ARTILLERY INTELLIGENCE BRIEFING

AR GLOBAL REVENUE FORECAST, 2018-2023

JULY 2019

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Executive Summary

Introduction

The augmented reality sector continues to show early-stage characteristics, including volatile levels of interest and investment. But how big is it now, and how big will it get? *ARtillery Intelligence* has quantified its revenue position and outlook, resulting in our latest forecast. This is the fourth wave of ARtillery's AR 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 devised a disciplined and independent market-sizing process. 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 AR 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 AR 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.

The goal, as always, is to empower you with a knowledge position.

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What's Included in AR Revenue Totals?

AR industry revenues totaled in this report include consumer and enterprise AR segments. These are each subdivided by several revenue sources, such as hardware (glasses and hearables), software (In-app purchases and productivity apps) advertising (social AR lenses), and commerce (affiliate revenue).

Though we track transaction value of consumer products purchased through AR interfaces, such as a new pair of shoes (AR visualization), we *do not* include them in AR revenue totals. Affiliate fees (revenue share or software licensing) for AR commerce tools that drive those transactions *are* included. AR hardware includes headsets, but *not* smartphone sales for mobile AR, nor network data fees. See more below.

Included

AR Hardware: e.g. smart glasses
AR Consumer Software: e.g. apps, in-app purchases
AR Enterprise Software: e.g. industrial visualization support, AR developer platforms
AR Advertising: e.g. Display (Snapchat Lenses), and Search (Google Lens) ad placements
AR Commerce Enablement: Affiliate revenue or software licensing for driving commerce through AR interfaces

Not Included

Smartphone Sales: e.g. iPhone to run ARkit apps
Hearables: e.g. AirPod sales*
Network Data: e.g. Telco-delivered data usage for AR
Professional Services: e.g. Enterprise AR consulting
App Creation Overhead: e.g. Developer salaries
Advertising Creation: e.g. Creative production, agency fees
Commerce (transaction value): Value of goods bought through AR interfaces (e.g. footwear, furniture).*

ARtillery Intelligence

Key Takeaways

Global AR Revenue

(Simplified View)

Consumer & Enterprise AR Revenues, by Source*

U.S. $Millions

Simplified view: Data labels and full detail provided later in this report

Chart data (U.S. $Millions):
- 2018: $1,959
- 2019: $4,664
- 2020: $7,812
- 2021: $12,059
- 2022: $18,630
- 2023: $27,409

Legend:
- AR Advertising
- Enterprise AR Software (Developer Tools)
- Enterprise AR Software (Glasses-Based)
- Enterprise AR Hardware (Glasses)
- Affiliate AR Commerce (Rev Share)
- Enterprise AR Software (Mobile & Tablet)
- Consumer Software (Mobile)
- Consumer AR Hardware (Glasses)
- Consumer AR Software (Glasses-Based)

*Does not include hearables (see separate drilldown)

ARtillery Intelligence

Key Takeaways

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

Consumer AR will grow from $957 million in 2018 to $7.9 billion in 2023, a 53 percent compound annual growth rate. Near-term revenues will be dominated by mobile AR. Revenues will also be software-centric during that time (mobile device sales aren't counted as AR revenue) and will include premium apps and in-app purchases. The latter will dominate software revenues in the near term, due to consumer resistance to pay upfront for AR apps,* as well as the in-app revenue model validated by Pokémon Go. Niantic will find success in its Harry Potter-themed follow-up game to Pokémon Go, and its AR developer platform built on PGO's architecture. A mobile AR killer app could emerge in 2020, likely built around a utility like visual search, or through viral growth of a native AR social/multiplayer app. Consumer AR revenue share will begin to shift towards hardware starting in 2022 as smart glasses, likely from Apple, approach consumer-friendly specs and standards. After that point, premium software share will grow as a corollary, as it's a model conducive to dedicated AR hardware (similar to how apps/games are purchased in VR). Until then, developers' work in mobile AR will be a training ground for an eventual glasses-dominant era beyond 2022. Mobile AR will likewise acclimate consumers to spatial experiences and seed demand for AR glasses in the long term. Hearables will be a wild card.**

Key Takeaways

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

Enterprise AR will grow from $1.002 billion in 2018 to $19.45 billion in 2023, an 81 percent compound annual growth rate. This is subdivided between hardware, enterprise productivity software (e.g. visualization support in industrial settings), enterprise advertising, affiliate commerce revenue, and AR developer/enablement platforms. In industrial/productivity contexts, growth will result from wide applicability across enterprise verticals, and clear ROI (e.g. manufacturing efficiencies). Adoption is currently dampened by typical organizational inertia and risk aversion. ARtillery Intelligence believes these factors will continue to stunt enterprise AR growth but will be outweighed eventually by the momentum, support and ROI realizations currently building. A tipping point will come in 2020 or 2021, after which adoption accelerates in a pattern that's similar to historical enterprise smartphone adoption. Meanwhile, greater near-term revenues are seen in other enterprise software subsegments such as AR developer platforms (e.g. Unity, Niantic). These will see healthy growth during this forecast period through Saas-like (ARaaS) packaging/pricing. Value propositions for such AR enablement tools, or "picks & shovels," are aligned with early-stage enterprise demand. They'll be key ingredients to boost AR creation, democratize advance capability and accelerate time to market.

Key Takeaways

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

AR Advertising will grow from $453 million in 2018 to $8.8 billion in 2023, an 81 percent compound annual growth rate. Included in our classification of "Enterprise AR" (due to the spending source), this involves product promotions through AR interfaces. As proved by Snapchat and Facebook, AR lenses can demonstrate products in highly immersive ways. This has shown relatively strong ad performance, which continues to attract brand advertisers and reinforce return on ad spend (ROAS). AR advertising also has a rare ability to span the "purchase funnel" from awareness-based advertising to direct-response. The former is delivered with high-reach mediums like the Facebook News Feed, while the latter is accomplished through AR lens-based product try-ons (think: cosmetics). As a corollary, ARtillery Intelligence projects $12.7 billion in products to be purchased through AR interfaces by 2023 (not counted as "AR revenue"). This will drive affiliate revenue (counted as "AR revenue") for AR ad-tech startups and enablers to the tune of $404 million by 2023. All of the above is in the category of display advertising, but the next advancement will come with search advertising. Visual search, a la Google Lens, identifies real world objects using one's smartphone camera or AR glasses. As an ad medium, it will see strong performance and ad premiums due to high consumer intent (just like core search).

