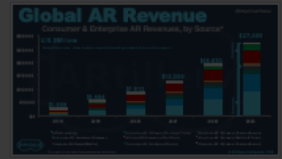




## Executive Summary

## Key Takeaways



### Key Takeaways

Consumer AR is projected to be the largest segment, followed by Enterprise AR. AR revenue is expected to grow significantly faster than overall mobile device revenue.

### Key Takeaways

AR revenue is expected to grow significantly faster than overall mobile device revenue.

# ARtillery Intelligence

## ARtillery Intelligence Briefing VR Global Revenue Forecast, 2018-2023 November 2019



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# Executive Summary

# Introduction

The virtual reality sector continues to show early-stage characteristics, including erratic levels of interest and investment. But how big is it, and how big will it get? *ARtillery Intelligence* has quantified the sector's revenue position and outlook, resulting in our latest forecast. This is the fourth wave of *ARtillery Intelligence*'s VR revenue forecast.

Built from daily market coverage, insider interviews and market-sizing experience from 15 years of analyst work (see methodology section), *ARtillery Intelligence* has constructed disciplined and independent market-sizing models. The analysis is segmented into revenue categories such as consumer, enterprise and sub-divisions of each.

So what did we find out? At a high level, *ARtillery Intelligence*'s position on VR revenue growth is best characterized as cautiously optimistic. Growth and scale will come, but likely slower than many industry proponents believe, due partly to the pace of adoption and other signals that *ARtillery Intelligence* – and its sister publication *AR Insider* – tracks.

In fact, you may notice that VR revenue projections in outer years are lower than other firms' figures. They're also notably lower than our past estimates, as we adjust to market signals. This is common in market forecasting, as proficient market watchers perpetually course-correct based on dynamic market conditions and variables.

The following pages quantify and project figures within several revenue categories, as well as hardware unit growth. Bulleted insights are included throughout to qualify the revenue drivers and rationale behind the numbers. And further narrative insights can be found in *ARtillery Intelligence*'s monthly reports, which can be accessed in the PRO library.

# What's Included in VR Revenue Totals?

VR industry revenues totaled in this report include consumer and enterprise segments. These are each subdivided by several revenue sources, such as **hardware** (headsets), **software** (game/app purchases and experience creation engines) **advertising** (in-game/app), and **LBVR** (VR spending and admissions revenue).

Consumer revenue is defined as anything consumers pay for (headsets, games, etc.). Enterprise revenue is anything companies pay for (visualization software, LBVR headset purchases, experience creation engines, etc.). Some of that deviates from common industry connotations for “enterprise” which is usually limited to industrial and corporate use cases. We track those revenue sources but also include tools for developers, brands and other entities that build/sell consumer-facing VR (B2B2C). See more below.

## Included\*

**VR Hardware:** e.g. headsets, bundled input devices

**Consumer VR Software:** e.g. apps, game subscriptions

**Enterprise VR Software:** e.g. enterprise visualization, training, developer platforms, LBVR game licenses

**VR Advertising:** e.g. in-game ad placements

**Location Based VR:** Hardware & game licenses (counted as enterprise VR spending), admissions (counted as consumer VR spending)

## Not Included

**PC or Gaming Consoles:** e.g. Playstation 4

**VR Cameras:** e.g. 360 degree camera hardware

**Network Data:** e.g. Telco-delivered data usage for VR

**Professional Services:** e.g. VR consulting & agencies

**App/Game Creation Overhead:** e.g. Developer salaries

**Advertising Creation:** e.g. Creative production, agency fees

**Commerce (transaction value):** Value of goods bought through VR interfaces (e.g. Cost of a couch bought through Macy's in-store furniture visualization).

# Key Takeaways



# Key Takeaways

Takeaways and growth dynamics for VR and its sub-sectors.

**Consumer VR** will grow from **\$3.07 billion** in 2018 to **\$10.55 billion** in 2023, a **28 percent** compound annual growth rate. Revenue will be hardware-dominant in early years as an installed base is established. Over time, software will gain ground with a faster refresh rate and as a larger cumulative installed base incentivizes VR content creators to invest in long-form content. Together, these factors will result in more robust VR content libraries, more users, and greater software spending per user (ARPU). Premium apps will dominate software revenues but in-app purchases, especially in gaming, will gain revenue share over time. Installed software will dominate VR, but slowly give way to web VR as its capability evolves. Price competition among VR headset manufacturers will meanwhile accelerate consumer adoption. **Oculus Quest** will impact aggregate VR unit and revenue growth. Based on signals from **Oculus**, we project the headset to reach **470,000** units and **\$202** million in revenue in 2019. That will be fueled by its Q2 launch blitz, and Q4 holiday season, given a giftable price point for some consumers. **Oculus** – with the advantage of **Facebook**-backing – has the flexibility to apply loss-leader pricing in order to strategically prioritize market share over margins. That will give it a strong competitive position versus players that are dependent on nearer-term hardware revenue.

# Key Takeaways

Takeaways and growth dynamics for VR and its sub-sectors.

**Enterprise VR** will grow from **\$829 million** in 2018 to **\$4.26 billion** in 2023, a **39 percent** compound annual growth rate. This includes any spending on VR technology from enterprise buyers, including deployed hardware, software running on VR headsets and VR creation tools (e.g. **Unity**). As for areas of applicability, VR won't add as much value in industrial settings (where AR shines) as it does in corporate contexts such as data visualization and industrial design. Employee training will be a key use case in retail and industrial segments. We also measure the VR spending of location based VR (LBVR) such as VR arcades (further detailed on slide 11). This includes VR hardware purchases and software licenses which are counted in this forecast as enterprise VR spending, while admissions are counted as consumer-spending. Like in consumer markets, VR's near-term enterprise revenue in all of the above categories will be hardware-dominant as it's the first step to tech adoption. That installed base will pave the way for enterprise VR software revenues to gain spending share over time. Unlike AR, which will have specialized hardware that's optimized for enterprise functions, enterprise VR will mostly utilize the same off-the shelf software used in consumer markets (with some exceptions like **VIVE PRO**). The off-the-shelf availability and economics of that hardware will lower enterprise VR adoption barriers.

# Key Takeaways

Takeaways and growth dynamics for VR and its sub-sectors.

**VR Hardware** will grow from **\$1.67 billion** in 2018 to **\$6.39 billion** in 2023, a **31 percent** compound annual growth rate. That includes spending across consumer and enterprise markets. In absolute terms, the market share leader in revenue and units is **Playstation VR (PSVR)** with an estimated **2.1 million** units sold this year. But, the most notable trend in headset market evolution is the rise of standalone headsets and the corresponding fall of mobile VR. Due to **Oculus'** loss-leader pricing referenced earlier, standalone headsets like **Go** and **Quest** are falling within striking distance of price points previously occupied by mobile VR headsets like **GearVR** and **Daydream View**. The same pricing strategy will drive **Oculus Rift S** unit sales in the coming quarters, though the equally-priced **Quest** will outsell it **3 to 1** by 2023. Compounding passive attrition to mobile VR -- driven by these better alternatives -- the segment is also actively retracting from the market. That most notably includes **Google's** official departure from the **Daydream** platform, and **Samsung's** sunsetting of the once-prevalent **Gear VR**. **Cardboard** and tier-4 headsets will be unsubstantial in revenue and market impact, though they'll still have substantial unit sales in markets like China. We've provided sales figures in this report both with and without these lower headset tiers for alternative market views.

# Key Takeaways

Takeaways and growth dynamics for VR and its sub-sectors.

**VR Software** will grow from **\$963 million** in 2018 to **\$5.2 billion** in 2023, a **40 percent** compound annual growth rate. That includes spending across consumer and enterprise markets. In consumer markets, software is led by game and app purchases (**\$282 million**), followed by game subscriptions such as **Viveport** (**\$127 million**), and in-app purchases (**\$23.5 million**). The latter will gain share over time though game/app purchases and subscriptions will dominate, as they do in PC and console gaming. In the enterprise, VR software is led by installed software and apps (**\$276 million**), followed by LBVR game licences (**\$188 million**), developer tools (**\$55 million**), and OEM software/support packages (**\$11.9 million**). Breaking down some of these categories, installed software includes VR visualization software in corporate or industrial environments (e.g. design prototyping). Developer tools include SaaS-delivered platforms for building VR experiences. This spending is informed largely by the category leader, Unity, though a long tail will also develop in the market as VR experience creation grows and fragments into specialized areas (e.g. vertical market focus). Though end-users in some of these VR development efforts are consumers (e.g. game creation), the software spend is from an enterprise buyer and therefore counted as *enterprise VR* software. This involves an enterprise sub-category we call *B2B2C*.



# Key Takeaways

Takeaways and growth dynamics for VR and its sub-sectors.

**Location-Based VR (LBVR)** will grow from **\$1.25 billion** in 2018 to **\$3.13 billion** in 2023, a **20 percent** compound annual growth rate. The sector's health today is driven by consumers' early-stage reticence to purchase VR hardware and instead "rent" VR experiences. However, that's a double-edged sword that diminishes the category's long-term health... just as video game console growth in the late 80's caused attrition to the arcades that came before it. Potentially counteracting that attrition is overall growth in VR demand that could rise all boats. In a potential growth environment, LBVR success will hinge on execution and factors like packaging, pricing and marketing. Bright spots could be social and experiential installations such as free-roam facilities that, depending on their fill rates, have higher ARPU potential. This includes **Sandbox VR**, which just secured **\$11 million** in series A funding from top-tier investors. LBVR revenue estimates are informed from facility volume (which vary in size and format) and unit economics. The latter includes variables like number of headsets on hand, revenue per hour of use, fill rates, and variable licensing costs. Best practices are starting to standardize such as usage yield in \$25 per-hour range, and game licensing costs that are roughly 15 percent of revenue. The key variable – and wild card for the sector's health – will be fill rates for LBVR facilities.

# Key Takeaways

Takeaways and growth dynamics for VR and its sub-sectors.

**VR Advertising** will grow from almost nothing today to **\$93 million** in 2023. This is by far the smallest spending category in this forecast, though we believe it is worth tracking for its long-term implications. It's also notable that advertising in VR is inversely positioned to its share of revenue in AR, where it's the leading category.\* That's mostly due to the scale reached by mobile AR by piggybacking on the massive smartphone installed base. It's further accelerated by the efforts of **Snap** and **Facebook** to create AR lens formats that have resonated with consumers and advertisers. But most of all, it's achieving scaled reach which is brand advertisers' primary consideration. We take that AR tangent to add context (and contrast) to advertising's place in VR. Though its highly immersive orientation has proven effective in key performance indicators (KPIs) like engagement and brand recall, VR advertising's scale is too low to attract brand marketers. Just as ARtillery analysts have built ad revenue forecasts for 15 years in desktop and mobile (search, display, social, etc.), ad market sizing builds up from unit economics such as reach, impressions, clicks and other KPIs that vary by format. Using those same measurements in VR – a fitting methodology as it aligns with the practices and comprehension of brand advertising buyers – yields revenue levels that are insubstantial today but worth watching closely.

# Global VR Revenue

# Global VR Revenues

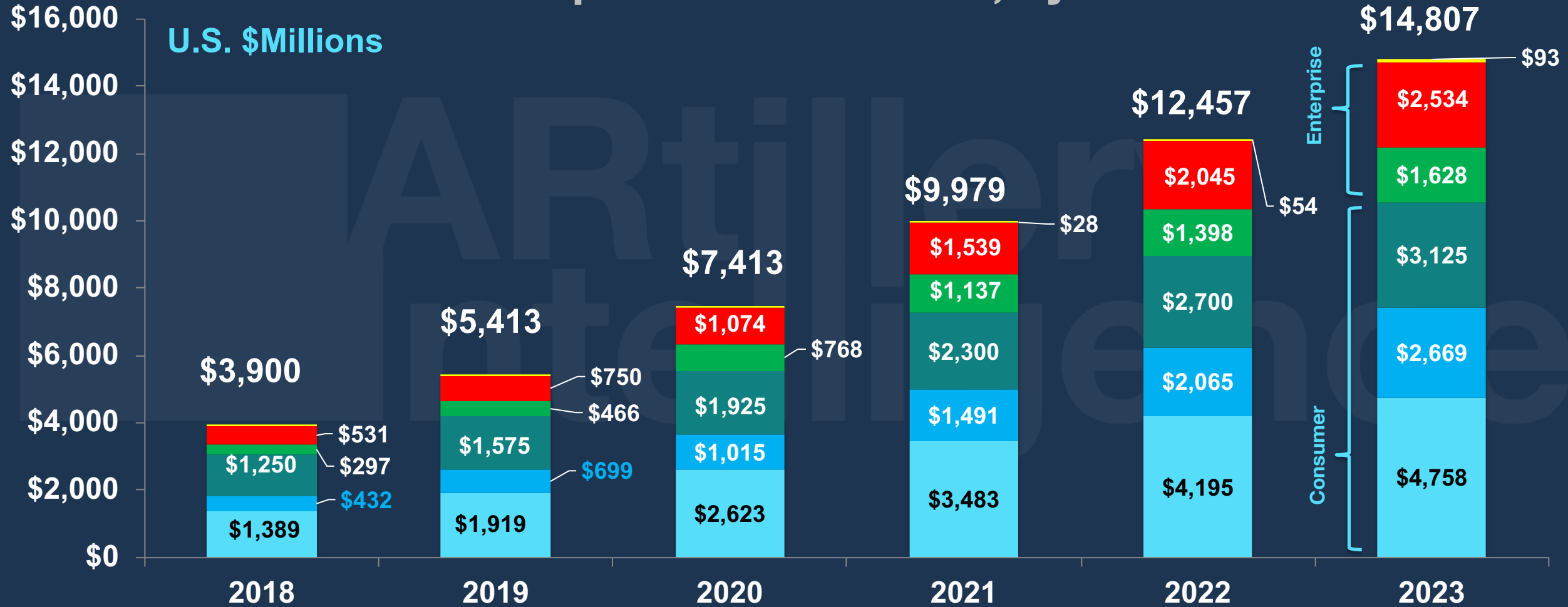
- Global VR revenues will grow from U.S. \$3.1 billion in 2019 to U.S. \$14.8 billion in 2023, a 31% compound annual growth rate (CAGR).
- Consumer VR revenue dominated its enterprise counterpart in 2018. This lead will continue through 2023, but enterprise VR will gain some ground.
  - Consumer VR comprises 79% of VR revenues in 2018 and 71% in 2023.
  - Enterprise VR comprises 21% of VR revenues in 2018 and 29% in 2023.
- VR's largest revenue source in 2018 was consumer hardware (\$1.39 billion).
  - This is due mostly to VR gaming's early lead, and the propensity for hardware to dominate revenue share in early stages of tech sectors.
  - The second largest VR revenue source in 2018 was LBVR admissions (\$1.25 billion), as many consumers prefer experiential VR over ownership.
  - The largest VR revenue source projected for 2023 is consumer hardware.



