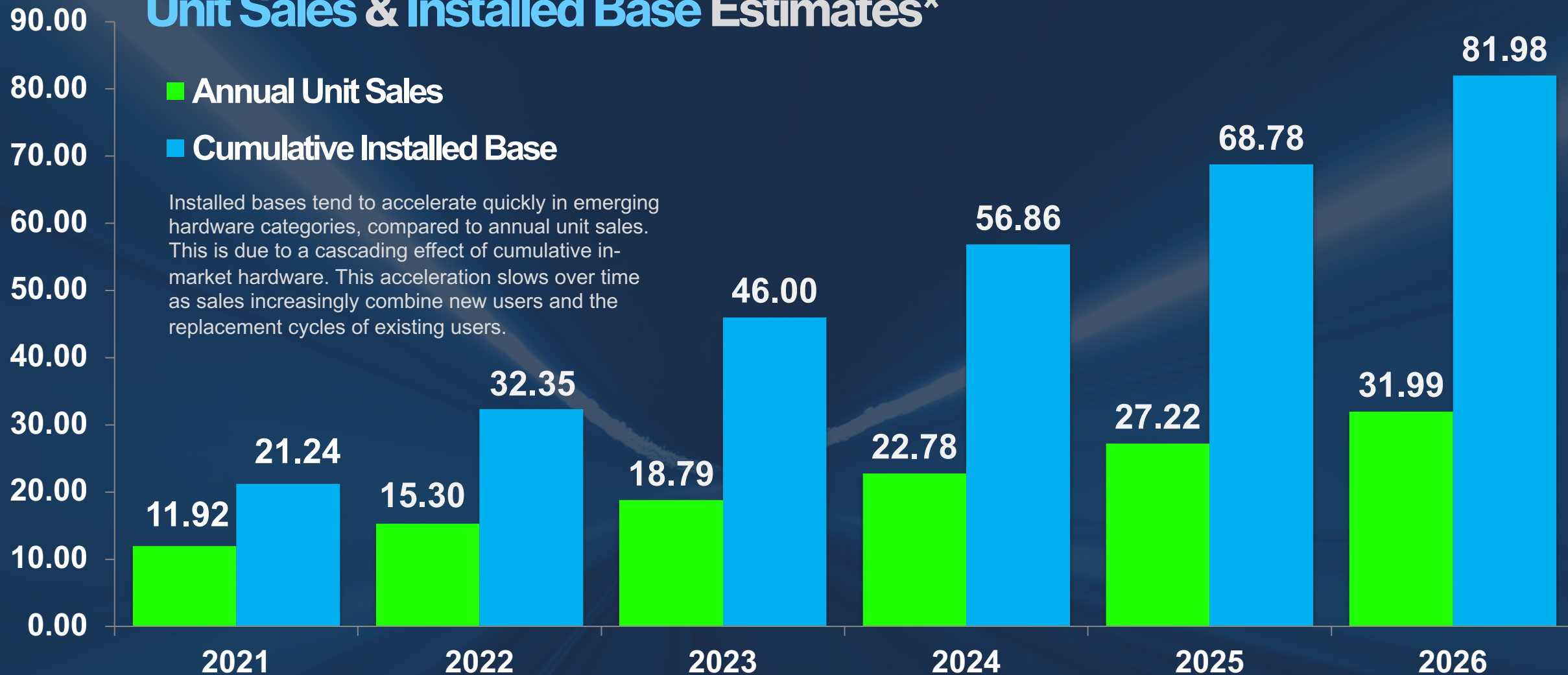


***“As financially-motivated developers flock to a platform, it results in greater content libraries that attract more users, which in turn attract more developers – a classic flywheel effect.”***

# VR Hardware Penetration

Millions of Units

## Unit Sales & Installed Base Estimates\*





## Pushing Limits

Sticking with Meta – as it continues to drive and steer the course of the VR market – it diversified its hardware line in 2022 with the launch of Quest Pro. Cousin to the flagship Quest 2, it pushes the limits of VR. Moreover, its passthrough AR capabilities represent a bridge toward Meta's larger AR ambitions.

Before getting into broader implications, the Quest Pro has an 1800 × 1920 per-eye LCD display. It employs the Qualcomm XR2+ chip, 72h and 90hz frame rates, 12 gigabytes of ram, 256 gigabytes of storage, color passthrough cameras, and a 1-2 hour battery.

One of the most noticeable things about the device is its comfort. Though it's heavier than Quest 2, it has smarter weight distribution, including a Hololens 2-like rear counterbalance. Pancake lenses also reduce the device's front profile by 40 percent versus Quest 2's front-heavy Fresnel lenses.