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Key Takeaways

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

AR Headsets will grow in unit sales from 130,000 in 2018 to 2.89 million in 2023. That correlates to an installed base of 5.03 million units in market by 2023. This includes both enterprise and consumer, the former leading in early years with 160,000 units sold in 2019. Consumer AR glasses will pull ahead in 2022 with 1.15 million units sold. This will result from improving standards and specs for consumer-grade smart glasses (size, weight, style, etc.). It will be further accelerated through Apple's market entrance – both through its own AR glasses sales and the halo effect they create on the rest of the market. Meanwhile, mobile AR is where scale lies, especially in consumer markets. There, the installed base is often cited as "1 billion units." This is true if counting only Apple (ARkit) and Google (ARcore) device penetration. However, it's much more nuanced, given a fragmented set of platforms and delivery channels for mobile AR. That includes web AR (2.97 billion), Facebook's Spark AR platform (1.6 billion) and Snap's Lens Studio (190 million). But the number that matters most is active AR users. When tallying and de-duplicating active users across these platforms, the total comes to 334 million. ARtillery Intelligence projects this figure to grow to 1.076 billion active mobile AR users by 2023. These addressable and active use figures are detailed later in this report for all mobile AR platforms.

Global AR Revenue

Global AR Revenues

Global AR revenue will grow from U.S. $1.96 billion in 2018 to U.S. $27.4 billion in 2023, a 69.5% compound annual growth rate (CAGR).

Consumer and enterprise AR are at parity today, but not for long...
- Consumer AR comprises 49% of AR revenues in 2018 and 29% in 2023.
- Enterprise AR comprises 51% of AR revenues in 2018 and 71% in 2023.

AR's largest revenue source in 2018 was consumer AR software ($863M).
- This is due mostly to in-app purchases from Pokemon Go.
- The second largest AR revenue source in 2018 was advertising ($453 million), mostly due to branded AR lenses from Snap and Facebook.
- The largest AR revenue source projected for 2023 will be advertising ($8.8 billion), followed by enterprise-facing AR developer platforms (ARaaS).

Global AR Revenues (cont'd)

- AR as a service (ARaaS) platforms enable companies to build AR for internal productivity, or for consumer-facing experiences (their customers).
  - The latter (B2B2C) scenarios are categorized as enterprise AR spending, due to the revenue source. It will most notably include retail & commerce.
  - AR enablement tools or "picks & shovels" will represent a large spending category as they democratize AR creation and accelerate time to market.

- AR Glasses will start slow for both consumer and enterprise, but will reach a combined installed base of 5.03 million units by 2023.
  - Apple AR glasses will accelerate consumer AR hardware starting in 2022.
  - Mobile AR is where near-term scale lies, given 3.4B global smartphones.
  - Of those, "1 billion" is often cited as being AR compatible. This is true of ARkit and ARcore, but the real total is greater, given additional platforms like web AR, Facebook and Snap (detailed later in this report).

Global AR Revenue

(Detailed View)

Consumer & Enterprise AR Revenues, by Source*

U.S. $Millions

Year	Total
2018	$1,959
2019	$4,664
2020	$7,812
2021	$12,059
2022	$18,630
2023	$27,409

2018:
- $10
- $83
- $864
- $158
- $2
- $157
- $105
- $127
- $453

2019:
- $31
- $131
- $1,308
- $422
- $7
- $399
- $345
- $440
- $1,580

2020:
- $62
- $205
- $1,896
- $577
- $30
- $599
- $705
- $1,160
- $2,578

2021:
- $84
- $249
- $2,875
- $598
- $83
- $849
- $1,110
- $2,343
- $3,868

2022:
- $239
- $1,206
- $3,939
- $510
- $1,099
- $195
- $1,530
- $4,103
- $5,810

2023:
- Consumer: $561
- $2,370
- $5,028
- $349
- $404
- $1,348
- $1,980
- $6,565
- Enterprise: $8,803

Legend
- ■ AR Advertising
- ■ Enterprise AR Software (Developer Tools)
- ■ Enterprise AR Software (Glasses-Based)
- ■ Enterprise AR Hardware (Glasses)
- ■ Affiliate AR Commerce (Rev Share)
- ■ Enterprise AR Software (Mobile & Tablet)
- ■ Consumer Software (Mobile)
- ■ Consumer AR Hardware (Glasses)
- ■ Consumer AR Software (Glasses-Based)

*Does not include hearables (see separate drilldown)