# Global VR Revenue

## Consumer & Enterprise VR Revenues, by Source

U.S. \$Millions



# Drilling Down: Consumer VR

# Consumer VR Revenue

■ Consumer VR revenue will grow from U.S. \$957 million in 2018 to U.S. \$10.5 billion in 2023, a 28% compound annual growth rate (CAGR).

■ Revenue is led today by hardware sales, followed by LBVR admissions.

■ Hardware sales often dominate early-stage tech sectors as installed bases are formed. Software then gains ground as it builds on that installed base.

■ Consumer hardware has a 36% share of overall revenues which shrinks to 32% by 2023, while consumer software grows from 11% to 18%.

■ Location-based VR (LBVR) admissions are the second largest revenue source.

■ LBVR revenues are strong and will continue growing but will lose share.

■ Currently at 32% of VR revenues, they will have 21% by 2023.

■ This will happen as consumer VR barriers to ownership (cost, cultural acceptance) fall and VR follows similar patterns as 1980s game consoles.

# Consumer VR Revenues (cont'd)

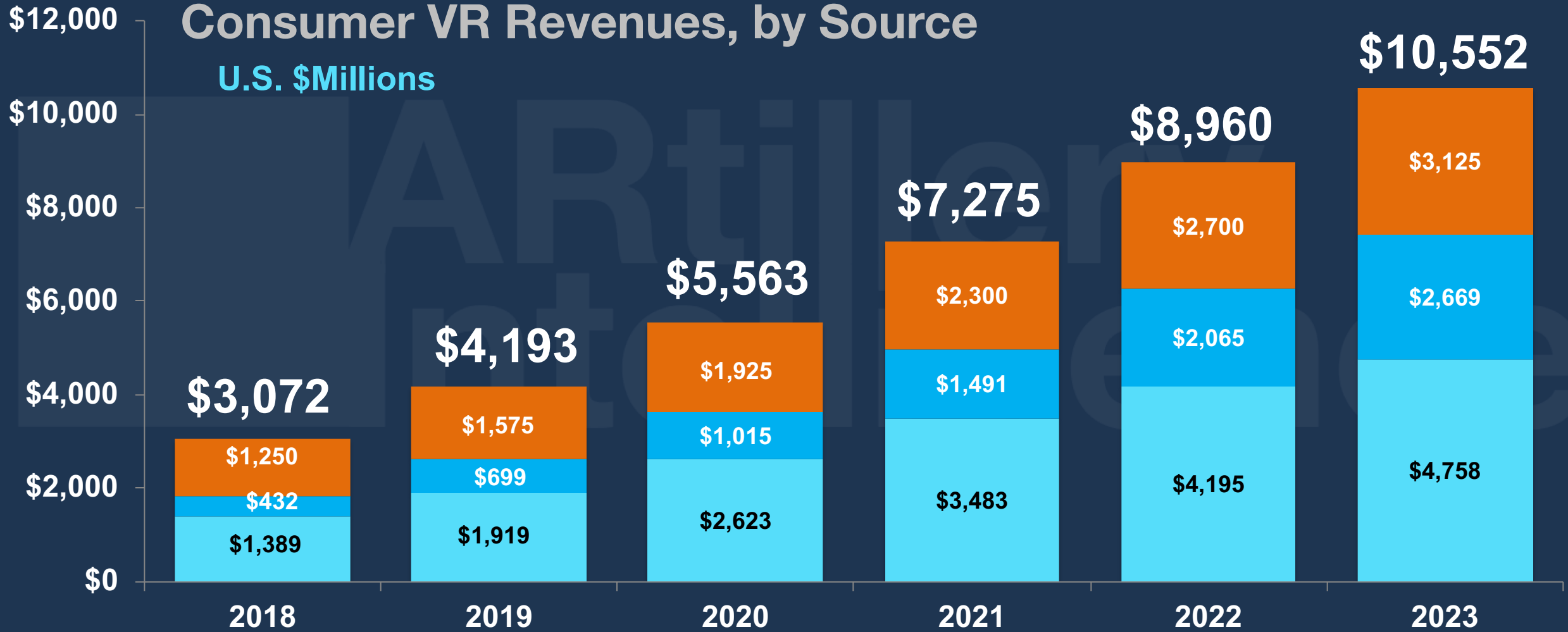
- Consumer VR headset share is currently led by Play Station VR (PSVR)
  - PSVR's lead is due to price and installed base of Playstation4 consoles.
- The greatest share gains in this forecast's five-year outlook will be achieved by standalone VR headsets such as Oculus Go and Quest.
  - These headsets will largely replace today's mobile VR category.
  - Standalone VR has the best "sweet spot" of affordability, low friction play and feature adequacy for mainstream interest.
  - Oculus is the clear leader in standalone headsets due to its product focus, proven quality for Go and Quest, and highly-competitive pricing.
- Consumer VR software is led by game/app purchases and subscriptions.
  - In-app purchases trail in revenue, opposite to the format's leading position in mobile AR (a vestige of behavioral economics in mobile gaming).



# Consumer VR

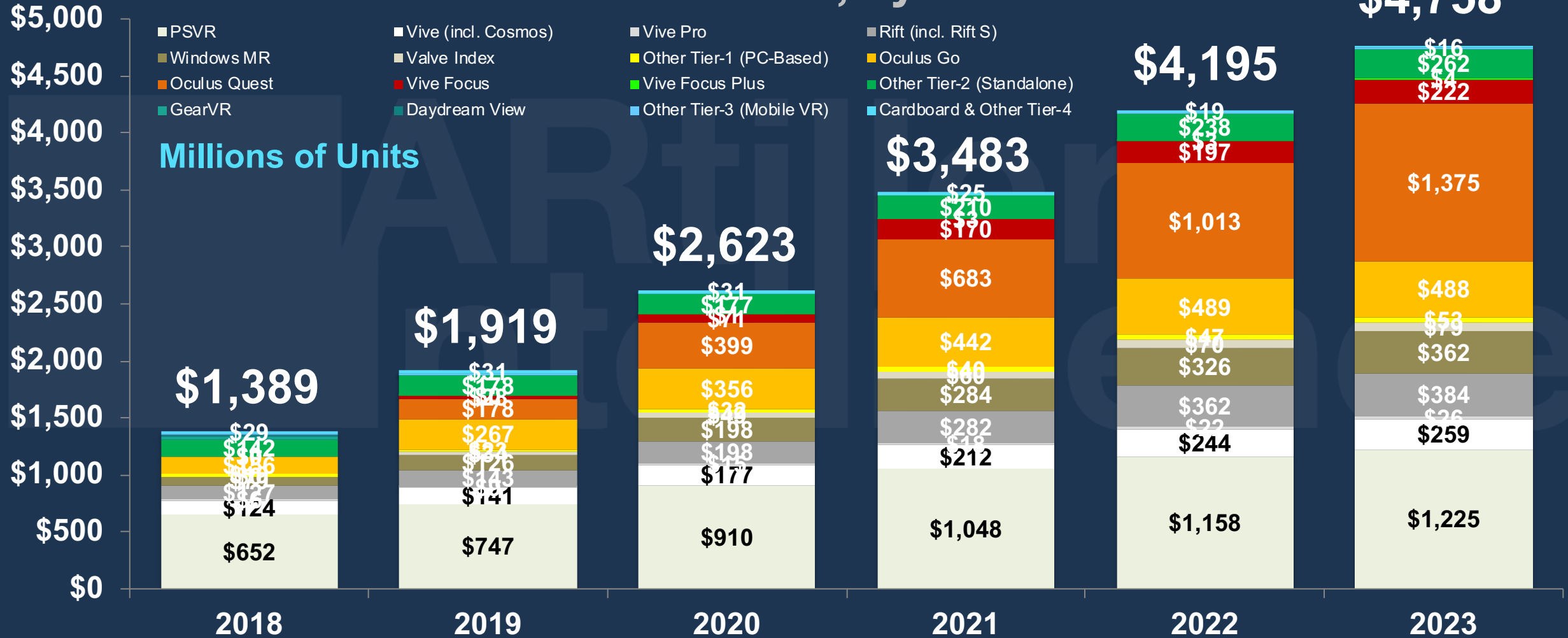
Consumer VR Revenues, by Source

U.S. \$Millions



# Consumer VR Hardware

## Consumer VR Hardware Sales, by Headset



\*Headsets are stacked from bottom to top in order of product classes (tier 1- tier 4).

\*\* Some headsets don't appear in some years if it's before their launch or after their discontinuation.

\*\*\* Data are available in chart form to decipher labels where clustered. Also see pie charts on the next slides.

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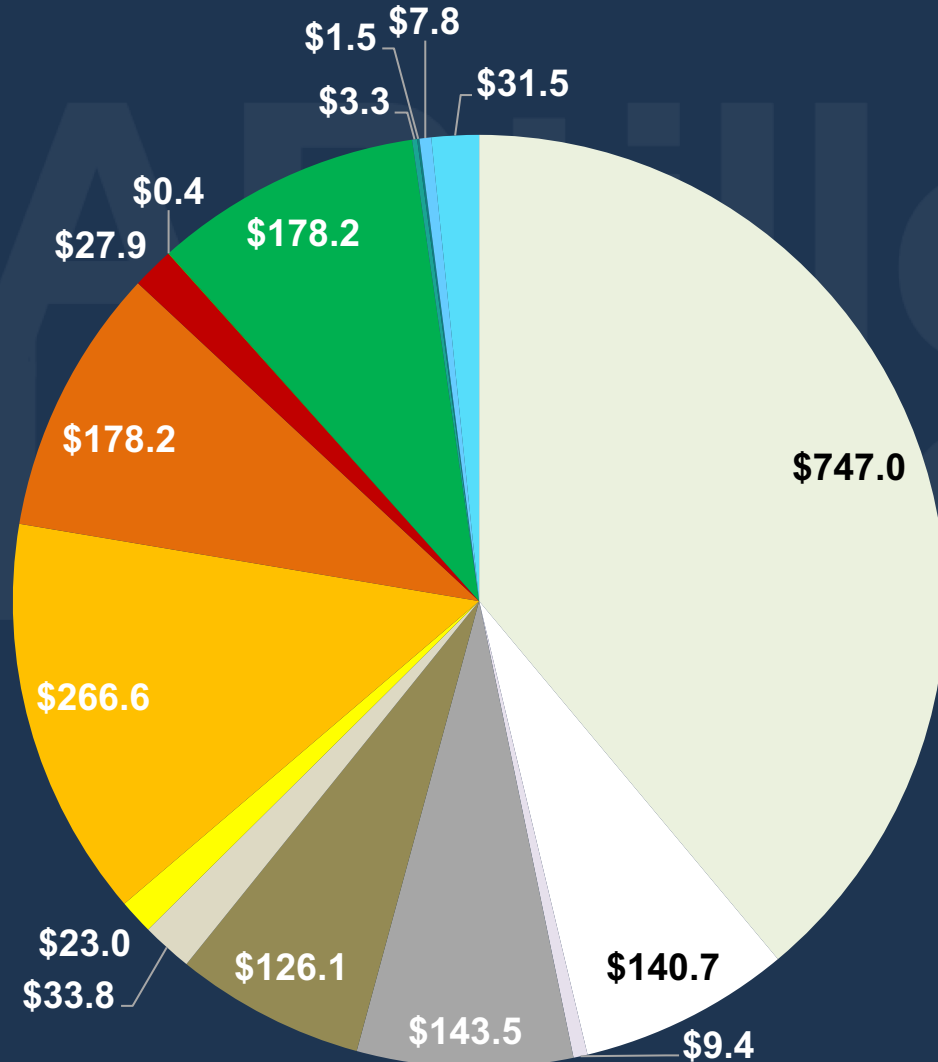
# Consumer VR Hardware

## 2019 VR Hardware Sales, by Headset

U.S. \$Millions

2019

\*Headsets don't appear if the time frame is before their launch or after their discontinuation



- PSVR
- Vive (incl. Cosmos)
- Vive Pro
- Rift (incl. Rift S)
- Windows MR
- Valve Index
- Other Tier-1 (PC-Based)
- Oculus Go
- Oculus Quest
- Vive Focus
- Vive Focus Plus
- Other Tier-2 (Standalone)
- GearVR
- Daydream View
- Other Tier-3 (Mobile VR)
- Cardboard & Other Tier-4

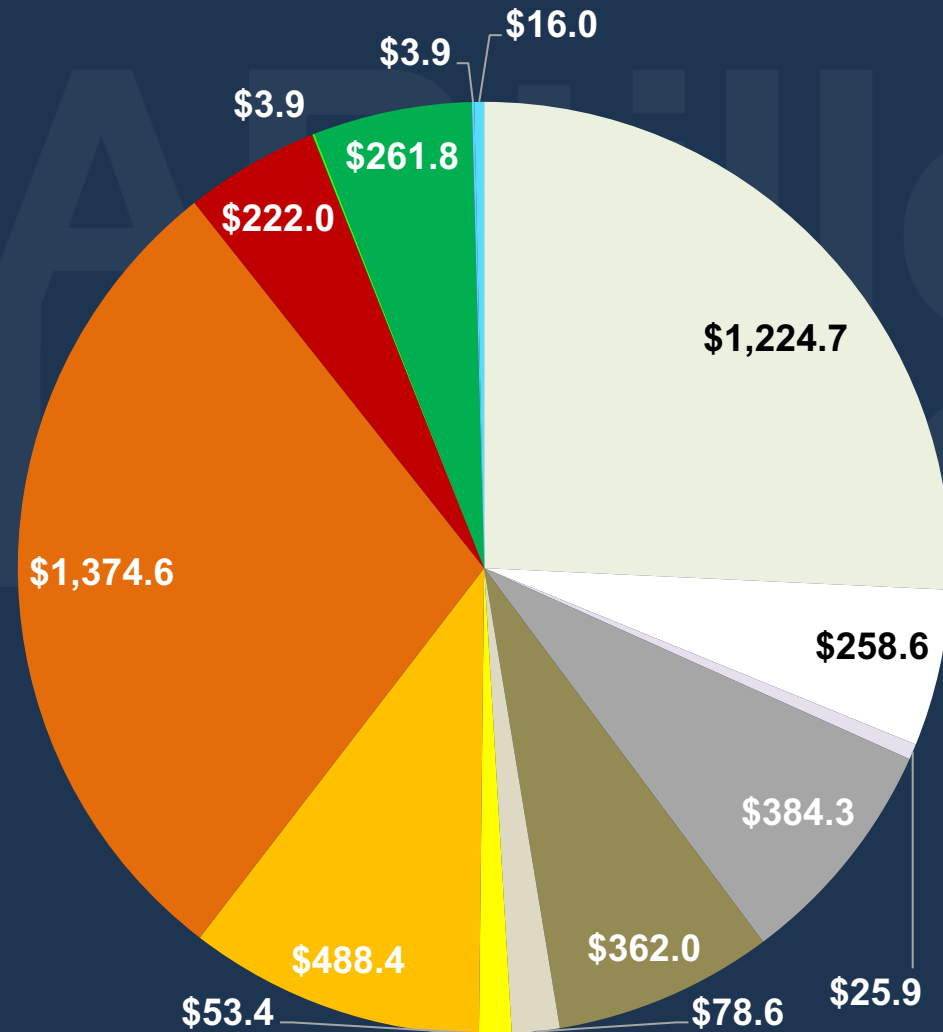
# Consumer VR Hardware

2023 VR Hardware Sales, by Headset

U.S. \$Millions

2023

\*Headsets don't appear if the time frame is before their launch or after their discontinuation