## Double Duty

Another standout feature is Quest Pro's controllers. It ditched Quest 2's outside-in tracking system which fell

apart when controllers drifted behind one's back or out of view of the headset's front cameras. They now have outside-in tracking for autonomous movement.

The controllers also have precise haptic engines, which come in handy for target enterprise use cases. These include things like training, collaborative design, or productivity. The latter utilizes the controllers' double duty as a stylus when flipped around.

Speaking of tracking, face tracking is a big selling point for Quest Pro. Inward-facing cameras track facial movement to render expressions – a key component of social interaction, and a missing VR puzzle piece.

Image Source: Meta



***“Cousin to the flagship Quest 2, Quest Pro pushes the limits of VR. Moreover, its passthrough AR capabilities represent a bridge toward Meta's larger AR ambitions.”***

# Going Pro (cont'd)

## Feature Parity

Zeroing in on social expression, it's a priority for Meta, as one of its biggest VR endpoints is to simulate real-life human interaction in VR. That includes remote collaboration and productivity, which for now are the biggest target use cases for Quest Pro.

But there's one issue... face tracking is only valuable if everyone (or at least two people interacting in VR) has it. This raises the issue of feature parity, which is challenged if Quest Pro falls short of network effect – a likely near-term outcome given the price point.

But that's not to say that advanced face tracking isn't strategically sound. Meta is testing the waters at the high end of its device spectrum and will likely migrate this and other features down-market in future generations. In other words, we could see face tracking in the Quest 3, when and if it launches.

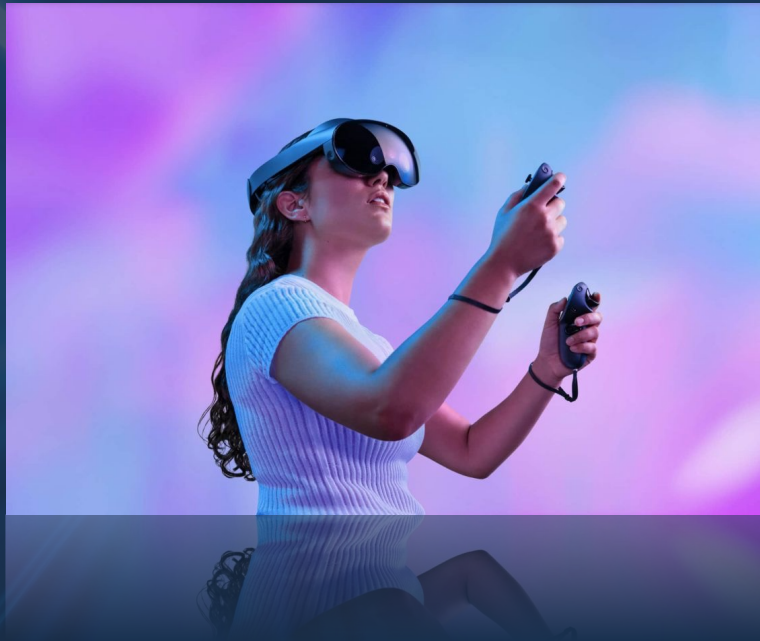
## Color, Contrast & Control

Saving the biggest update for last, Quest Pro's color passthrough cameras enable mixed reality. Cameras

render the world beyond the headset in greater definition and scale so that users can operate in their surroundings while interacting with digital elements.

This brings Quest Pro into AR territory. Indeed, one flavor of head-worn AR is passthrough camera-based, versus optical waveguides that project graphics on see-through lenses. Passthrough AR has a few advantages including color, contrast, and control.

Image Source: Meta



***“Meta is testing the waters at the high end of its device spectrum, and will likely migrate face tracking and other features down-market to all device tiers in future generations.”***



# Going Pro (cont'd)

## Continuous and Natural

Sticking with passthrough AR, one downside is device bulk, given that it requires more of a VR form factor. Counteracting this was a core design target for Quest Pro, which can be seen in its ergonomics, as well as its framework that prioritizes peripheral vision.

Though it has slip-in side blinders for more contained VR experiences, the default is to see one's periphery. This is so users' passthrough field of view ends where their peripheral vision begins, thus achieving a continuous and natural view of one's surroundings.

These unobstructed views are where the "Pro" in Quest Pro comes in. Again, it's targeting productivity use cases that require you to move around and grab things as needed. That could be picking up a controller/stylus, or grabbing records if you're a DJ.