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Global AR Revenue
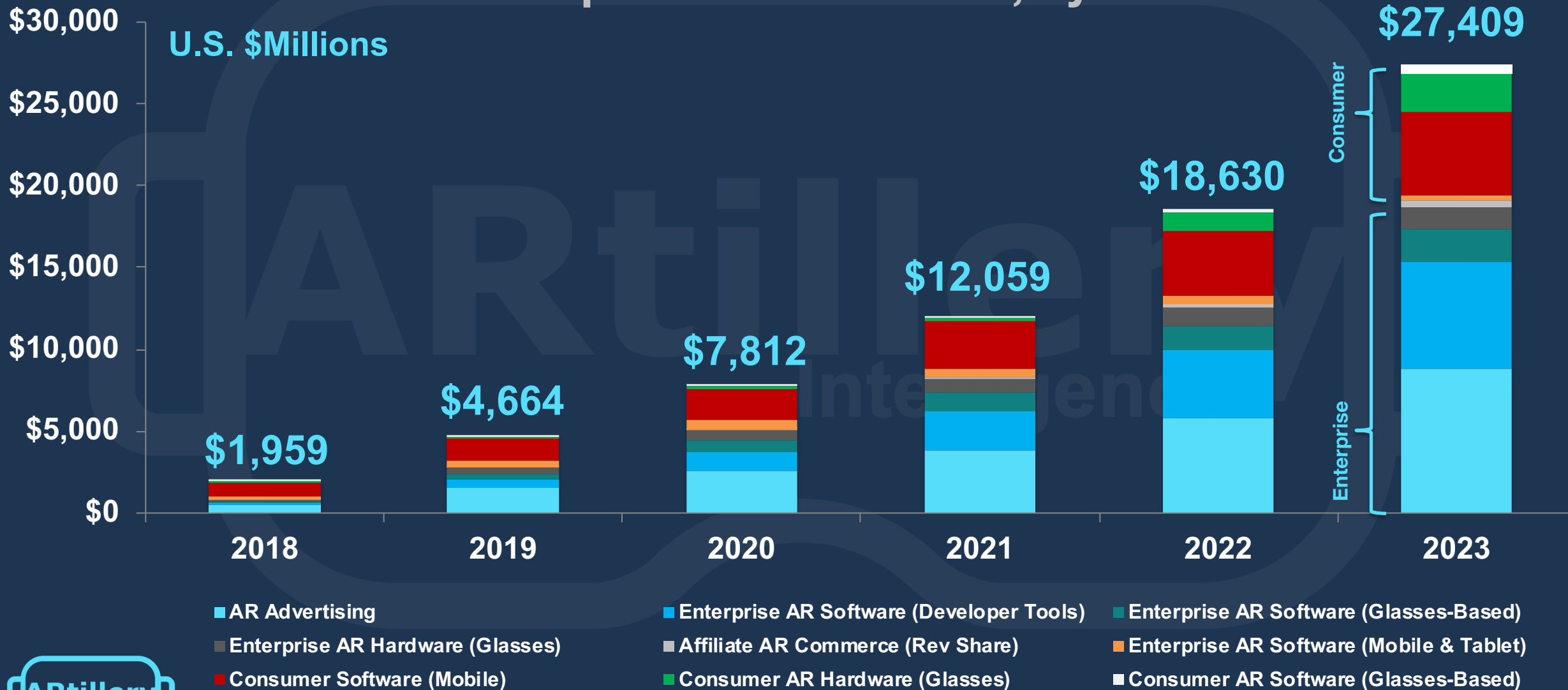
(Simplified View)

Consumer & Enterprise AR Revenues, by Source*

U.S. $Millions

$30,000	
$25,000	
$20,000	
$15,000	
$10,000	
$5,000	
$0	

2018 $1,959

2019 $4,664

2020 $7,812

2021 $12,059

2022 $18,630

2023 $27,409

Consumer

Enterprise

Legend:
- AR Advertising
- Enterprise AR Software (Developer Tools)
- Enterprise AR Software (Glasses-Based)
- Enterprise AR Hardware (Glasses)
- Affiliate AR Commerce (Rev Share)
- Enterprise AR Software (Mobile & Tablet)
- Consumer Software (Mobile)
- Consumer AR Hardware (Glasses)
- Consumer AR Software (Glasses-Based)

*Does not include hearables (see separate drilldown)

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Drilling Down: Consumer AR

Consumer AR Revenue

- Consumer AR revenue will grow from U.S. $957 million in 2018 to U.S. $7.9 billion in 2023, a 53% compound annual growth rate (CAGR).

- Revenues are led today by mobile AR software (consumer purchases).
  - Mobile AR hardware (smartphone sales) aren't counted as AR revenue, as it's a ubiquitous consumer device on which AR's function is secondary.

- In-app purchases (IAP) will dominate near-term mobile AR revenue – a vestige of the existing mobile app economy and its consumer acclimation.
  - IAP has been further validated through its revenue generation for Pokémon Go, which will be replicated in several AR games and use cases.
  - At mobile AR's early stages of consumer adoption, users aren't ready to commit to upfront (premium) app purchases, but are comfortable with IAP.*

*Validated in ARtillery Intelligence original survey research. See report: Mobile AR Usage & Consumer Attitudes, April 2019

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Consumer AR Revenues (cont'd)

- Premium app revenue will grow as a corollary to smart glasses, after 2022, as that's how software will be bought for AR headsets (similar to VR).

- Speaking of AR glasses, Apple's projected market entrance in 2022 will accelerate consumer AR hardware, both directly and through a "halo effect."
  - AR hardware (glasses) will grow from $83 million in 2018 to $2.37 billion by 2023, representing the second largest revenue source in consumer AR.
  - "Hearables" such as AirPods will outsell face-worn devices in the near term and already have an installed base approaching 100 million units.*

- Other AR hardware players will find success with differentiated product models and target markets, such as Magic Leap. Some will compete on price, such as nReal. There will be room for several players and product classes.