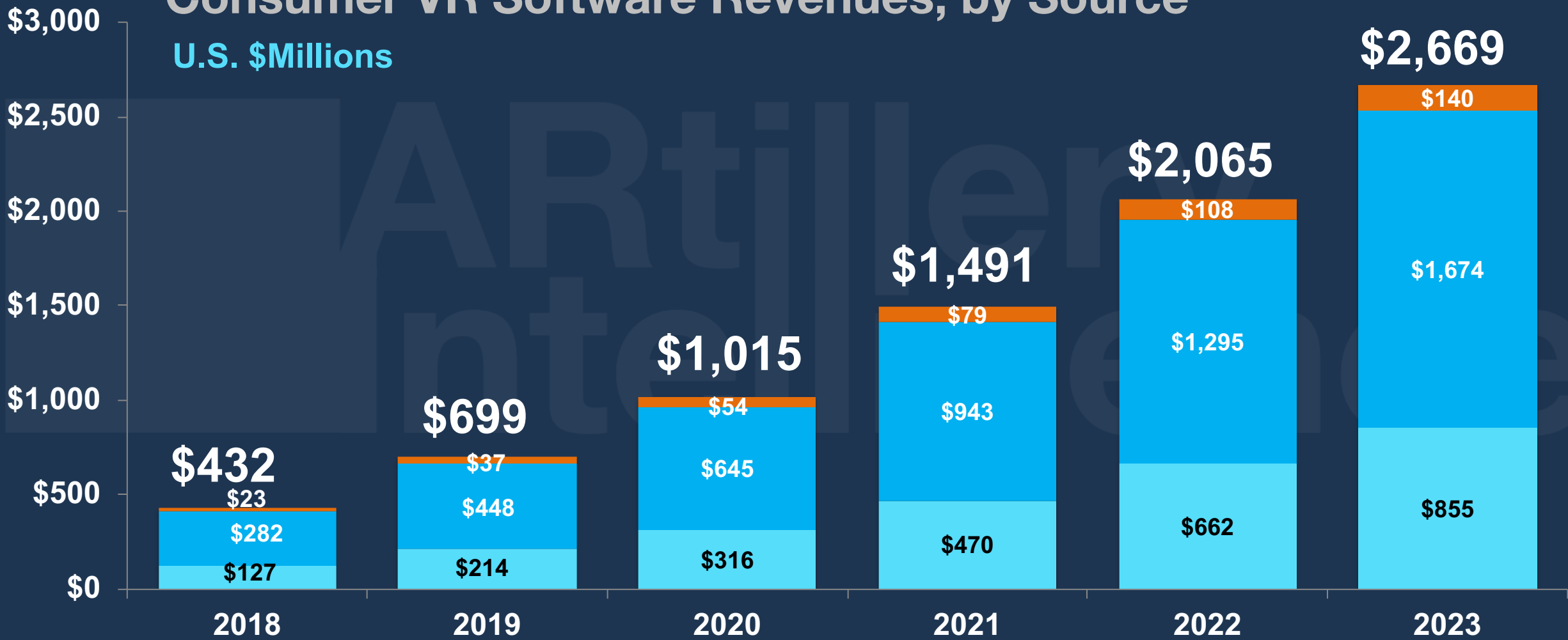


- PSVR
- Vive (incl. Cosmos)
- Vive Pro
- Rift (incl. Rift S)
- Windows MR
- Valve Index
- Other Tier-1 (PC-Based)
- Oculus Go
- Oculus Quest
- Vive Focus
- Vive Focus Plus
- Other Tier-2 (Standalone)
- GearVR
- Daydream View
- Other Tier-3 (Mobile VR)
- Cardboard & Other Tier-4

# Consumer VR Software

Consumer VR Software Revenues, by Source

U.S. \$Millions



# Drilling Down: Enterprise VR



# Enterprise VR Revenue

- Enterprise VR revenue will grow from U.S. \$829 million in 2018 to U.S. \$4.3 billion in 2023, a 39% compound annual growth rate (CAGR).
- Unlike consumer markets, enterprise VR revenues are led today by software.
  - Enterprise VR Software is divided between visualization apps, OEM support packages, VR creation tools and LBVR game licensing.
  - Enterprise VR's Software dominance is based on the fact that it's not confined to an installed base of hardware, as it is in consumer markets.
  - Varied forms of VR software are endemic to enterprise environments such as developer tools and VR experience creation (e.g. Unity).
- Visualization and productivity apps hold the greatest share of enterprise VR software today and through 2023, followed by LBVR game licensing.
  - Training and industrial design will be top enterprise VR use cases.

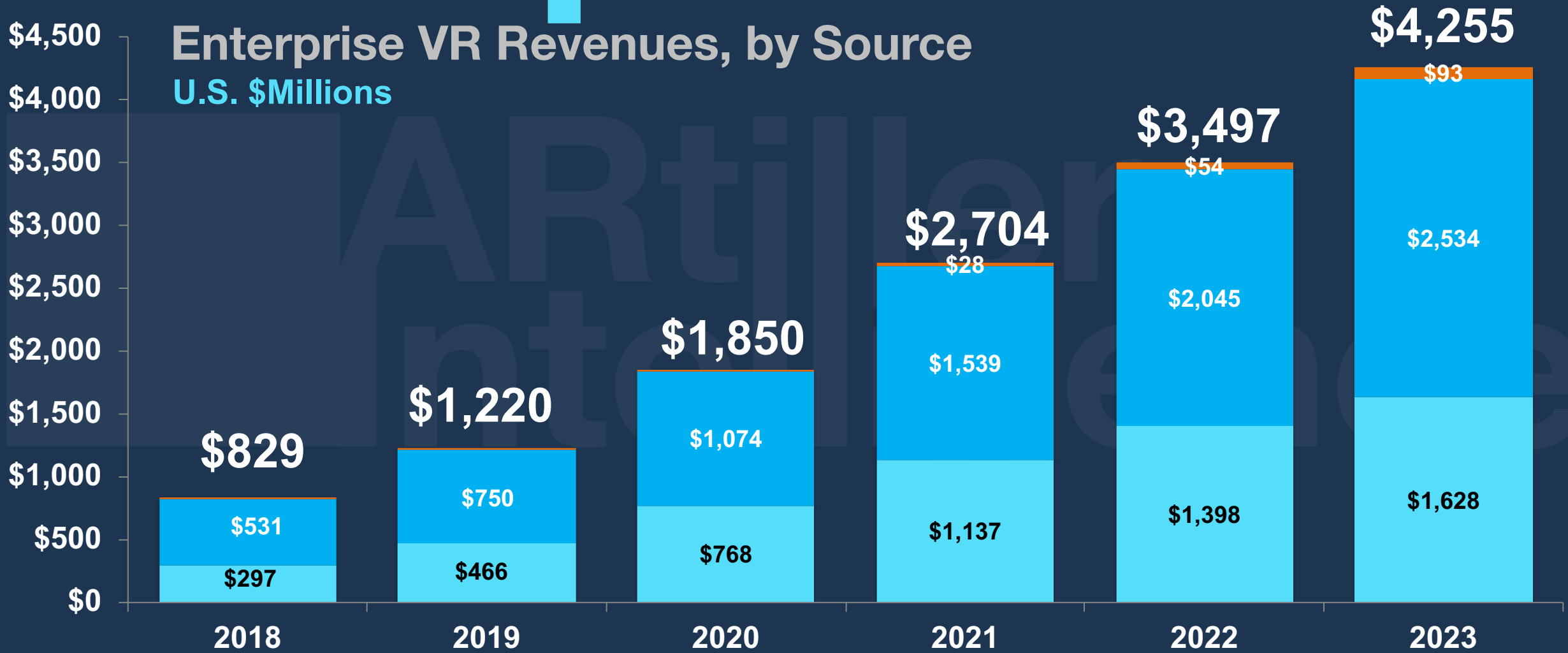
# Enterprise VR Revenues (cont'd)

- As for vertical segmentation, top enterprise VR areas include architecture & design, automotive, and entertainment (experience creation).
  - Industrial settings won't be as conducive to VR as they are to AR, due to VR's isolation which inhibits situational awareness and all-day use.
  - VR will be prevalent in industrial verticals like construction, but more so in non-industrial functions such as training, design and prototyping.
- Like in consumer markets, software's share of revenue will grow over time, as it builds upon a larger installed base of hardware.
  - This happens as a function of more in-market units on which to run software, as well as growth in per-user software/app spending (ARPU).
- Vertical-specific AR adoption hinges on product/market fit; buyer urgency/need; spending power; and regulatory freedom (see slide 35).