## Bridge to AR

Altogether this lands Quest Pro between Quest 2 and Hololens 2. This is a mixed reality proposition mostly seen in higher-end devices like Varjo's XR-3. And though it doesn't match Varjo's graphics and processing, Quest Pro's price tag is about \$5000 less.

Similarly, Quest Pro's passthrough capabilities make it more competitive with Magic Leap 2 and Hololens 2 than any VR device. And it's less than half the price of those units. This means Meta has once again disrupted an XR segment by undercutting it in a big way. But not to be outdone, HTC VIVE Elite subsequently undercut Quest Pro.

But the larger point is that Quest Pro is a bridge to AR. Meta's spatial computing ambitions span AR and VR, but most of its focus has been on the latter. It's separately building AR glasses with Essilor Luxottica, but Quest Pro represents another track. It will attack the spatial spectrum from many angles.

Image Source: Meta



***“Quest Pro’s passthrough field of view ends where users’ peripheral vision begins, thus achieving a continuous and natural view of one’s surroundings.”***

# The Competitive Field

## Deep Pockets

Though this section has focused on Meta, as its investments accelerate and define the VR landscape, there are other notable players. They include Valve Index in PC VR and PSVR 2 in console-based VR.

Elsewhere in the competitive field is Pico, including the Pico 4 and Pico Pro. Zeroing in on the former, the standalone VR device could challenge Quest 2 with a competitive spec sheet and price tag.

To that end, Pico could share Meta's ability to lower hardware costs given its deep-pocketed owner, ByteDance. In fact, ByteDance is a social media giant using ad revenue to invest in VR. If this sounds familiar, it's because it's Meta's VR playbook.

## Organizational Priority

What this all means is that a Meta v. Pico rivalry will be one to watch. That said, Meta holds three key advantages. The first is its organizational priority and billions in spending on VR. Second is its technical acumen that flows from the R&D at Meta Reality Labs. And third is its head start in the content ecosystem.

Indeed, one of the things that makes or breaks a given VR headset is content availability on a given platform. Meta continues to invest in content by attracting developers through a larger headset base – part of its reason for the loss-leader pricing examined earlier.

And Meta continues to invest in content by acquiring VR game publishers. That not only fuels content creation through cash infusions but incentivizes content creators to enter the market (and venture funding to fuel them) through validated exit potential. Put another way, as with most other forms of media and tech, content is king.



Image Source: Pico

***“Pico’s owner ByteDance is a social media giant using ad revenue to invest in VR. If this sounds familiar, it’s because it’s Meta’s VR playbook.”***



# Video Companion

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## ARtillery Briefs, Episode 67

VR Revenue Outlook

# Part IV

# The Metaverse

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# The M-Word

## Co-opted and Conflated

The topic of VR in the previous section is a bridge to our next chapter: The metaverse. If there's one term that's reverberated throughout AR and VR circles more than any other in the past two years, it's the m-word. Though it represents legitimate principles, the term has become co-opted and conflated through overuse... as it often goes with tech buzzwords.

Stepping back, what is the metaverse? We're hesitant to define something that's so early and abstract, but there's some consensus among leading thinkers about what it someday could be. And there are examples today of *metaverse-like* experiences.

Starting at a high level, the metaverse could have two tracks. One involves purely virtual and immersive experiences, often accessed through VR. The second involves digital interaction with the physical world, accessed through AR. Let's examine each of these...

## Digital Domains

Starting with the first track, the metaverse broadly involves digital domains that host time-synchronous interaction between place-shifted participants. Mark

Zuckerberg calls it an "embodied internet," offering the web's connected experiences, but fleshed out in 3D.