Consumer AR Revenue

Consumer AR Hardware & Software Spending*

U.S. $Millions

- AR Glasses Hardware
- AR Glasses Software
- Mobile AR Software
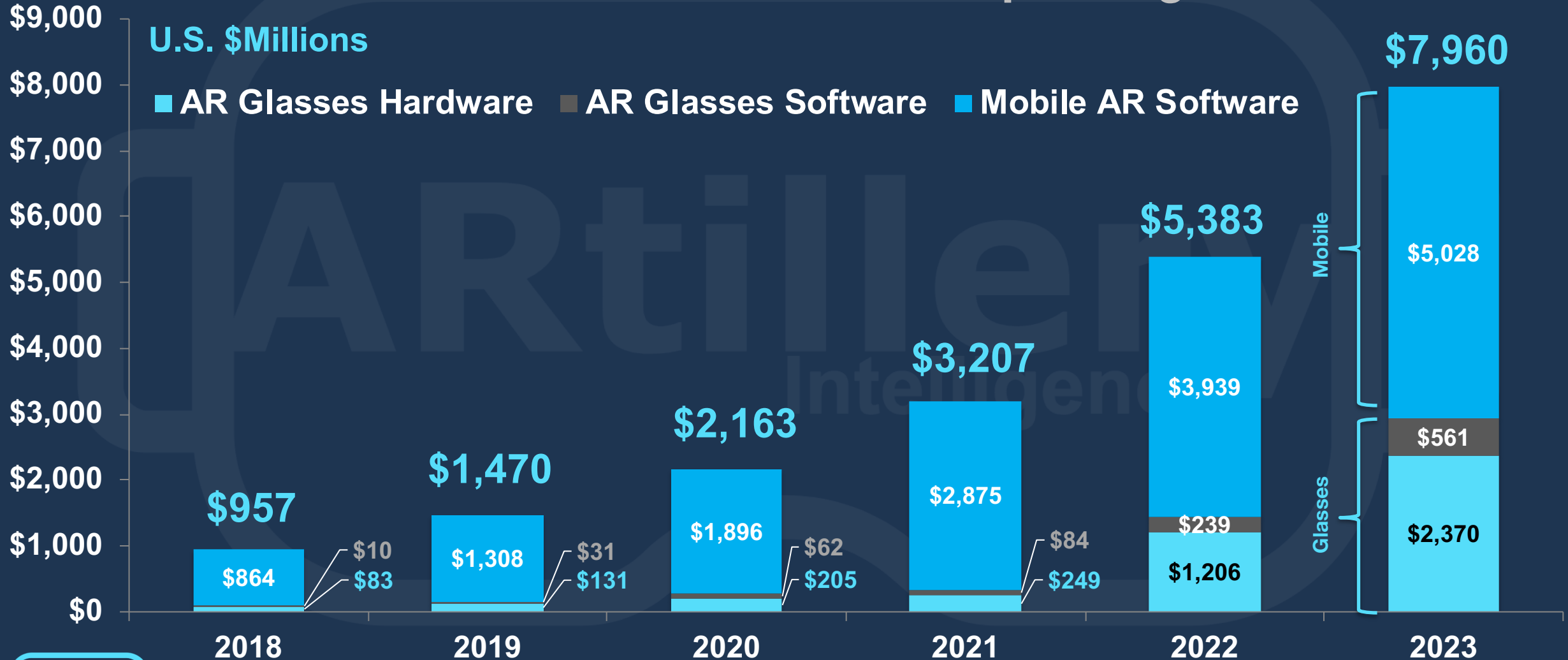
2018 — $957
- $864
- $10
- $83

2019 — $1,470
- $1,308
- $31
- $131

2020 — $2,163
- $1,896
- $62
- $205

2021 — $3,207
- $2,875
- $84
- $249

2022 — $5,383
- $3,939
- $239
- $1,206

2023 — $7,960
- Mobile: $5,028
- Glasses: $561
- $2,370

*Does not include hearables (see separate drilldown)

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Mobile AR Revenue

Consumer Mobile AR Software Revenue, by Country*

U.S. $Millions
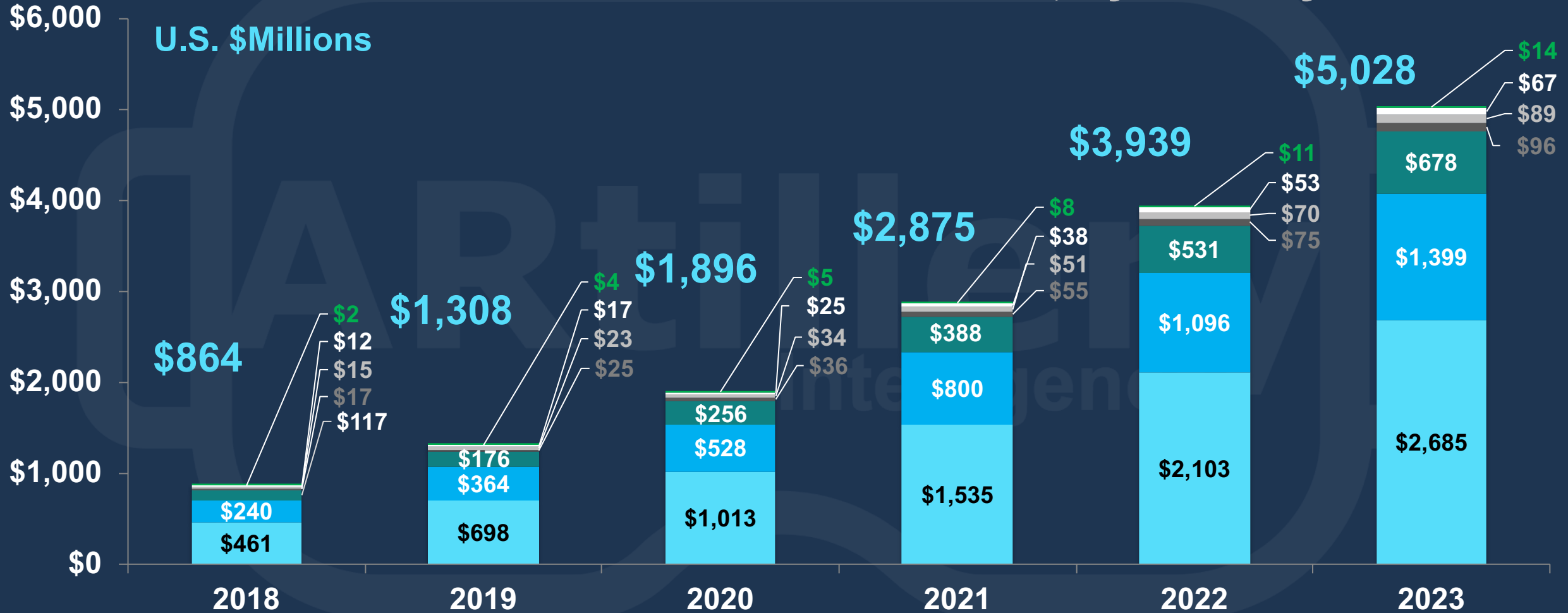
2018 — $864
- $461
- $240
- $117
- $17
- $15
- $12
- $2

2019 — $1,308
- $698
- $364
- $176
- $25
- $23
- $17
- $4

2020 — $1,896
- $1,013
- $528
- $256
- $36
- $34
- $25
- $5

2021 — $2,875
- $1,535
- $800
- $388
- $55
- $51
- $38
- $8

2022 — $3,939
- $2,103
- $1,096
- $531
- $75
- $70
- $53
- $11

2023 — $5,028
- $2,685
- $1,399
- $678
- $96
- $89
- $67
- $14

Legend: Asia ■ North America ■ Europe ■ Australia ■ South America ■ Middle East ■ Africa