# Enterprise VR

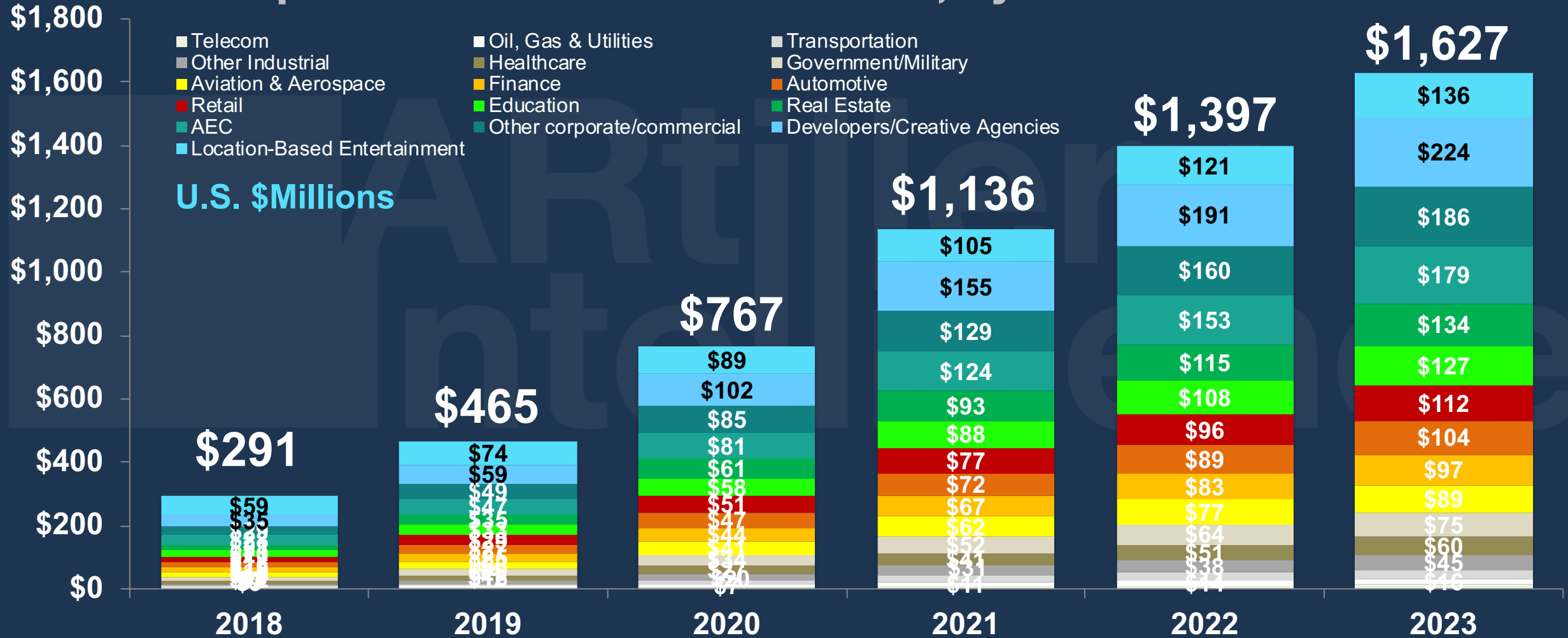
## Enterprise VR Revenues, by Source

U.S. \$Millions



# Enterprise VR Hardware

## Enterprise VR Hardware Revenues, by Vertical



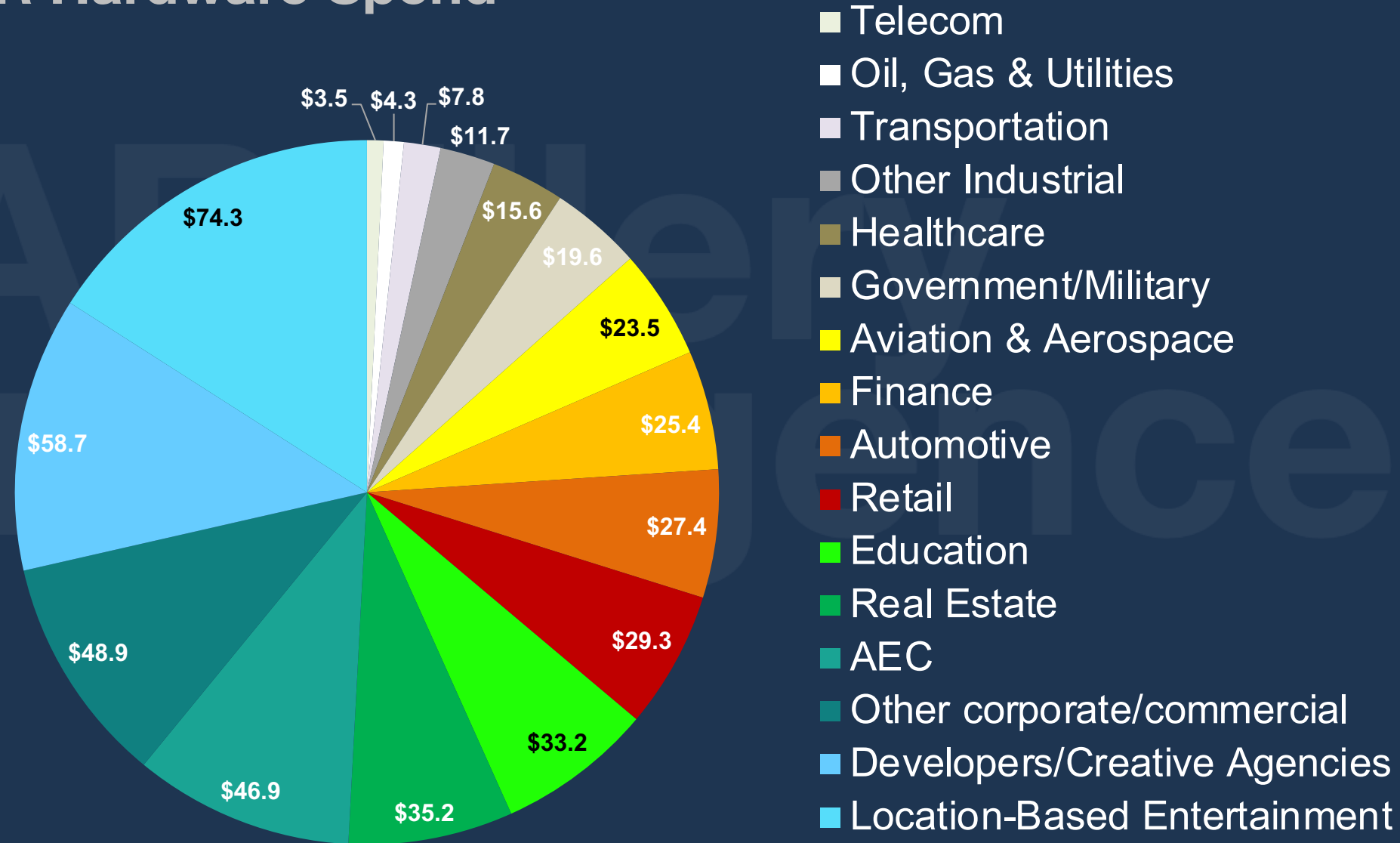
# Enterprise VR Hardware

## 2019 Enterprise VR Hardware Spend

U.S. \$Millions

Location-based entertainment spend is the hardware purchases by LBVR facilities. Software (game licenses) are shown on the corresponding enterprise VR software chart. Admissions revenues for LBVR facilities are measured separately under consumer VR spending.

# 2019



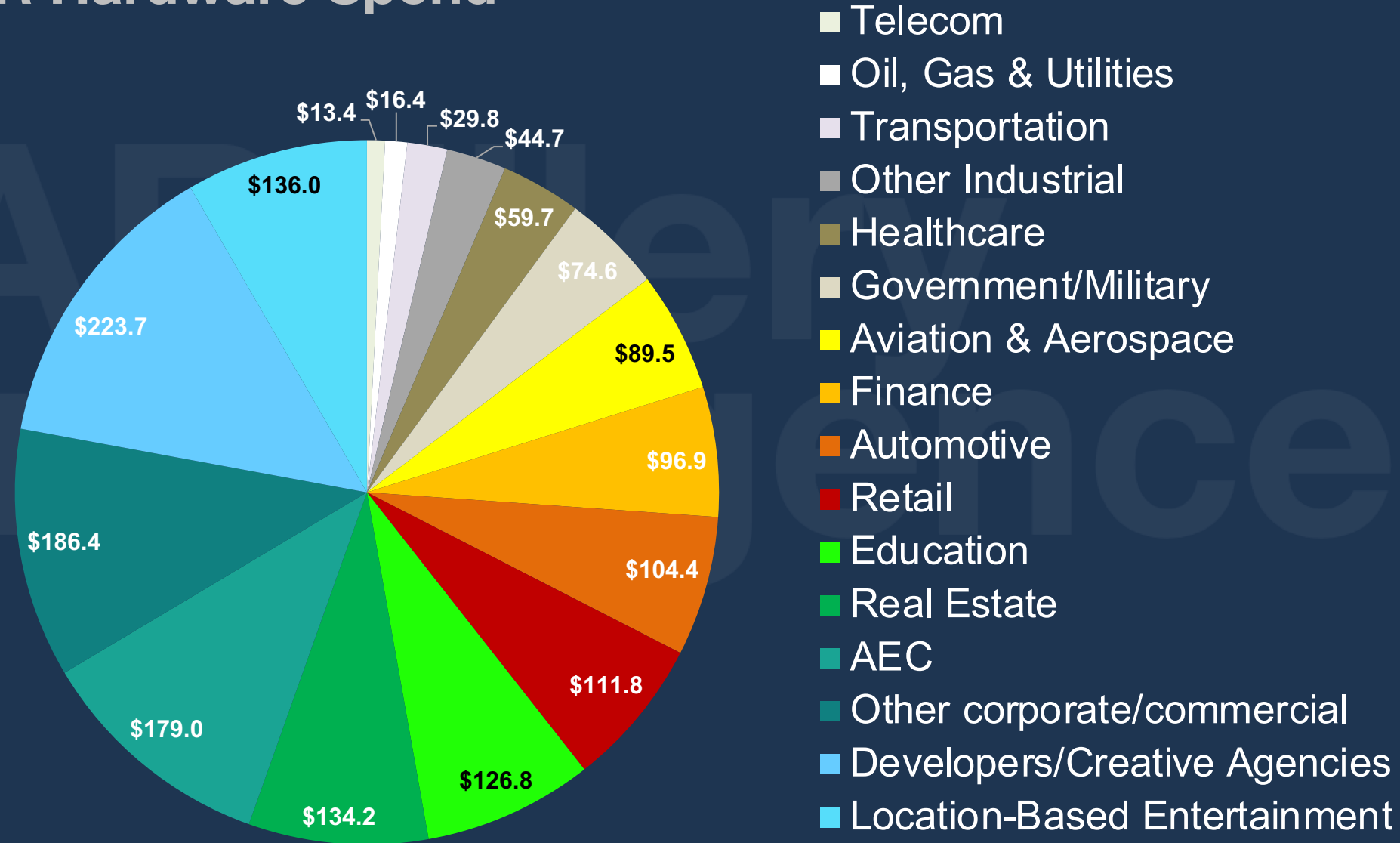
# Enterprise VR Hardware

## 2023 Enterprise VR Hardware Spend

U.S. \$Millions

Location-based entertainment spend is the hardware purchases by these facilities. Software (game licenses are shown on the corresponding enterprise VR software chart. Admissions revenues for LBVR facilities are measured separately under consumer VR spending.

# 2023

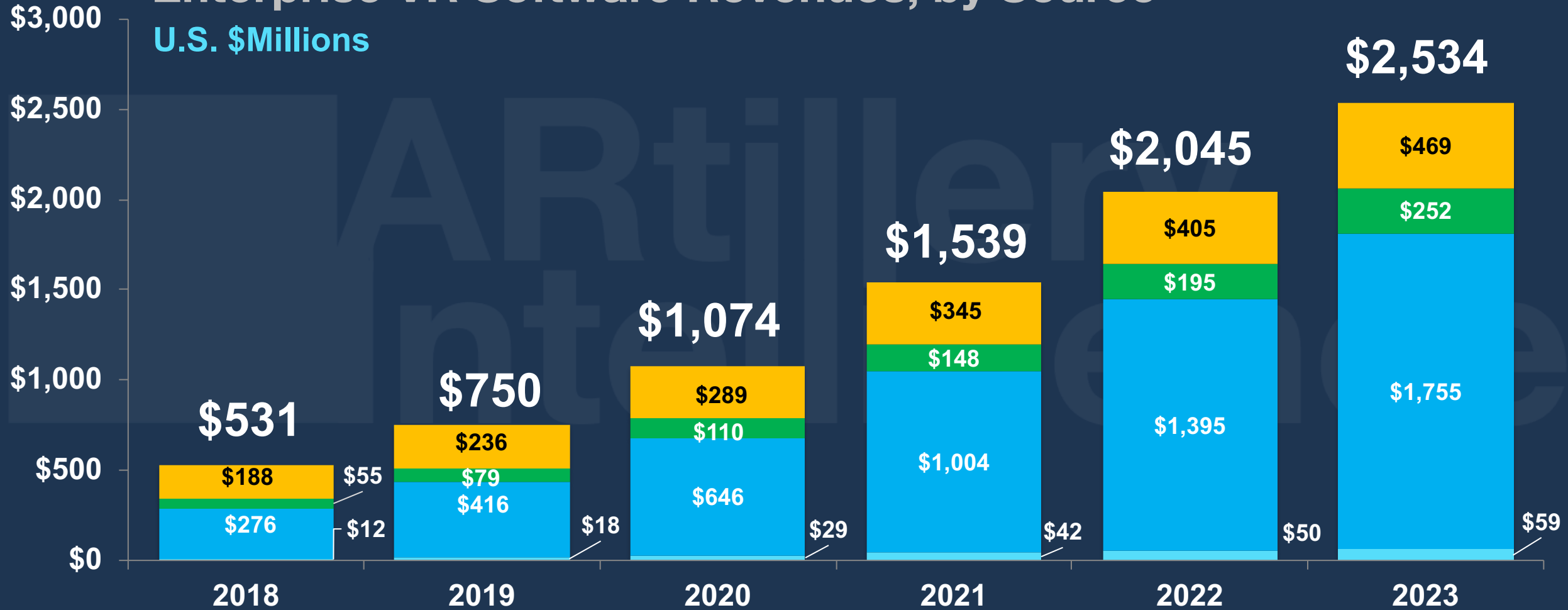




# Enterprise VR Software

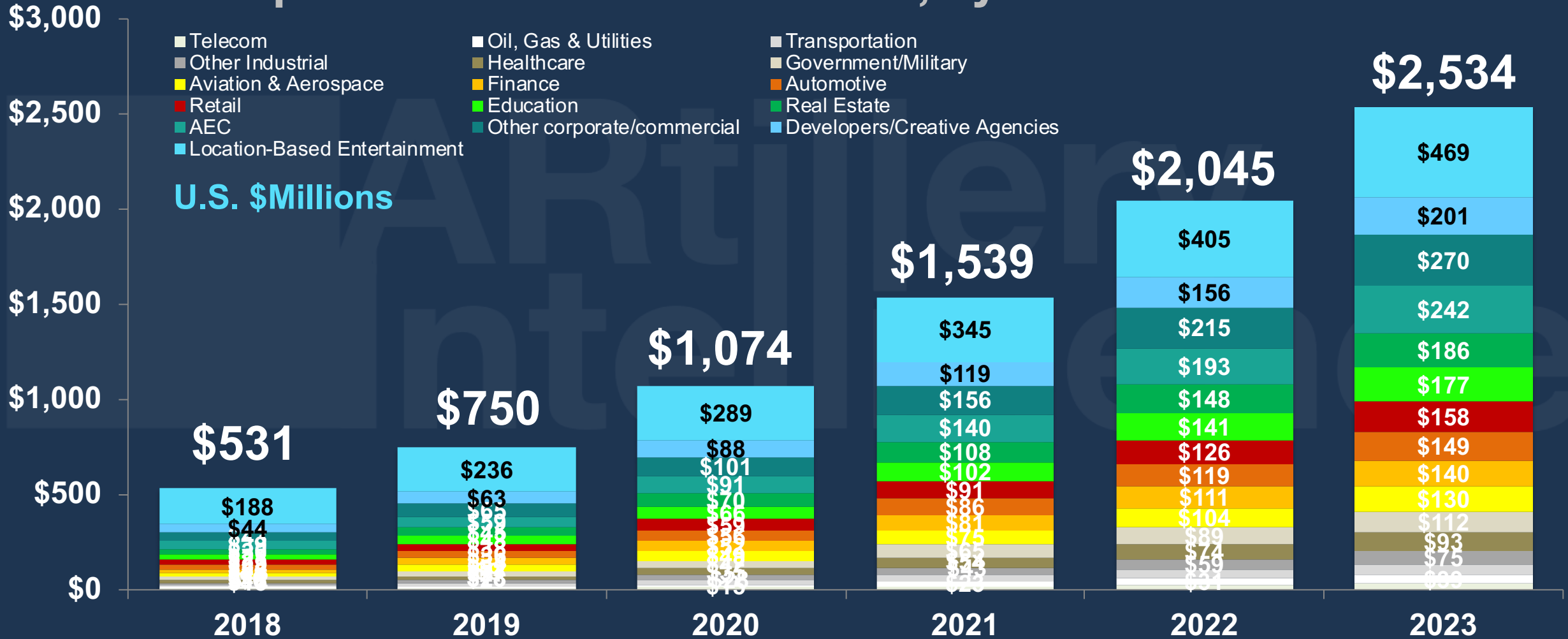
Enterprise VR Software Revenues, by Source