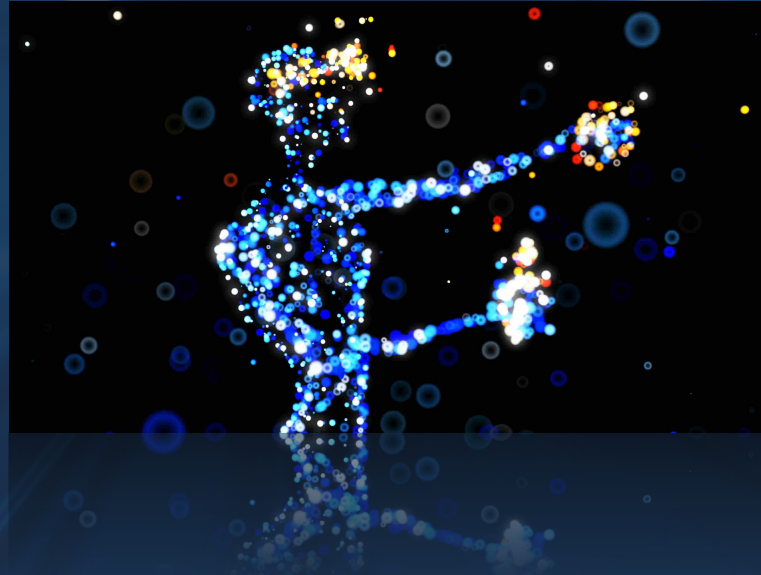
One way this happens is through interactions with far-flung friends, represented by avatars. These experiences are often discussed in VR terms. And today's examples of metaverse-like experiences include Rec Room, and VRChat. We also have non-VR worlds like Fortnite, Roblox, and Second Life.

Within this track, there's some agreement about what the metaverse should and shouldn't be. For example,

it should be interoperable in that users can transport from place to place with consistent identities. It should also be open and not owned or operated by one entity.

***“Though it represents legitimate principles, the m-word has become co-opted and conflated through overuse... as it often goes with tech buzzwords.”***

Image Source: Julien Tromeur on Unsplash



# The M-Word (cont'd)

## Invest and Innovate

These metaverse guidelines make it start to sound like today's web. And indeed, that should be the model. The web offers balance between proprietary business interest (incentive to invest and innovate), and common standards of interoperability. The latter include protocols (HTTPS) and languages (HTML).

"We already have a metaverse... it's called the Internet," MetaVRse founder & CEO Alan Smithson quipped during an ARtillery-moderated panel at the VR/AR Global Summit.

Though tongue-in-cheek, Smithson's comments carry key insights about metaverse, and the conceptual model that underpins it. Though the term isn't new, it will take on new forms of networked presence that build incrementally on the internet that we know today.

## The Metavearth

As for the second metaverse track – that which synchronizes with the physical world – this is all about geo-anchored data that signals AR devices to evoke

digital content where and when it's relevant. After all, the Greek root meta translates to "beyond." AR can activate content and information that goes *beyond* the physical manifestations of real-world objects.

Several companies are already building this. For example, Google created immense value indexing the web over the past 20 years. It now wants to bring that principle to the physical world. This is what we call the "Internet of places," or the "Metavearth," and Google is well-positioned to build it, given its knowledge graph.

Meanwhile, Niantic is making moves to build a "real-world metaverse." Its Lightship platform takes the

architecture and learnings of Pokémon Go and bakes them into an AR development kit (ARDK). This will accelerate innovation around geospatial AR.

***"After all, the Greek root meta translates to "beyond." AR can activate content and information that goes beyond the physical manifestations of real-world objects."***

Image Source: Esri





# Why Now?

## Stimulated Voraciously

With both metaverse tracks just outlined, the question is *why now*? Though a fully actualized metaverse is years or even decades away, the question remains why interest in this concept has lately been stimulated so voraciously. Beyond Meta's well-exposed investments, a few macro factors can be attributed.

These factors have been outlined by leading metaverse thinker, Matthew Ball. Among other things, he manages the Ball Roundhill Metaverse ETF, an exchange-traded fund of metaverse-related companies. It has reached as high as \$300 million in assets under management.

Addressing the question of timing, Ball acknowledges that the conceptual underpinnings of the metaverse aren't new, but a few impactful factors are now in effect. Specifically, he points to four phenomena:

**1. Network Effect:** Concurrent players in online games went from 8-12 people in *Call of Duty* or *Mario Kart* to hundreds in battle royale competitions like *Fortnite*. The latter also hosted virtual concerts attended by millions

**2. Virtual Economies:** Digital content grew from a \$5 billion to a \$50 billion market in 2020. This includes in-app and in-game purchases like skins, tools, weapons, and apparel. Demand and user comfort levels for paying real dollars for virtual goods is now a thing.

**3. Virtual Currency:** NFTs and cryptocurrency create an economic framework to standardize the value of digital goods. They also engender peer-to-peer economies, as opposed to centralized digital sales from a game publisher.

**4. The Covid Effect:** Covid de-stigmatized spending time in virtual worlds. This behavior was disparaged by pre-Covid mainstream culture but has become more accepted and commonplace, including remote work.

Beyond timing, it's also about money. The metaverse has deep-pocketed benefactors that could accelerate its development. These include Epic Games, Nvidia, Niantic, and of course, Meta. But the construction of the metaverse will be a decades-long process, starting with the work being done today in AR.