*Includes hearables

Mobile AR Global Penetration

2019 AR-Compatible Devices & Active Users, Across Platforms*

Millions of Units

Devices ← → **Active Users**

334M Active Mobile AR Consumers (de-duplicated)

Web AR has the most growth potential & headroom

3391
2978
1650
1664
1114
550
190
334
129
92
83
137
84
33

- Global Smartphones
- Web AR (Devices)
- Facebook AR (Devices)
- Visual Search (Devices)
- ARkit (Devices)**
- ARCore (Devices)
- Snap AR (Devices)
- Total AR Active (De-Duped)
- Snap (Active)
- Visual Search (Active)
- Facebook AR (Active)
- ARkit (Active)**
- ARCore (Active)
- Web AR (Active)
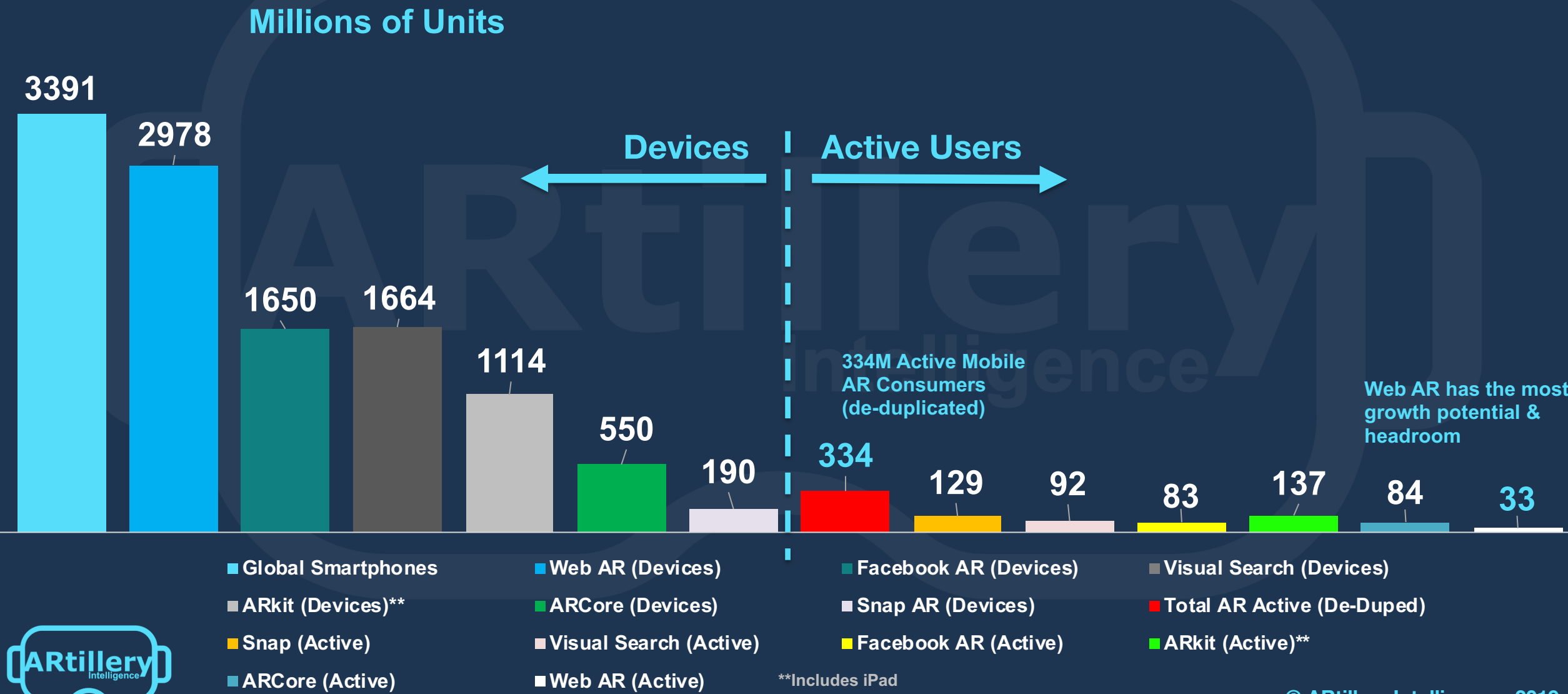
**Includes iPad
*Excludes platforms endemic to China (separate calculation)

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AR Hearables

Hearables Revenue

- Hearables revenue will grow from U.S. $6.6 billion in 2018 to U.S. $30.6 billion in 2023, a 36% compound annual growth rate (CAGR).

- Hearables are defined by audio devices worn persistently to deliver sensor-informed audio overlays, and "augment" consumer experiences.
  - Hearables is an early AR modality whose future is uncertain, but strong potential is indicated by the hardware installed base (e.g. AirPods).
  - Hearables will materialize as a meaningful product class when experiences and apps are built upon this hardware base. Until then, the use cases are speculative.*

- Revenues are led today by hardware, such as sales of Apple AirPods.
  - Software's revenue share will grow as the hardware installed base is established and as hardware providers open their platforms for developers.
  - Bose has already created an open platform (Bose AR) on which developers can build apps that create sensor-driven sound overlays.