U.S. \$Millions



# Enterprise VR Software

## Enterprise VR Software Revenues, by Vertical



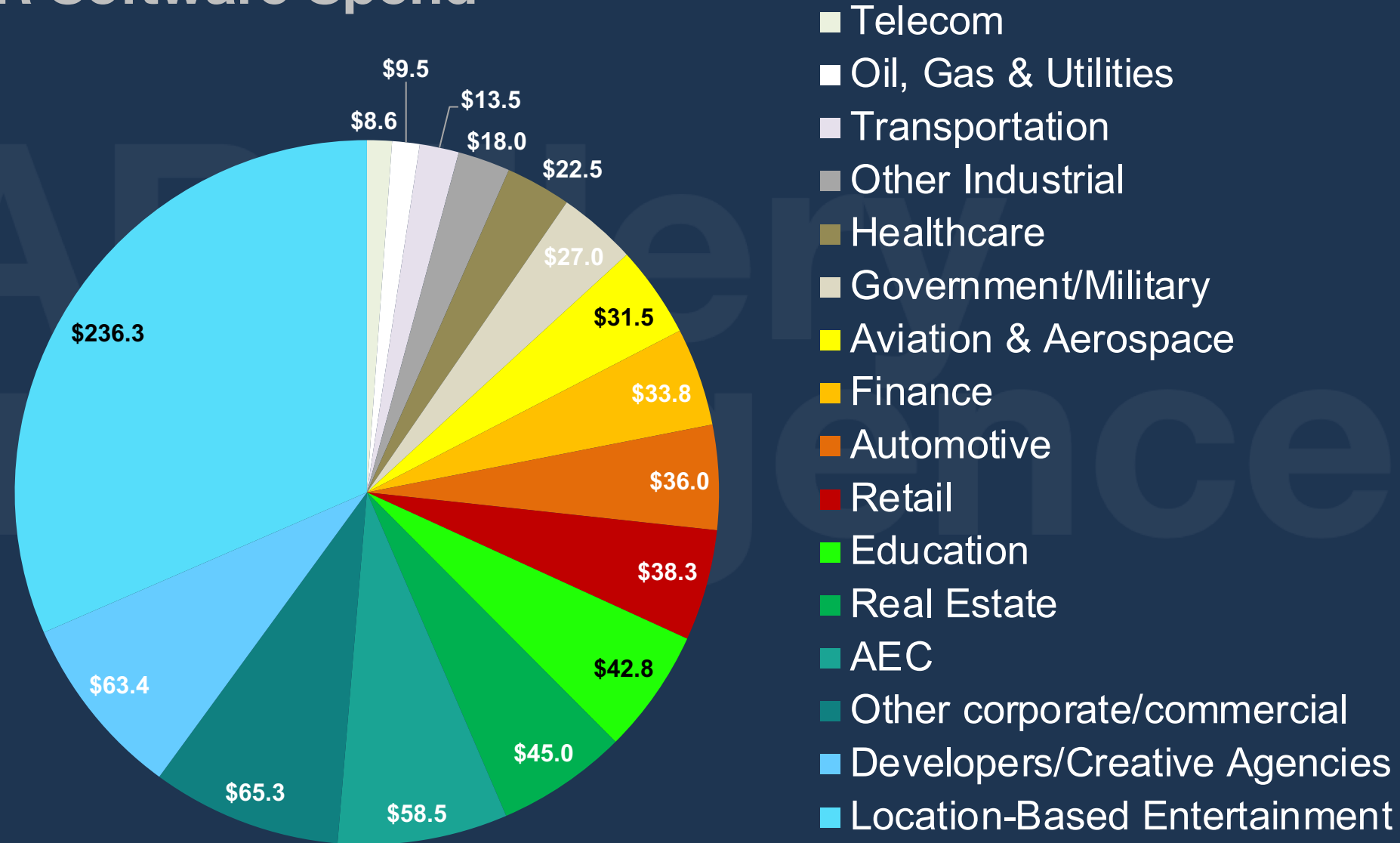
# Enterprise VR Software

## 2019 Enterprise VR Software Spend

U.S. \$Millions

Location-based entertainment spend consists of Software (game licenses). Hardware purchases by these facilities are shown on the corresponding enterprise VR hardware chart. Admissions revenues for LBVR facilities are measured separately under consumer VR spending.

# 2019



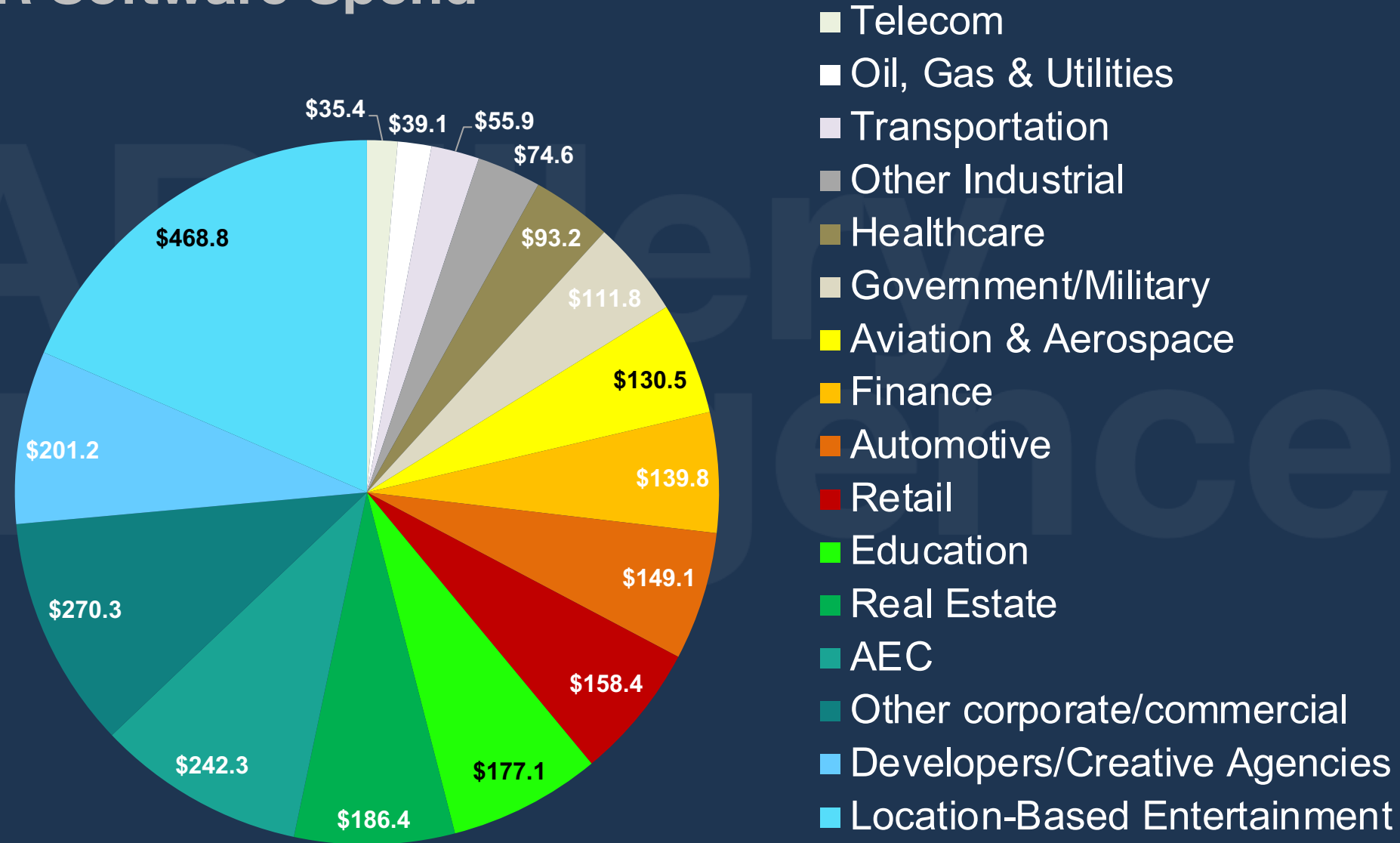
# Enterprise VR Software

## 2023 Enterprise VR Software Spend

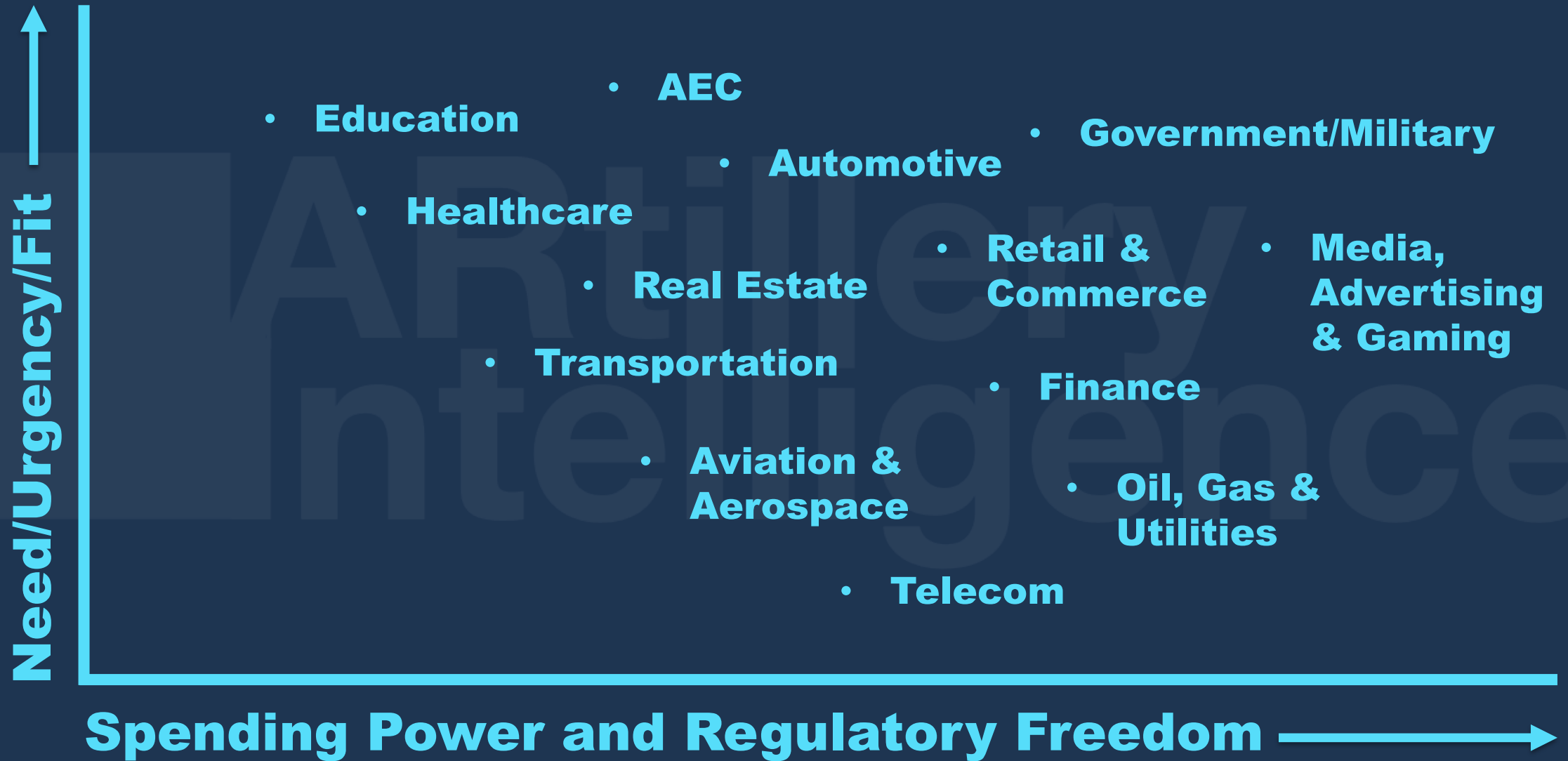
U.S. \$Millions

Location-based entertainment spend consists of Software (game licenses). Hardware purchases by these facilities are shown on the corresponding enterprise VR hardware chart. Admissions revenues for LBVR facilities are measured separately under consumer VR spending.

# 2023



# VR Adoption Factors, by Vertical



# Drilling Down: VR Devices



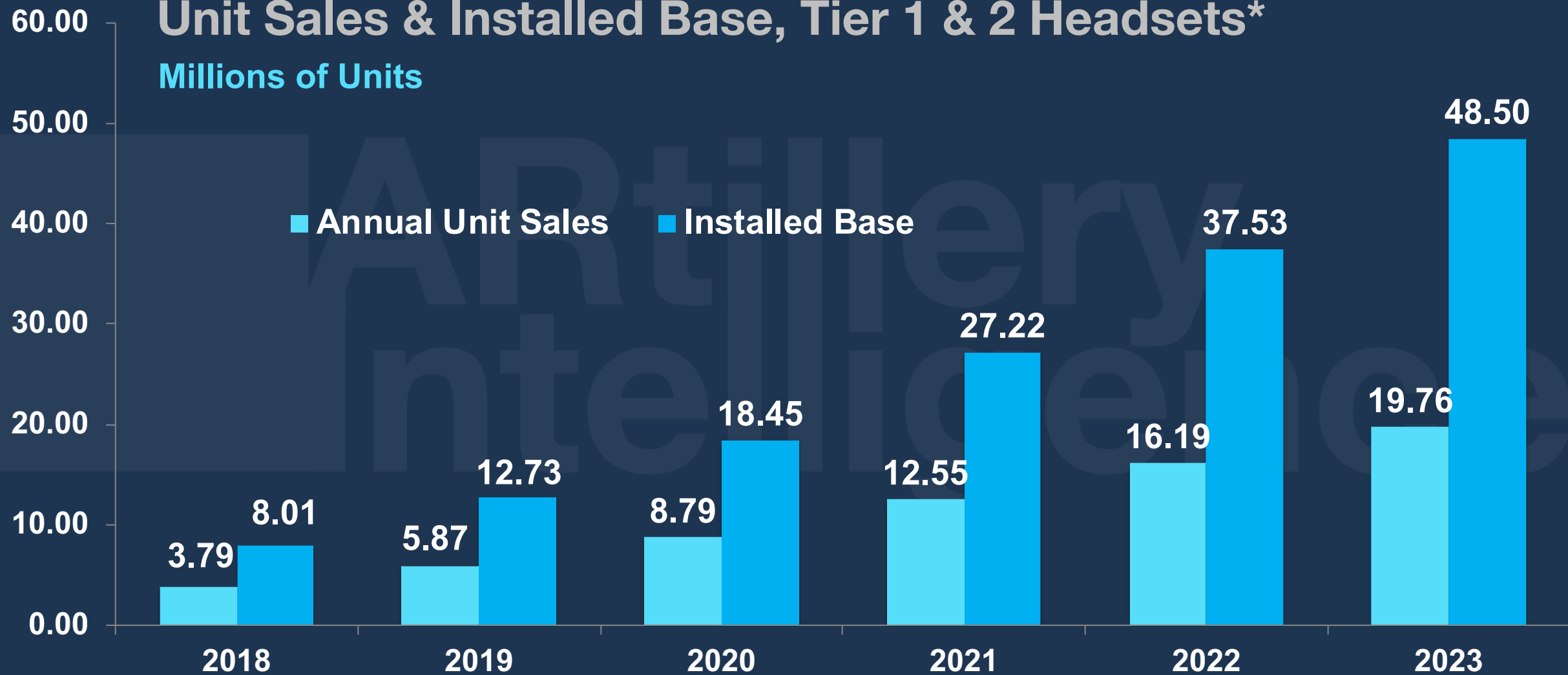
# VR Device Forecast

- Beyond revenue forecasting throughout this report, it's worth drilling down on unit sales projections for VR devices.
  - Unit sales for Tier-1 (PC-based) and Tier-2 (standalone) VR will grow from 3.8 million in 2018 to 19.76 million by 2023.
  - This correlates to a cumulative installed base of in-market headsets of 8.01 million in 2018, growing to 48.5 million by 2023.
  - This installed base applies a calculation that includes a 3-year product replacement cycle.
- Breaking down unit sales by individual headsets, the market leader today among tier-1 and tier-2 headsets (excluding Cardboard) is Playstation VR.
  - PSVR will continue to lead throughout the forecast period but its share will diminish as attrition is caused by top standalone headsets
  - Standalone leaders will most notably include Oculus Quest and Go.