***“Though a fully actualized metaverse is years or even decades away, the question remains why interest in this concept has lately been stimulated so voraciously.”***

# The Metavearth Materializes

## Foundational Principle

Going deeper into the concept of a “real-world metaverse,” this is one of the two metaverse “tracks” we outlined earlier. As noted, it involves geo-anchored data that enables AR devices to evoke relevant digital content. It’s also what we call the metavearth.

As background for the metavearth, one of AR’s foundational principles is to fuse the digital and physical worlds. By definition, the real world is a key part of that formula....and real-world relevance is often defined by location. For example, that same relevance and scarcity are what drive real estate value.

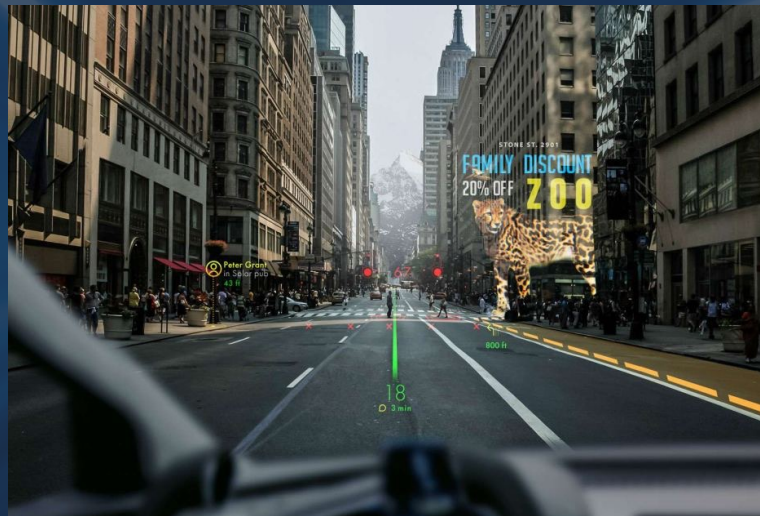
To that end, one of AR’s battlegrounds will be in augmenting the world in location-relevant ways. That could be wayfinding with Google Live View, or visual search with Google Lens. It’s about pointing your phone (or future glasses) at places and things to identify and contextualize them, as examined earlier.

As you can tell from these examples, Google will have a key stake in this Internet of places. It’s driven to future proof its core search business, given gen-Z’s

affinity for the camera. Also seen in Snap Scan, visual content joins text and voice as a search input.

And Google is well-positioned, given existing assets. For example, it utilizes imagery from Street View as a visual database for object recognition so that AR devices can localize themselves and know what they’re looking at. That forms the basis for its storefront recognition in Google Lens and urban navigation in Live View. These are just the beginning.

Image Source: WayRay



***“One of AR’s battlegrounds will be to augment the world in location-relevant ways. It’s all about pointing your phone (or future glasses) at places and things to contextualize them.”***

***them.”  
contextualize***



# The Metavearth Materializes (cont'd)



## Turf Battle

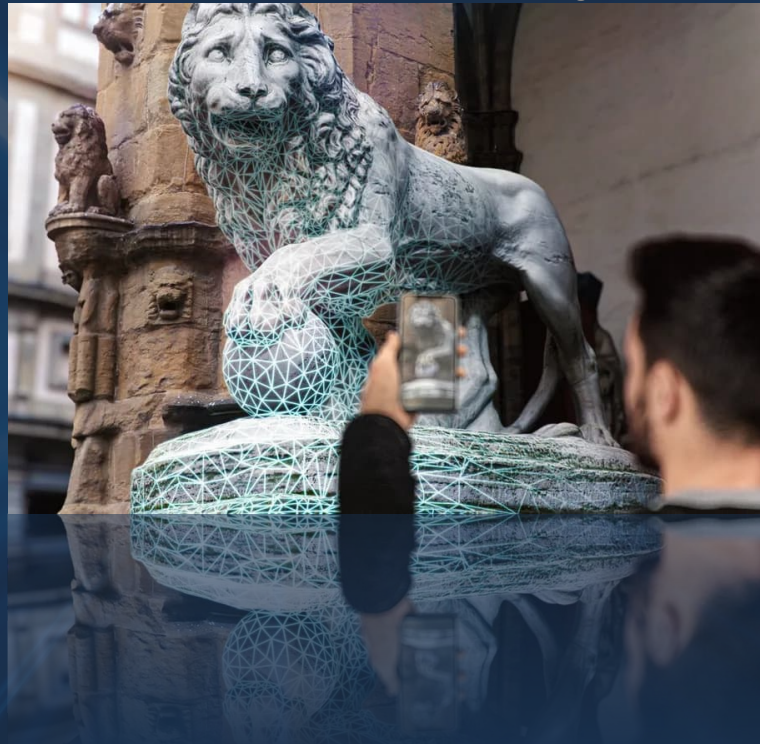
But Google isn't alone. Apple signals interest in location-relevant AR through its geo-anchors. These evoke AR's location-based underpinnings by letting users plant and discover spatially-anchored graphics. And Niantic's Lightship platform aims to provide a framework for developers to build real-world metaverse apps, as noted earlier.