Hearables Revenue

Consumer Hearables, Hardware & Software*

U.S. $Millions

■ Hardware ■ Software

2018 — $6,625
- $6,625 (Hardware)

2019 — $10,973
- $174 (Software)
- $10,799 (Hardware)

2020 — $15,500
- $646 (Software)
- $14,854 (Hardware)

2021 — $20,286
- $1,338 (Software)
- $18,948 (Hardware)

2022 — $25,317
- $2,274 (Software)
- $23,042 (Hardware)

2023 — $30,594
- $3,457 (Software)
- $27,137 (Hardware)
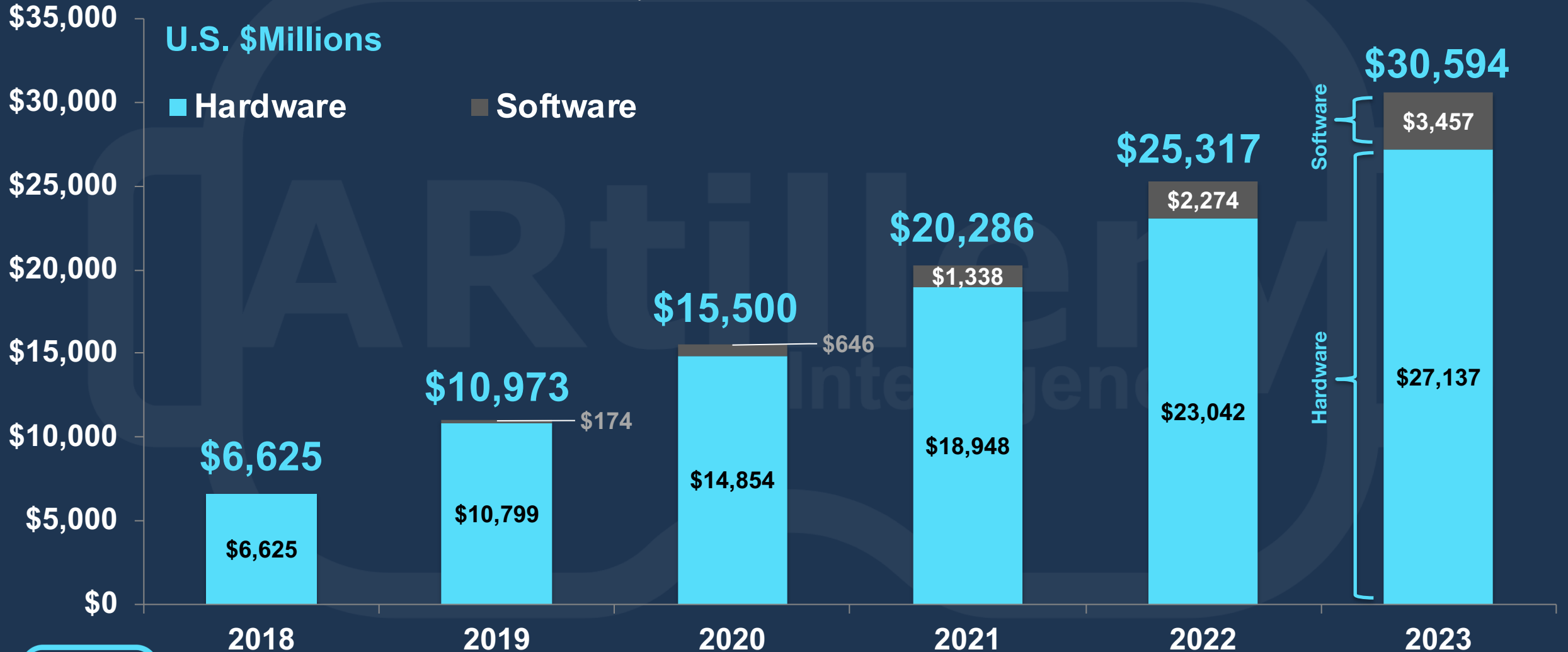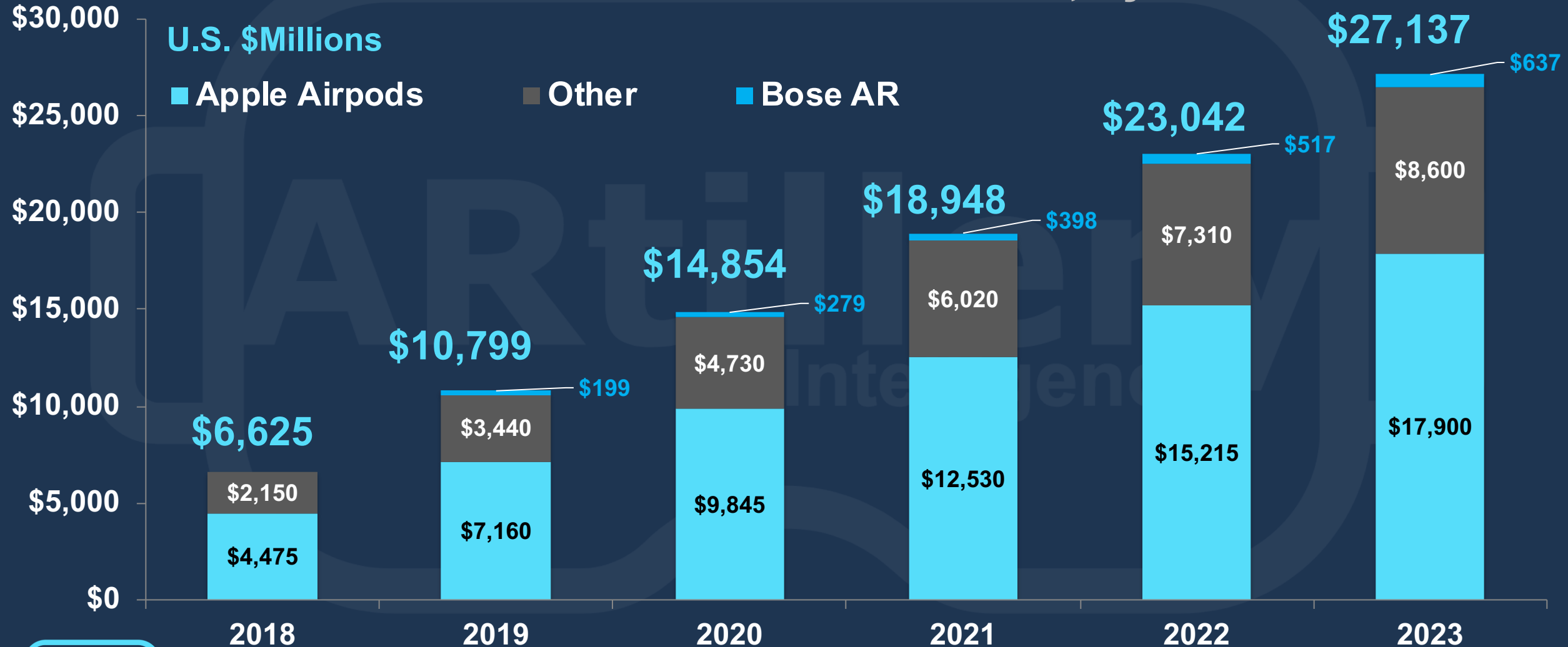
* Hearables revenue is tracked here, but isn't yet counted towards top-level AR revenue totals. See explanation slide.