# VR Hardware Penetration

Unit Sales & Installed Base, Tier 1 & 2 Headsets\*

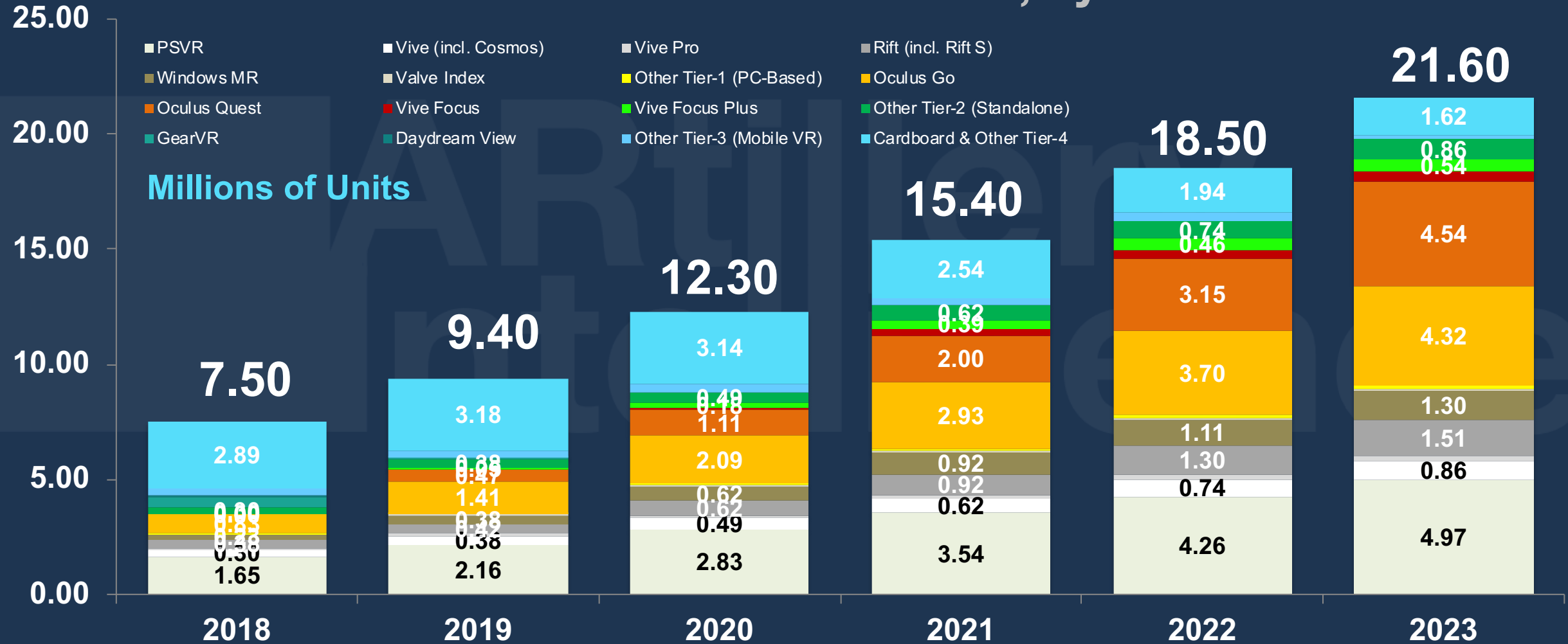
Millions of Units



\* Tier 1 includes console and PC VR headsets (e.g. Rift S). Tier 2 includes Standalone VR Headsets (e.g. Oculus Go)

# VR Hardware Unit Sales

## Global VR Hardware Annual Unit Sales, by Headset



\*Headsets are stacked from bottom to top in order of product classes (tier 1- tier 4).

\*\* Some headsets don't appear in some years if it's before their launch or after their discontinuation.

\*\*\* Data are available in chart form to decipher labels where clustered. Also see pie charts on the next slides.

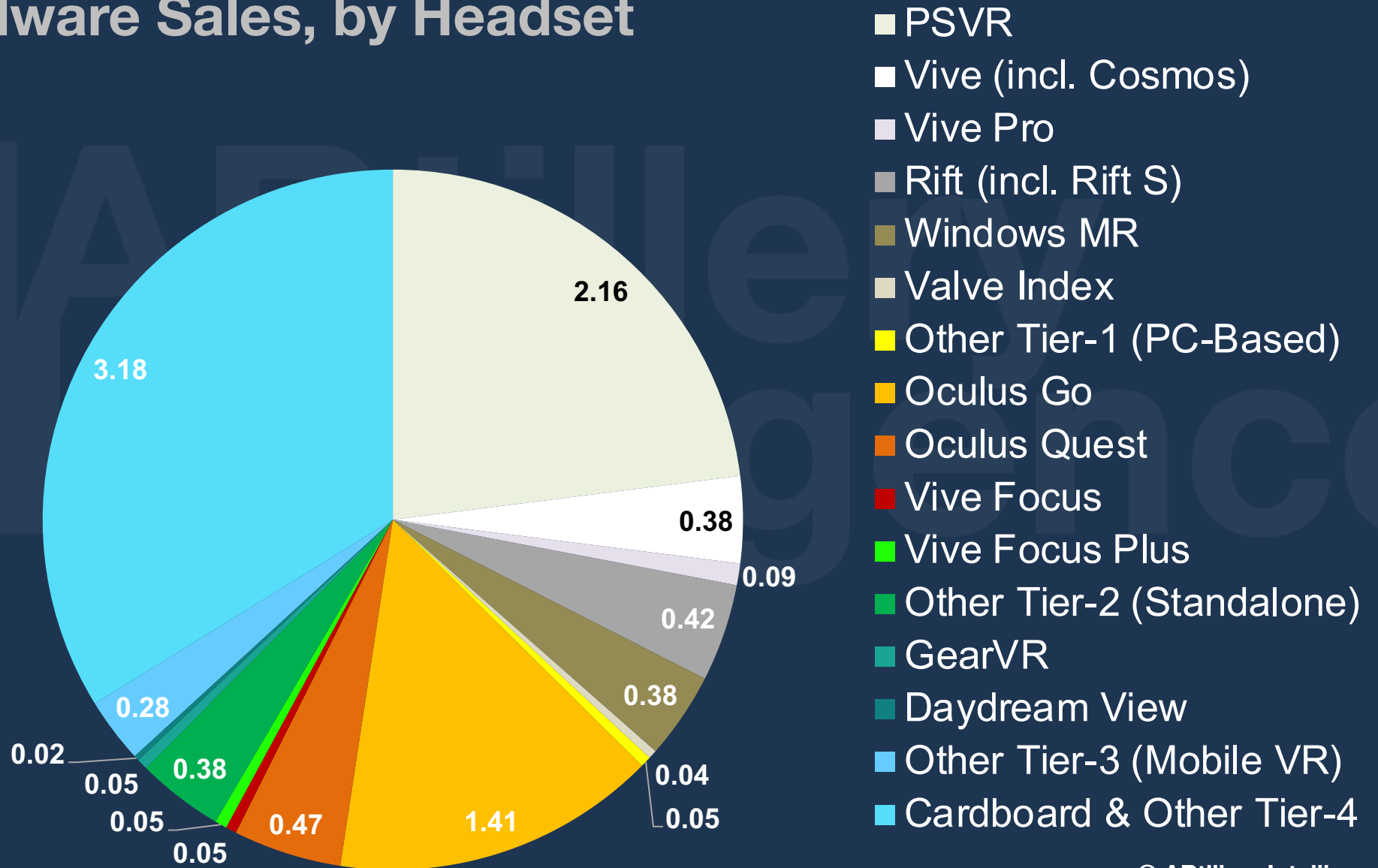
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# VR Hardware Unit Sales

2019 VR Hardware Sales, by Headset

Millions of Units

2019



\*Headsets don't appear if the time frame is before their launch or after their discontinuation

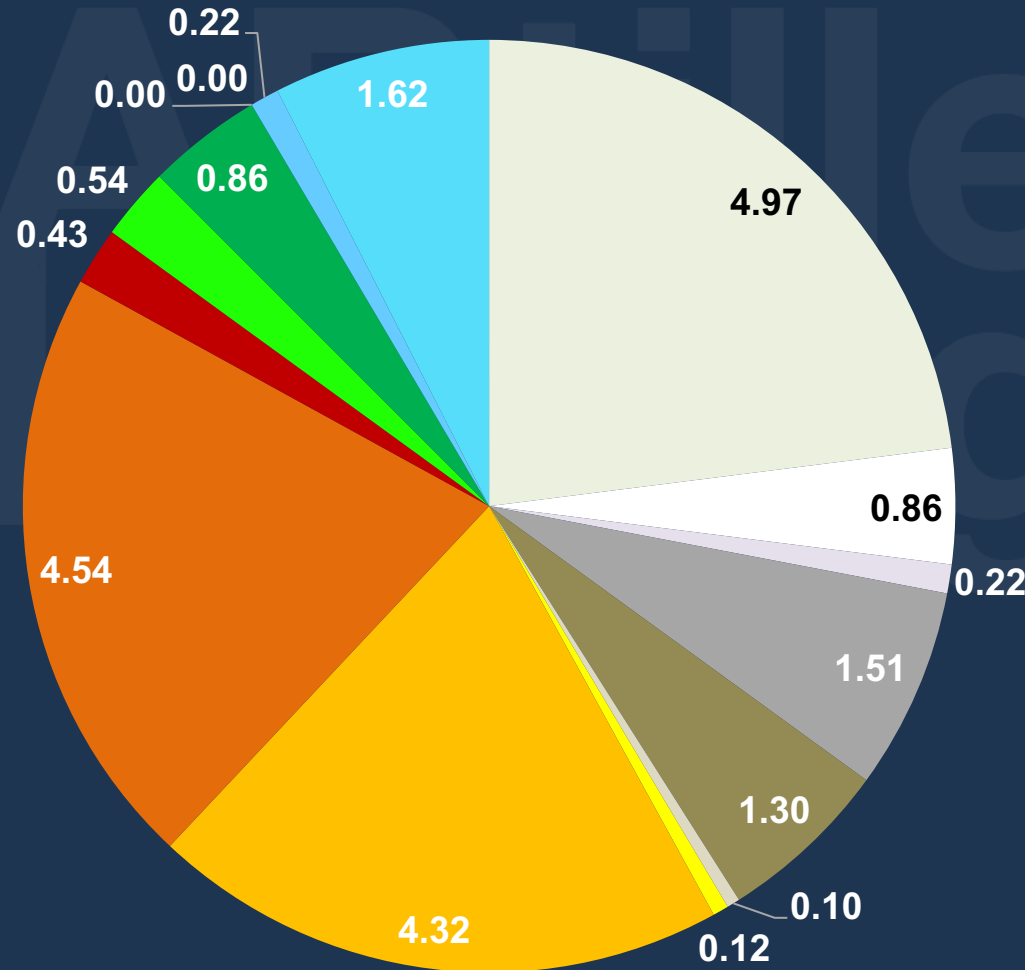
# VR Hardware Unit Sales

2023 VR Hardware Sales, by Headset

Millions of Units

2023

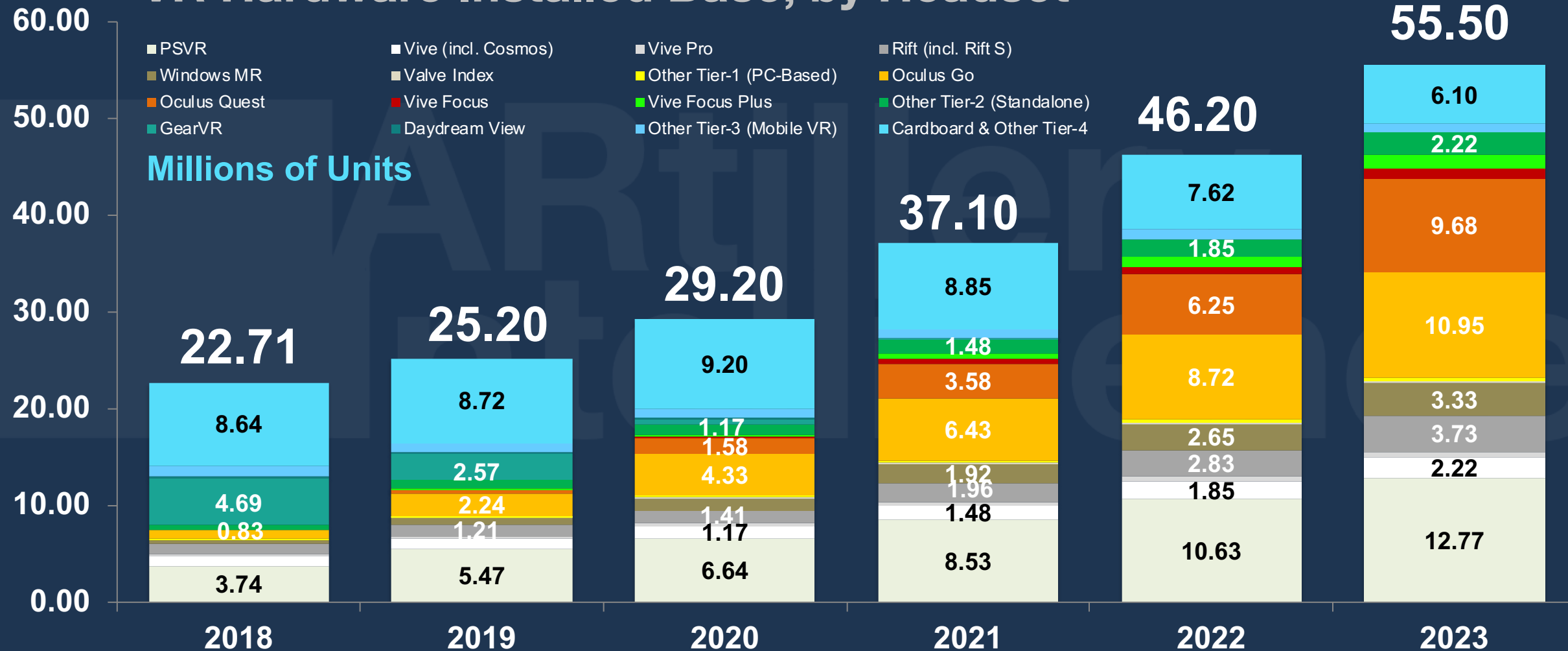
\*Headsets don't appear if the time frame is before their launch or after their discontinuation



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- Rift (incl. Rift S)
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- Valve Index
- Other Tier-1 (PC-Based)
- Oculus Go
- Oculus Quest
- Vive Focus
- Vive Focus Plus
- Other Tier-2 (Standalone)
- GearVR
- Daydream View
- Other Tier-3 (Mobile VR)
- Cardboard & Other Tier-4

# VR Installed Base

## VR Hardware Installed Base, by Headset



\*Headsets are stacked from bottom to top in order of product classes (tier 1- tier 4).