Meanwhile, Meta is building "Live Maps." As explained by Meta Reality Labs' chief scientist Michael Abrash, this involves building indexes (geometry) and ontologies (meaning) of the physical world. This will be the data backbone for Meta's AR ambitions.

Then there's Snapchat, the reigning champion of consumer AR. Erstwhile propelled by selfie lenses, Snap's larger AR ambitions will flip the focus to the rear-facing camera to augment the broader canvas of the physical world. This is the thinking behind its Local Lenses and Landmarkers, among other things.

Beyond tech giants, several startups are filling in the gaps for the metavearth. These include Darabase, Resonaii, YouAR, Gowalla, Foursquare, 6D.ai (acquired by Niantic) Scape Technologies (acquired by Meta), and ARWay (acquired by NexTech). This competitive field will continue to expand and evolve as the metavearth opportunity itself does.

Image Source: Niantic



***“Meta’s Live Maps involve building indexes (geometry) and ontologies (meaning) of the physical world. This will be the data backbone for its geo-local AR ambitions.”***



# Enter Lightship

## Visual Positioning System

To further illustrate the real-world metaverse, we'll drill down on one of the above examples: Niantic's Lightship. In short, it lets developers build Pokémon Go-like geospatial experiences. The idea is to package up Niantic's architecture and spatial mapping capabilities into a developer kit.

Specifically, the AR development kit (ARDK) builds on the concept of a visual positioning system. Rather than GPS satellite data, it uses visual signals in the world around us to localize a given device. Once that device knows where it is and what it's looking at, it can infuse relevant and intended digital content.

## Planet-Scale AR

Niantic isn't the only one developing this principle. Google's Live View 3D navigation localizes devices using Street View imagery as noted in the previous section. Object recognition from its Street View database can inform a device where it is, what direction it's pointing, and what it's looking at.

That gives Google a meaningful edge in developing VPS-based navigation. So how will Niantic gain that level of visual data in its VPS system? The answer is its players. For a few years, it's been crowdsourcing the development of spatial maps as Pokémon Go players wander the earth to play the game.

With Lightship, it hopes to scale up these efforts and gain more comprehensive spatial maps through several apps. This works toward what Niantic calls "planet-scale AR." And it's well on its way, given tens of thousands of VPS-activated locations globally, each with centimeter-level precision.

All these efforts are amplified by the fact that Niantic reduces AR "activation energy." With its 8th Wall

acquisition, it brings all the above to easier-to-launch web AR. That could engender greater participation, thus scaling up its ongoing spatial map construction.

***"How will Niantic gain Google-like geo data? The answer is its players. It can collect spatial mapping data, as Pokémon Go players wander the earth to play the game."***

Image Source: Niantic





# Captions for the Physical World

## Qualities of Killer Apps

One question that remains is what will be the killer apps of the real-world metaverse? To answer that requires looking at the qualities of killer apps. Often, they're utilities that have wide-scale applicability, inherently-frequent usage, and large addressable markets. One possibility that checks these boxes is what we call captions for the physical world.

Taking that term broadly, it includes everything from business information about storefronts, to calories in a menu selection, to where to buy a jacket you just saw on the street. And that all traces back to visual search as an AR killer app, as we examined earlier.

## Knowledge Layer

And Google could be the right company to deliver it. Google Translate provides the translation layer, while Google Lens taps into Google's image AI and knowledge graph. And as examined earlier, Google Street View imagery can localize AR devices in order to inform relevant AR content placement.