Consumer AR Revenue

Consumer AR Spending (incl. hearables)*

U.S. $Millions

- AR Glasses Hardware
- AR Glasses Software
- Mobile AR Software
- Hearables Hardware
- Hearables Software

Year	Total	Values
2018	$7,582	$6,625 / $864 / $10 / $83
2019	$12,444	$10,799 / $1,308 / $31 / $131 / $174
2020	$17,663	$14,854 / $1,896 / $62 / $205 / $646
2021	$23,494	$18,948 / $2,875 / $84 / $249 / $1,338
2022	$30,700	$23,042 / $3,939 / $1,206 / $239 / $2,274
2023	$38,554	$27,137 / $5,028 / $2,370 / $561 / $3,457

Hearables / Mobile / Glasses
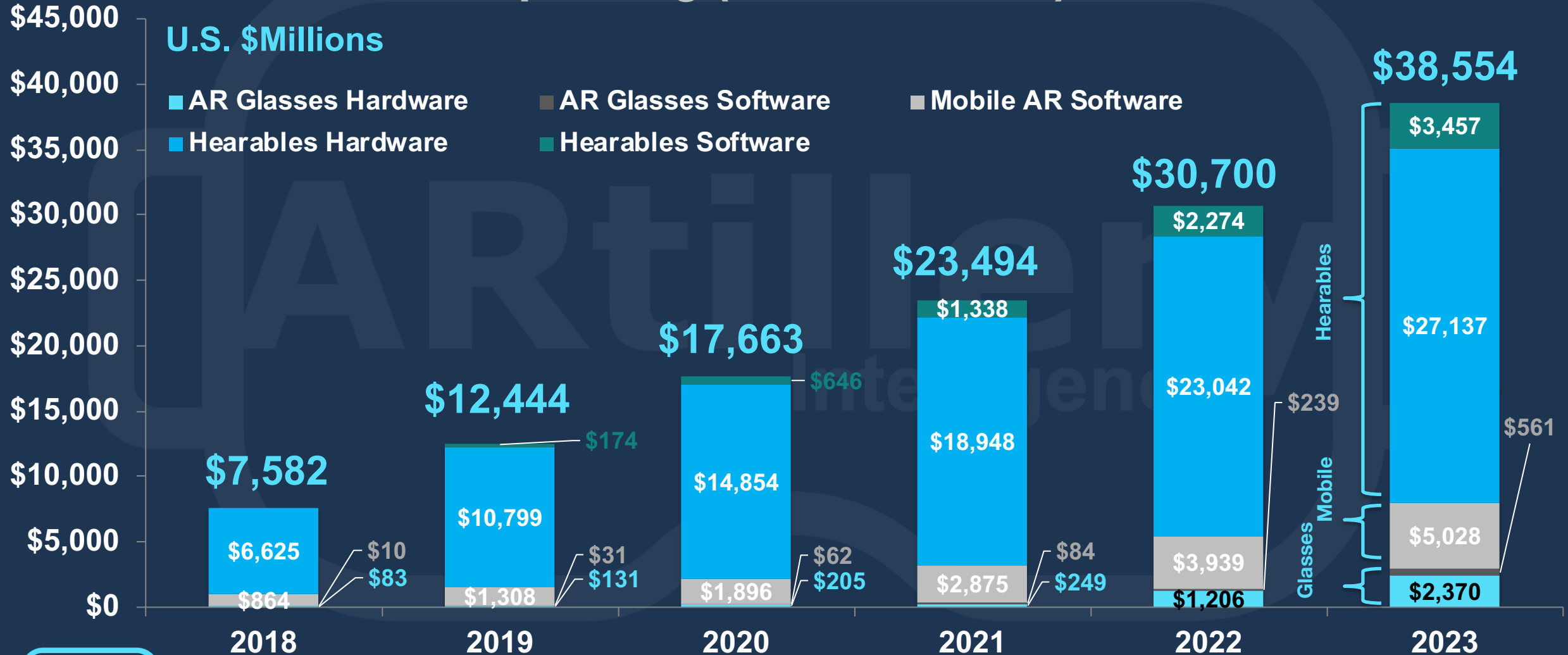
* Hearables revenue is tracked here for the sake of comparison, but isn't yet counted towards top-level AR revenue totals. See explanation slide.

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Drilling Down: Enterprise AR

Enterprise AR Revenue

Enterprise AR revenue will grow from U.S. $1.002 billion in 2018 to U.S. $19.5 billion in 2023, an 81% compound annual growth rate (CAGR).

Enterprise AR revenues are led today by software.
- Enterprise AR Software is divided between productivity apps, affiliate commerce revenue*, advertising* and AR developer platforms (ARaaS).
- Advertising has leading enterprise AR revenue share throughout the forecast period, but ARaaS developer platforms will see the most growth.

AR as a service tools (ARaaS) enable companies to build AR experiences.
- This includes AR experiences for a given brand's customers (B2B2C) and will be prevalent in retail & commerce as well as gaming & entertainment.
- ARaaS enablement tools or "picks & shovels" will be a large spending category as they democratize AR creation and accelerate time to market.

* Advertising and commerce enablement are counted in "Enterprise AR" due to the spending source, but are also examined separately in detail in the next section

Enterprise AR Revenues (cont'd)

- Enterprise AR productivity, such as visualization support in industrial settings, is experiencing slower than expected growth.
  - We've dialed back previous figures due to signals that indicate prevalence of "pilot purgatory" and organizational adoption barriers.*

- The starting point for enterprise AR productivity implementations is hardware, where signals indicate a slower than expected adoption.
  - Software revenue (e.g. remote assistance) partly correlates to hardware.
  - Nearer-term implementations include smartphone and tablet-based AR applications such as visualization support on trusted/owned hardware.