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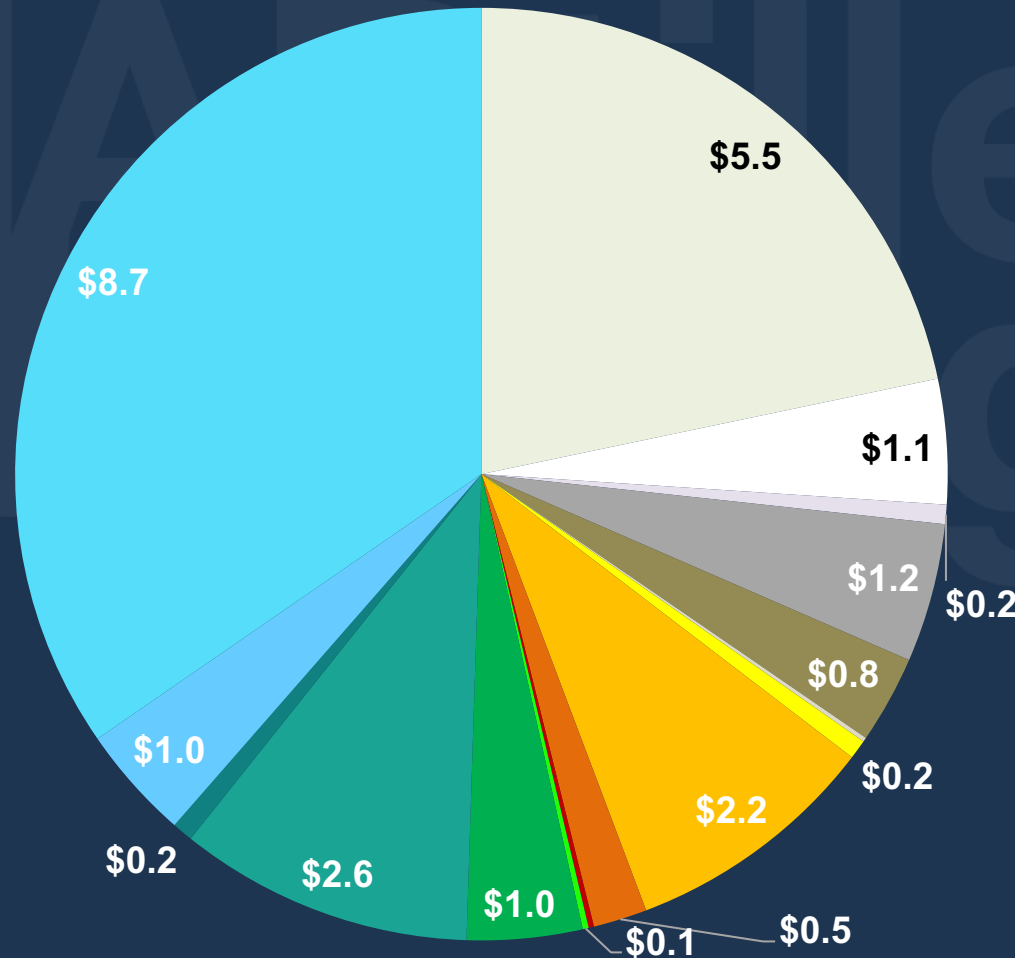


# VR Installed Base

## 2019 VR Installed Base, by Headset

Millions of Units

2019



\*Headsets don't appear if the time frame is before their launch or after their discontinuation

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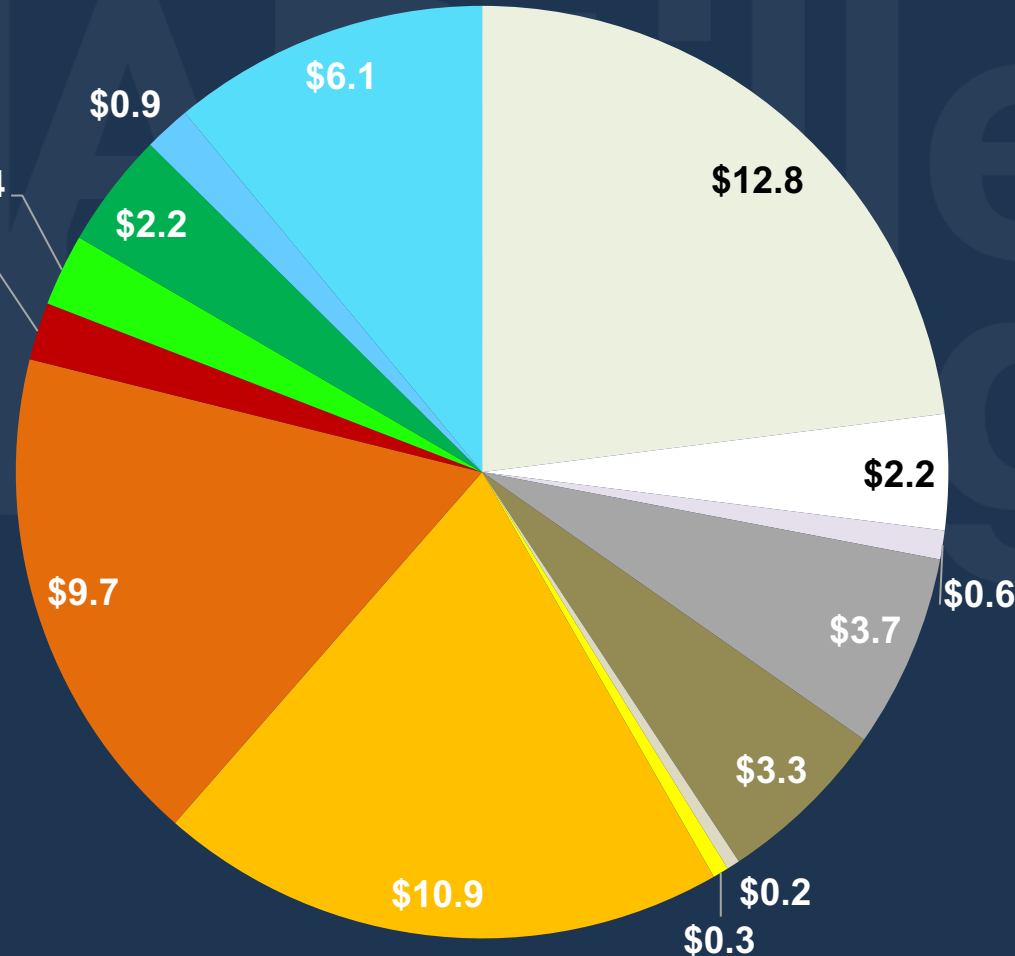
# VR Installed Base

## 2023 VR Installed Base, by Headset

Millions of Units

2023

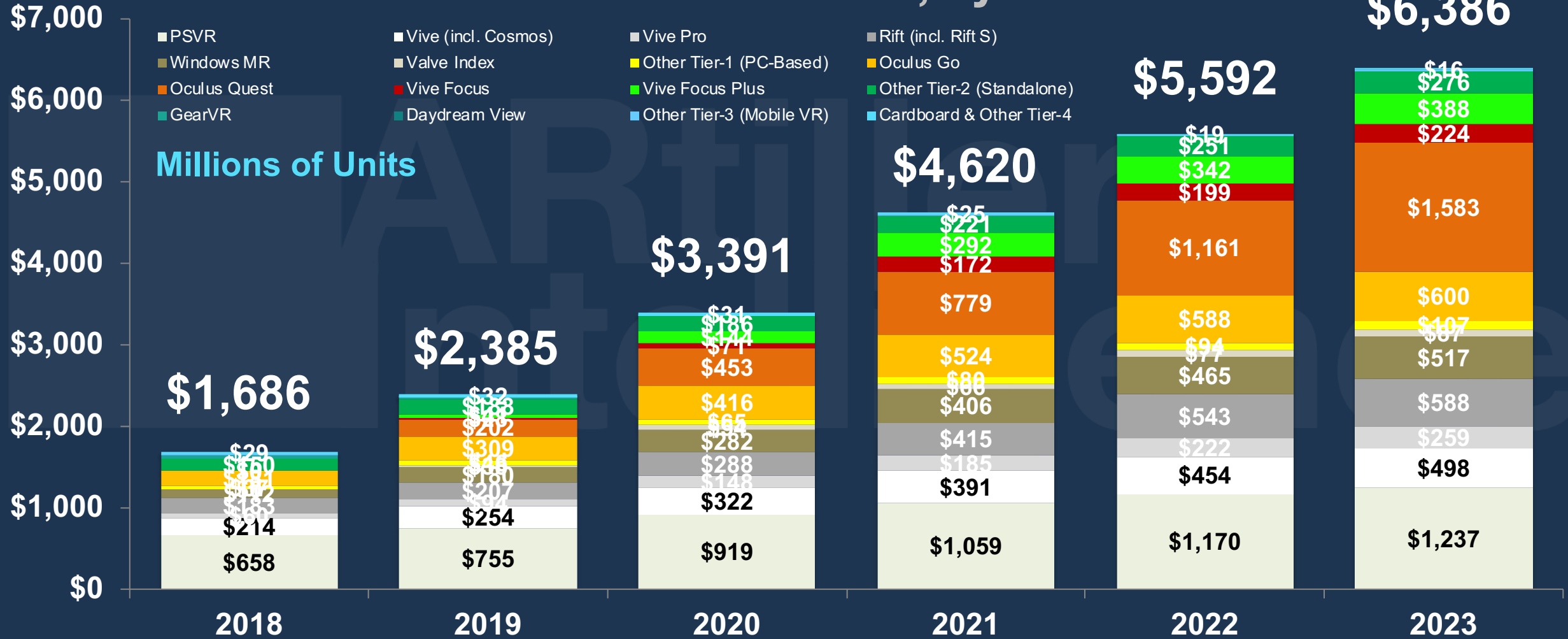
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- Other Tier-3 (Mobile VR)
- Cardboard & Other Tier-4

# VR Hardware Revenue

## Global VR Annual Hardware Sales, by Headset



\*Headsets are stacked from bottom to top in order of product classes (tier 1- tier 4).

\*\* Some headsets don't appear in some years if it's before their launch or after their discontinuation.

\*\*\* Data are available in chart form to decipher labels where clustered. Also see pie charts on the next slides.

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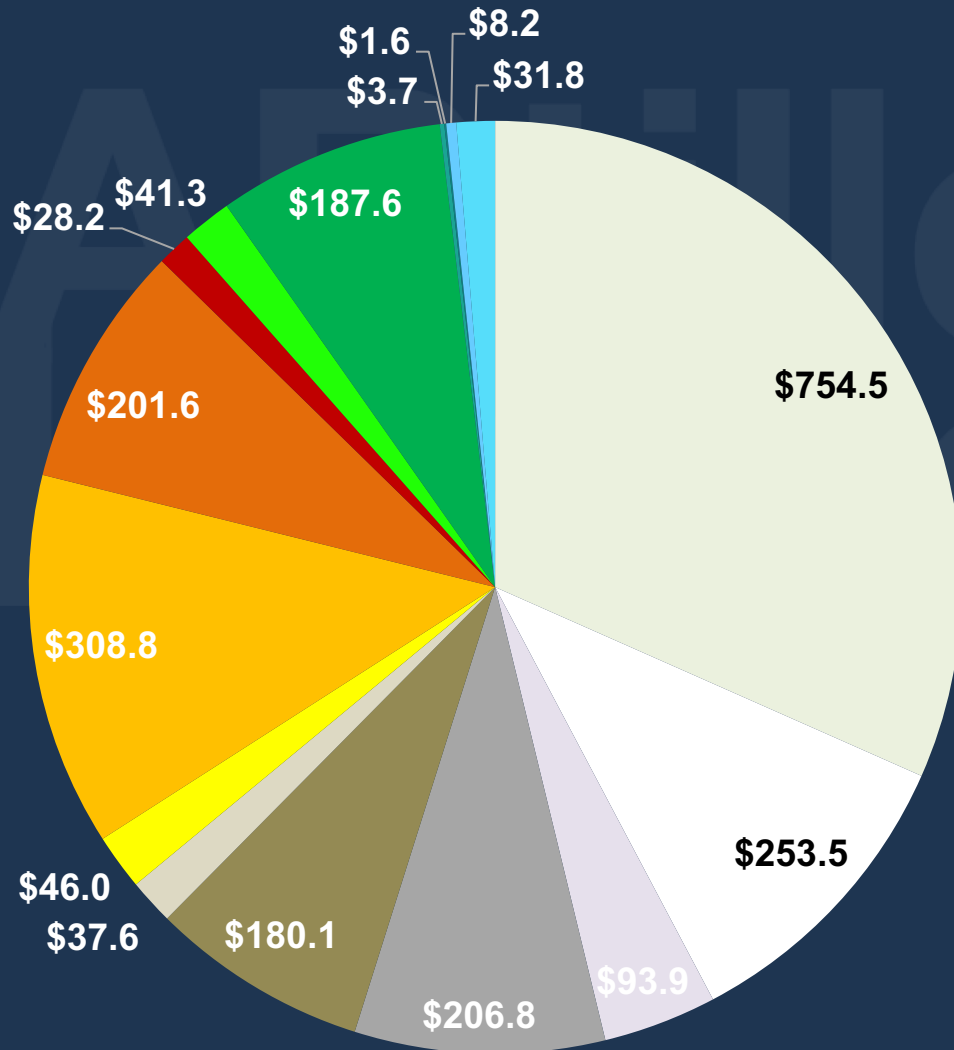
# VR Hardware Revenue

## 2019 VR Hardware Sales, by Headset

U.S. \$Millions

2019

\*Headsets don't appear if the time frame is before their launch or after their discontinuation



- PSVR
- Vive (incl. Cosmos)
- Vive Pro
- Rift (incl. Rift S)
- Windows MR
- Valve Index
- Other Tier-1 (PC-Based)
- Oculus Go
- Oculus Quest
- Vive Focus
- Vive Focus Plus
- Other Tier-2 (Standalone)
- GearVR
- Daydream View
- Other Tier-3 (Mobile VR)
- Cardboard & Other Tier-4