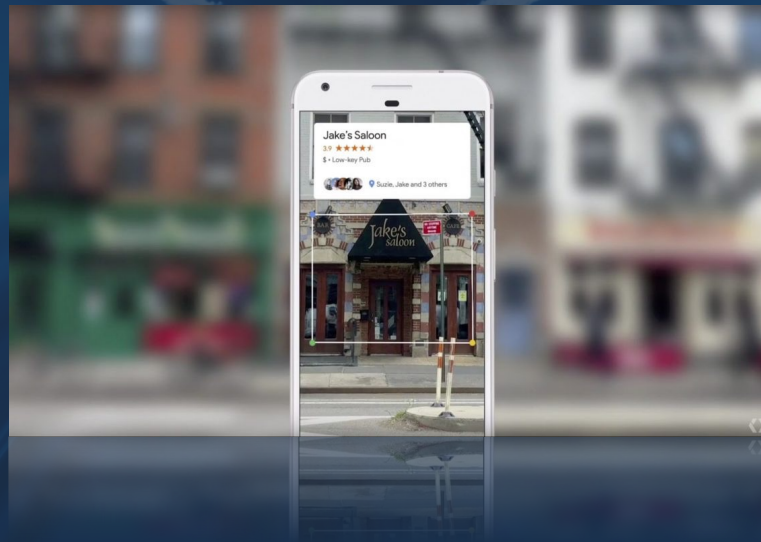
So for Google, AR success will lie in the Venn diagram between killer apps and competency. That will mean

some type of knowledge layer for the physical world. Expect similar from Meta (social layer), Amazon (commerce layer), Microsoft (productivity layer), and Niantic (social gaming layer) to name a few.

But none of this will happen quickly. Based on all the moving parts and technological underpinnings, this will be a slow revolution. Or to quote Matthew Ball:

*We should not expect a single, all-illuminating definition of the 'metaverse'. Especially not at a time in which the metaverse has only just begun to emerge. Technologically driven transformation is too organic and unpredictable*

Image Source: Google



*of a process. Furthermore, it's this very messiness that enables and results in such large-scale disruption.*

***“Killer apps are often utilities that have wide-scale applicability, frequent usage, and large addressable markets. One use case that checks these boxes is captions for the physical world.”***



# Video Companion

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 ARtillery  
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## ARtillery Briefs, Episode 56

Metaverse: The What, When & Where



# Part V

# Looking Ahead

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# The Long Run

## Full Circle

Aside from the previous section on the metaverse, most of this report has focused on the present and near-term outlook for spatial computing. But what about the longer-term future? Indeed, when talking about emerging tech, the discussion should include both short and long-run perspectives.

That brings us full circle to spatial computing's lifecycle, examined in this report's introduction. As part of that lifecycle, one key lesson learned after the circa-2016 period of elevated XR hype is that it's ill-advised to set overblown expectations. Many companies and investors got burned from believing that AR and VR's revolutionary impact was imminent.

## Cautionary Tale

Consumers have also been turned off to some degree. That's not because these technologies aren't compelling, but because they've been disappointing relative to their hyped promises. Magic Leap's first headset is one example of this sequence, and the company has paid for it

With that backdrop, what's the timeline for fully actualized AR and VR? For example, when will we get all-day AR glasses that offer both graphically robust UX and stylistic viability? That combination isn't possible today due to the technological realities and tradeoffs examined earlier in this report.

The consensus is that these goals will be reached in the 2030 timeframe. For example, Snap CEO Evan Spiegel is one executive who's been realistic about this longer time horizon in his public statements. Meta CEO Mark Zuckerberg has also begun to publicly acknowledge this reality.

Image Source: : Joshua Coleman on Unsplash



***One key lesson learned after the circa-2016 period of elevated XR hype is that it's ill-advised to set overblown expectations. Many companies and investors got burned."***



# Road to 2030

## Full Effect

To further underscore these sentiments from AR leaders, we've collected some of their public statements. Here they are for full effect:

### Mark Zuckerberg on The Information Podcast.

"When we got phones, we didn't get rid of our computers. We maybe just shifted some of our time toward phones. My guess is that we'll have phones for a while too, so that part of what we do will always be important. But I think over time, [AR] will become the platform for more and more people, and I think that there's a lot of awesome stuff that comes from that. If you can deliver a computing platform that's fundamentally more human and about creating natural interactions between people, that's sort of the dream that we've been chasing for a long time. If we can build that — and I do think it will be in a decade — a lot of the things we've talked about today should be delivered and at scale. I think that that will be very exciting. A lot of this stuff will start to come about in the 2020s. It may not really reach the full scale until 2030."

### Evan Spiegel at TechCrunch Disrupt

"Spectacles represent a long-term investment in augmented reality hardware. [...] So I think it'll be roughly ten years before there's a consumer product with a display that could be really widely adopted. But in the meantime, we've built a relationship with our community and all these people who love building [AR] experiences and we're sort of working our way toward that future, rather than go in a hole or in an R&D center, and try to make something that people like, then show them ten years later. We've sort of created a relationship with our community where we build that future together."

Image Source: TechCrunch



***"If you can deliver a computing platform that's fundamentally more human and about creating natural interactions between people, that's sort of the dream that we've been chasing."***

# Realistic Expectations

## Signature Schadenfreude

Though the road to AR glasses' endpoints is long and winding, there are meaningful wins along the way. The above two tech leaders helm companies that are achieving such milestones, including user engagement and ad revenue for mobile AR viral lenses. But that's not often the story told in the signature schadenfreude of the tech press.

These short-term wins from the likes of Snap and Meta fuel their ability to speak honestly about the long term. They can temper expectations for AR glasses while armed with the confidence that the spatial computing work they're doing today is producing tangible and financial – albeit gradual – results.

## Easier to Swallow

But these short-term results do make AR's 2030 deferment easier to swallow. And the sooner we all come to terms with that, – including generalist tech articles that still parade AR glasses' and VR.

headsets' world-changing impendence – the more we'll set these technologies up to succeed through realistic expectations.

Image Source: Morning Brew on Unsplash



***“Snap and Meta can temper expectations for AR glasses while armed with the confidence that the mobile AR work they’re doing produces tangible and financial – albeit gradual – results.”***



# Resources & Reference

Executive  
Summary

Introduction

Part I:  
Mobile AR

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Headworn AR

Part III:  
VR

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The Metaverse

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# About ARtillery Intelligence

ARtillery Intelligence chronicles the evolution of spatial computing (AR, VR, and the metaverse). Through writings and multimedia, it provides deep and analytical views into the industry's biggest players, opportunities and strategies.

Run by analysts and former journalists, coverage is grounded in a disciplined and reportorial approach. It also maintains a business angle: Though there are fun and games in spatial computing, cultural, technological, and financial implications are primary.

Products include the *AR Insider* publication and the *ARtillery PRO* research subscription, which together engender a circular flow of knowledge. Research includes monthly narrative reports, market-sizing forecasts, original consumer survey data, and multimedia – all housed in a robust intelligence vault.

Learn more [here](#).

***“Though there are fun and games in spatial computing, cultural, technological and financial implications are primary.”***





# About Intelligence

## Briefings

## Briefings

ARtillery Intelligence Briefings are monthly installments of spatial computing data and analysis. They synthesize original data to reveal opportunities and dynamics of spatial computing sectors. In addition to data, a layer of insights is applied to translate market events and raw figures into concrete insights.

More information, past reports, and editorial calendar can be seen [here](#).



# About the Author

Mike Boland was one of Silicon Valley's first tech reporters of the Internet age as a staff reporter for Forbes (print) starting in 2000. He's been an industry analyst covering emerging and immersive tech since 2005; and is now Chief Analyst of ARtillery Intelligence and Editor of AR Insider.

Mike is a frequent speaker at industry conferences such as AWE, XRDC, Lens Fest, and the VR/AR Global Summit. He has authored more than 150 reports and market-sizing forecasts on the tech & media landscape. He contributes regularly to news sources such as TechCrunch, Business Insider, and Huffington Post.

A trusted source for tech journalists, his comments have appeared in A-list publications, including The New Yorker, The Wall Street Journal, and The New York Times.

Further background, history, and credentials can be read [here](#).

# Methodology



This report highlights ARtillery Intelligence viewpoints, gathered from its daily in-depth market coverage. To support narratives, data are cited throughout the report. These include ARtillery Intelligence original data, as well as that of third parties. Sources are linked or attributed in each case.

For market sizing and forecasting, ARtillery Intelligence follows disciplined best practices, developed and reinforced through its principles' 18 years in tech-sector research and intelligence. This includes the past 8 years covering AR & VR exclusively, as seen in research reports and daily reporting.

This approach primarily applies a *bottom-up* forecasting methodology, which is secondarily vetted against a *top-down* analysis. Together, confidence is achieved through triangulating revenues and projections in a disciplined way.

More about ARtillery Intelligence's market-sizing methodology can be seen [here](#) and more on its credentials is [here](#).

# Disclosure & Ethics Policy

Unless specified in its [stock ownership disclosures](#), ARtillery Intelligence has no financial stake in the companies mentioned in its reports. The production of this report likewise wasn't commissioned. With all market sizing, ARtillery Intelligence

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