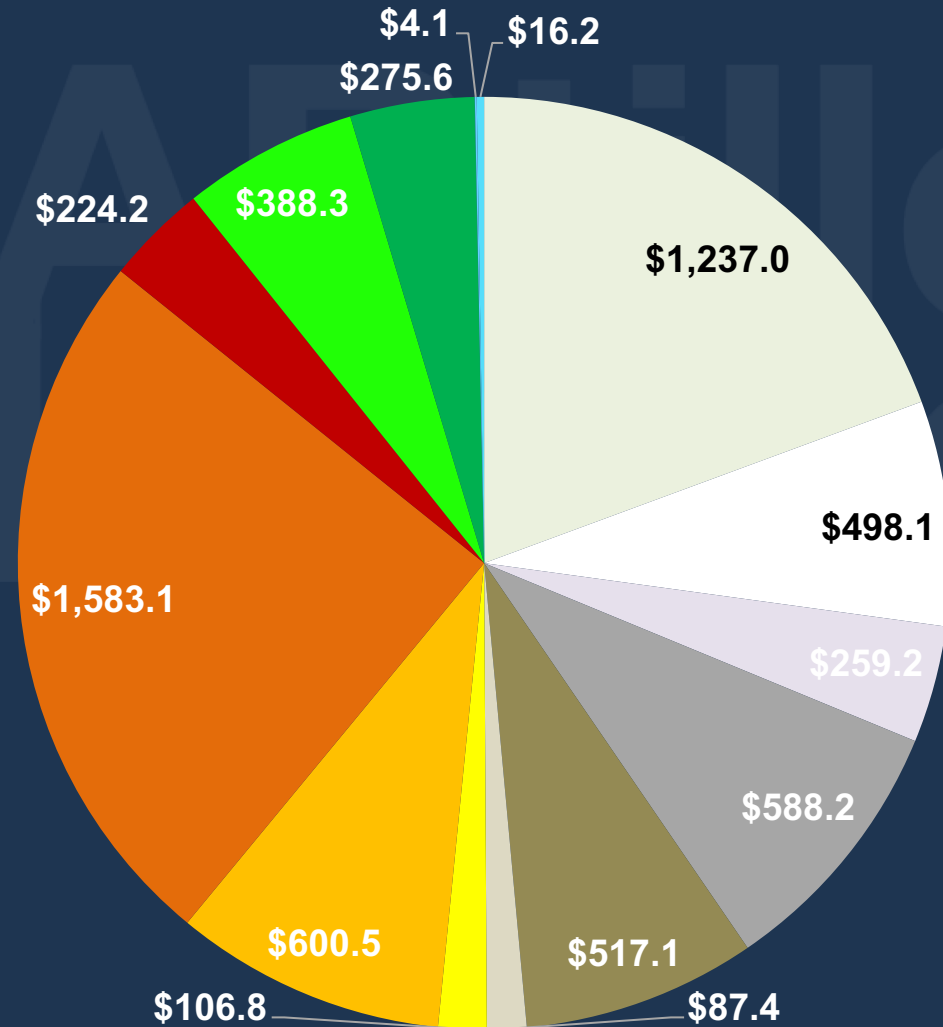
# VR Hardware Revenue

2023 VR Hardware Sales, by Headset

U.S. \$Millions

2023

\*Headsets don't appear if the time frame is before their launch or after their discontinuation



- PSVR
- Vive (incl. Cosmos)
- Vive Pro
- Rift (incl. Rift S)
- Windows MR
- Valve Index
- Other Tier-1 (PC-Based)
- Oculus Go
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- Other Tier-2 (Standalone)
- GearVR
- Daydream View
- Other Tier-3 (Mobile VR)
- Cardboard & Other Tier-4

# Key Takeaways (Redux)

# Key Takeaways

Takeaways and growth dynamics for VR and its sub-sectors.

**Consumer VR** will grow from **\$3.07 billion** in 2018 to **\$10.55 billion** in 2023, a **28 percent** compound annual growth rate. Revenue will be hardware-dominant in early years as an installed base is established. Over time, software will gain ground with a faster refresh rate and as a larger cumulative installed base incentivizes VR content creators to invest in long-form content. Together, these factors will result in more robust VR content libraries, more users, and greater software spending per user (ARPU). Premium apps will dominate software revenues but in-app purchases, especially in gaming, will gain revenue share over time. Installed software will dominate VR, but slowly give way to web VR as its capability evolves. Price competition among VR headset manufacturers will meanwhile accelerate consumer adoption. **Oculus Quest** will impact aggregate VR unit and revenue growth. Based on signals from **Oculus**, we project the headset to reach **470,000** units and **\$202** million in revenue in 2019. That will be fueled by its Q2 launch blitz, and Q4 holiday season, given a giftable price point for some consumers. **Oculus** – with the advantage of **Facebook**-backing – has the flexibility to apply loss-leader pricing in order to strategically prioritize market share over margins. That will give it a strong competitive position versus players that are dependent on nearer-term hardware revenue.



# Key Takeaways

Takeaways and growth dynamics for VR and its sub-sectors.

**Enterprise VR** will grow from **\$829 million** in 2018 to **\$4.26 billion** in 2023, a **39 percent** compound annual growth rate. This includes any spending on VR technology from enterprise buyers, including deployed hardware, software running on VR headsets and VR creation tools (e.g. **Unity**). As for areas of applicability, VR won't add as much value in industrial settings (where AR shines) as it does in corporate contexts such as data visualization and industrial design. Employee training will be a key use case in retail and industrial segments. We also measure the VR spending of location based VR (LBVR) such as VR arcades (further detailed on slide 11). This includes VR hardware purchases and software licenses which are counted in this forecast as enterprise VR spending, while admissions are counted as consumer-spending. Like in consumer markets, VR's near-term enterprise revenue in all of the above categories will be hardware-dominant as it's the first step to tech adoption. That installed base will pave the way for enterprise VR software revenues to gain spending share over time. Unlike AR, which will have specialized hardware that's optimized for enterprise functions, enterprise VR will mostly utilize the same off-the shelf software used in consumer markets (with some exceptions like **VIVE PRO**). The off-the-shelf availability and economics of that hardware will lower enterprise VR adoption barriers.

# Key Takeaways

Takeaways and growth dynamics for VR and its sub-sectors.

**VR Hardware** will grow from **\$1.67 billion** in 2018 to **\$6.39 billion** in 2023, a **31 percent** compound annual growth rate. That includes spending across consumer and enterprise markets. In absolute terms, the market share leader in revenue and units is **Playstation VR (PSVR)** with an estimated **2.1 million** units sold this year. But, the most notable trend in headset market evolution is the rise of standalone headsets and the corresponding fall of mobile VR. Due to **Oculus'** loss-leader pricing referenced earlier, standalone headsets like **Go** and **Quest** are falling within striking distance of price points previously occupied by mobile VR headsets like **GearVR** and **Daydream View**. The same pricing strategy will drive **Oculus Rift S** unit sales in the coming quarters, though the equally-priced **Quest** will outsell it **3 to 1** by 2023. Compounding passive attrition to mobile VR -- driven by these better alternatives -- the segment is also actively retracting from the market. That most notably includes **Google's** official departure from the **Daydream** platform, and **Samsung's** sunsetting of the once-prevalent **Gear VR. Cardboard** and tier-4 headsets will be unsubstantial in revenue and market impact, though they'll still have substantial unit sales in markets like China. We've provided sales figures in this report both with and without these lower headset tiers for alternative market views.

# Key Takeaways

Takeaways and growth dynamics for VR and its sub-sectors.

**VR Software** will grow from **\$963 million** in 2018 to **\$5.2 billion** in 2023, a **40 percent** compound annual growth rate. That includes spending across consumer and enterprise markets. In consumer markets, software is led by game and app purchases (**\$282 million**), followed by game subscriptions such as **Viveport** (**\$127 million**), and in-app purchases (**\$23.5 million**). The latter will gain share over time though game/app purchases and subscriptions will dominate, as they do in PC and console gaming. In the enterprise, VR software is led by installed software and apps (**\$276 million**), followed by LBVR game licences (**\$188 million**), developer tools (**\$55 million**), and OEM software/support packages (**\$11.9 million**). Breaking down some of these categories, installed software includes VR visualization software in corporate or industrial environments (e.g. design prototyping). Developer tools include SaaS-delivered platforms for building VR experiences. This spending is informed largely by the category leader, Unity, though a long tail will also develop in the market as VR experience creation grows and fragments into specialized areas (e.g. vertical market focus). Though end-users in some of these VR development efforts are consumers (e.g. game creation), the software spend is from an enterprise buyer and therefore counted as *enterprise VR* software. This involves an enterprise sub-category we call *B2B2C*.

# Key Takeaways

Takeaways and growth dynamics for VR and its sub-sectors.

**Location-Based VR (LBVR)** will grow from **\$1.25 billion** in 2018 to **\$3.13 billion** in 2023, a **20 percent** compound annual growth rate. The sector's health today is driven by consumers' early-stage reticence to purchase VR hardware and instead "rent" VR experiences. However, that's a double-edged sword that diminishes the category's long-term health... just as video game console growth in the late 80's caused attrition to the arcades came before it. Potentially counteracting that attrition is overall growth in VR demand that could rise all boats. In a potential growth environment, LBVR success will hinge on execution and factors like packaging, pricing and marketing. Bright spots could be social and experiential installations such as free-roam facilities that, depending on their fill rates, have higher ARPU potential. This includes **Sandbox VR**, which just secured **\$11 million** in series A funding from top-tier investors. LBVR revenue estimates are informed from facility volume (which vary in size and format) and unit economics. The latter includes variables like number of headsets on hand, revenue per hour of use, fill rates, and variable licensing costs. Best practices are starting to standardize such as usage yield in \$25 per-hour range, and game licensing costs that are roughly 15 percent of revenue. The key variable – and wild card for the sector's health – will be fill rates for LBVR facilities.

# Key Takeaways

Takeaways and growth dynamics for VR and its sub-sectors.

**VR Advertising** will grow from almost nothing today to **\$93 million** in 2023. This is by far the smallest spending category in this forecast, though we believe it is worth tracking for its long-term implications. It's also notable that advertising in VR is inversely positioned to its share of revenue in AR, where it's the leading category.\* That's mostly due to the scale reached by mobile AR by piggybacking on the massive smartphone installed base. It's further accelerated by the efforts of **Snap** and **Facebook** to create AR lens formats that have resonated with consumers and advertisers. But most of all, it's achieving scaled reach which is brand advertisers' primary consideration. We take that AR tangent to add context (and contrast) to advertising's place in VR. Though its highly immersive orientation has proven effective in key performance indicators (KPIs) like engagement and brand recall, VR advertising's scale is too low to attract brand marketers. Just as ARtillery analysts have built ad revenue forecasts for 15 years in desktop and mobile (search, display, social, etc.), ad market sizing builds up from unit economics such as reach, impressions, clicks and other KPIs that vary by format. Using those same measurements in VR – a fitting methodology as it aligns with the practices and comprehension of brand advertising buyers – yields revenue levels that are insubstantial today but worth watching closely.

# Resources & References



# Next Steps

In addition to standalone status, this forecast lays the groundwork for ARtillery Intelligence future deliverables.

With the foundation of this data set, several subsequent narratives will be developed in the coming months that each drill down into VR sub-sectors, rationale, revenue-drivers and strategic implications.

We will also update this data set annually, projecting a five-year time horizon with each forecast. We will expand the scope of this forecast over time as well, to include more categories of VR spending (see slide 5 for exclusions).

We encourage questions and coverage suggestions [here](#).

# About ARtillery Intelligence

ARtillery Intelligence chronicles the evolution of spatial computing. 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 journalistic approach. It also maintains a business angle: Though there are lots of fun and games in spatial computing such as AR & VR, cultural, technological and financial implications are the primary focus.

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 consumer survey data and multimedia, all housed in a robust intelligence vault. Learn more [here](#).



# About Intelligence Briefings

ARtillery Intelligence Briefings are monthly installments of VR/AR data and analysis. They synthesize original and third-party data to reveal opportunities and dynamics of VR and AR sectors. In addition to data, a layer of insights is applied to translate market events and raw figures into prescriptive advice.

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 has been an industry analyst covering mobile and social media since 2005, and is now Chief Analyst of *ARtillery Intelligence* and Editor-in-Chief of *AR Insider*.

Mike is a frequent speaker at industry conferences such as AWE, VRLA and LeadsCon. He has authored more than 120 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](#).

# Forecast Methodology

*ARtillery Intelligence* follows disciplined best practices in market sizing and forecasting, developed and reinforced through its principles' 15 years in research and intelligence in tech sectors. This includes the past 3.5 years covering AR & VR as a main focus.

This report focuses on AR and VR revenue projections in various sub-sectors and product areas. *ARtillery Intelligence* has built financial models that are customized to the specific dynamics and unit economics of each. These include variables like unit sales, company revenues, pricing trends, market trajectory and several other micro and macro factors that *ARtillery Intelligence* tracks.

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. For more information on what's included and not included in the forecast (a key consideration when evaluating the figures) see slide 5.

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

## Disclosure & Ethics Policy

ARtillery has no financial stake in the companies mentioned in this report, nor received payment for its production. Similarly with market sizing, ARtillery Intelligence remains independent of players and practitioners in the sectors it covers, thus mitigating bias in industry revenue calculations and projections. ARtillery's disclosure and ethics policy can be seen in full [here](#).



# What's Included in VR Revenue Totals?

VR industry revenues totaled in this report include consumer and enterprise segments. These are each subdivided by several revenue sources, such as **hardware** (headsets), **software** (game/app purchases and experience creation engines) **advertising** (in-game/app), and **LBVR** (VR spending and admissions revenue).

Consumer revenue is defined as anything consumers pay for (headsets, games, etc.). Enterprise revenue is anything companies pay for (visualization software, LBVR headset purchases, experience creation engines, etc.). Some of that deviates from common industry connotations for “enterprise” which is usually limited to industrial and corporate use cases. We track those revenue sources but also include tools for developers, brands and other entities that build/sell consumer-facing VR (B2B2C). See more below.

## Included\*

**VR Hardware:** e.g. headsets, bundled input devices

**Consumer VR Software:** e.g. apps, game subscriptions

**Enterprise VR Software:** e.g. enterprise visualization, training, developer platforms, LBVR game licenses

**VR Advertising:** e.g. in-game ad placements

**Location Based VR:** Hardware & game licenses (counted as enterprise VR spending), admissions (counted as consumer VR spending)

## Not Included

**PC or Gaming Consoles:** e.g. Playstation 4

**VR Cameras:** e.g. 360 degree camera hardware

**Network Data:** e.g. Telco-delivered data usage for VR

**Professional Services:** e.g. VR consulting & agencies

**App/Game Creation Overhead:** e.g. Developer salaries

**Advertising Creation:** e.g. Creative production, agency fees

**Commerce (transaction value):** Value of goods bought through VR interfaces (e.g. Cost of a couch bought through Macy's in-store furniture visualization).

# Contact & Reference

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