- Vertical-specific AR adoption follows predictable patterns and factors such as product/market fit; buyer urgency/need; spending power; and regulatory freedom. These factors, and vertical breakdowns in revenue, are detailed.

Enterprise AR Revenue

Enterprise AR Hardware & Software, by Source

U.S. $Millions

*Developer tools include AR creation and enablement software used by industrial and consumer-facing (i.e. retail) brands who build AR experiences.

**AR commerce enablement includes revenue share or software licensing for AR tools that help drive consumer purchases.

$1,002	$3,193	$5,649	$8,851	$13,247	$19,450

2018
- $2
- $453
- $127
- $158
- $105
- $157

2019
- $7
- $1,580
- $440
- $422
- $345
- $399

2020
- $30
- $2,578
- $1,160
- $577
- $705
- $599

2021
- $83
- $3,868
- $2,343
- $598
- $1,110
- $849

2022
- $195
- $5,810
- $4,103
- $510
- $1,530
- $1,099

2023
- $404
- $8,803
- $6,565
- $349
- $1,980
- $1,348

Legend:
- Hardware (Glasses)
- Productivity Software (Glasses-Based)
- Productivity Software (Mobile & Tablet-Based)
- Software (Developer Tools)*
- Advertising
- Commerce Enablement**

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Enterprise AR Hardware

AR Glasses Revenue, by Headset

U.S. $Millions

Totals include Microsoft's $480 million contract to supply up to 100,000 Hololens 2 units to the U.S. Army over the next five years. This spending total is amortized over the full contract period.

2018 — $157
- $9
- $3
- $5
- $11
- $25
- $105

2019 — $399
- $20
- $6
- $10
- $26
- $58
- $280

2020 — $599
- $30
- $9
- $16
- $38
- $86
- $420

2021 — $849
- $42
- $13
- $22
- $54
- $122
- $595

2022 — $1,099
- $54
- $29
- $17
- $70
- $158
- $770

2023 — $1,348
- $67
- $35
- $21
- $86
- $194
- $945

Legend: Hololens (1 & 2), Google Glass, Realware, Vuzix, Epson, Other

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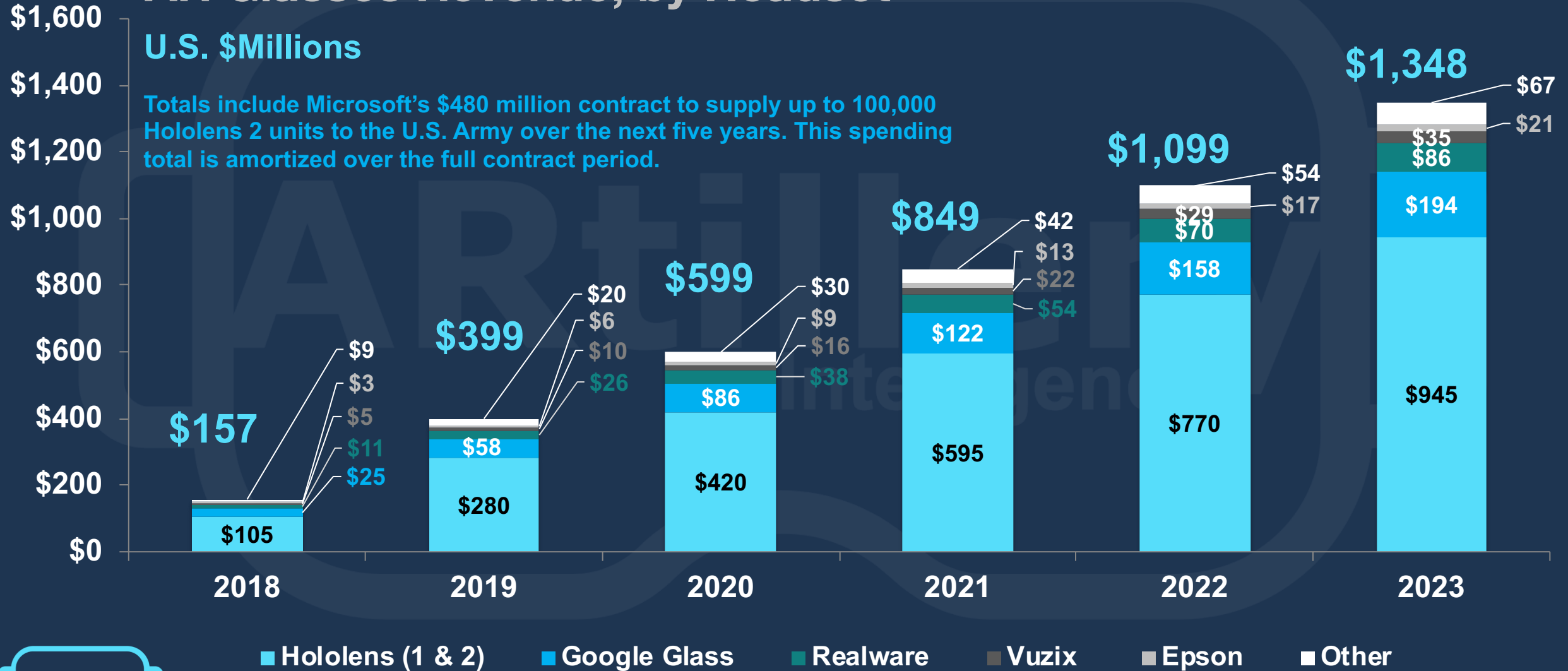
Enterprise AR Hardware

AR Hardware (Glasses) Spend, by Vertical

U.S. $Millions

Government/Millitary spending includes Microsoft's $480 million contract to supply up to 100,000 Hololens 2 units to the U.S. Army over the next five years.

Remaining data labels are available upon request, and further broken down in the following slide (2019 drilldown).

Legend:
- Government/Military
- Oil, Gas & Utilities
- Automotive
- Aviation & Aerospace
- AEC
- Transportation
- Telecom
- Other Industrial
- Healthcare
- Other Corporate/Commercial
- Finance
- Education
- Real Estate
- Retail & Commerce

© ARtillery Intelligence, 2019
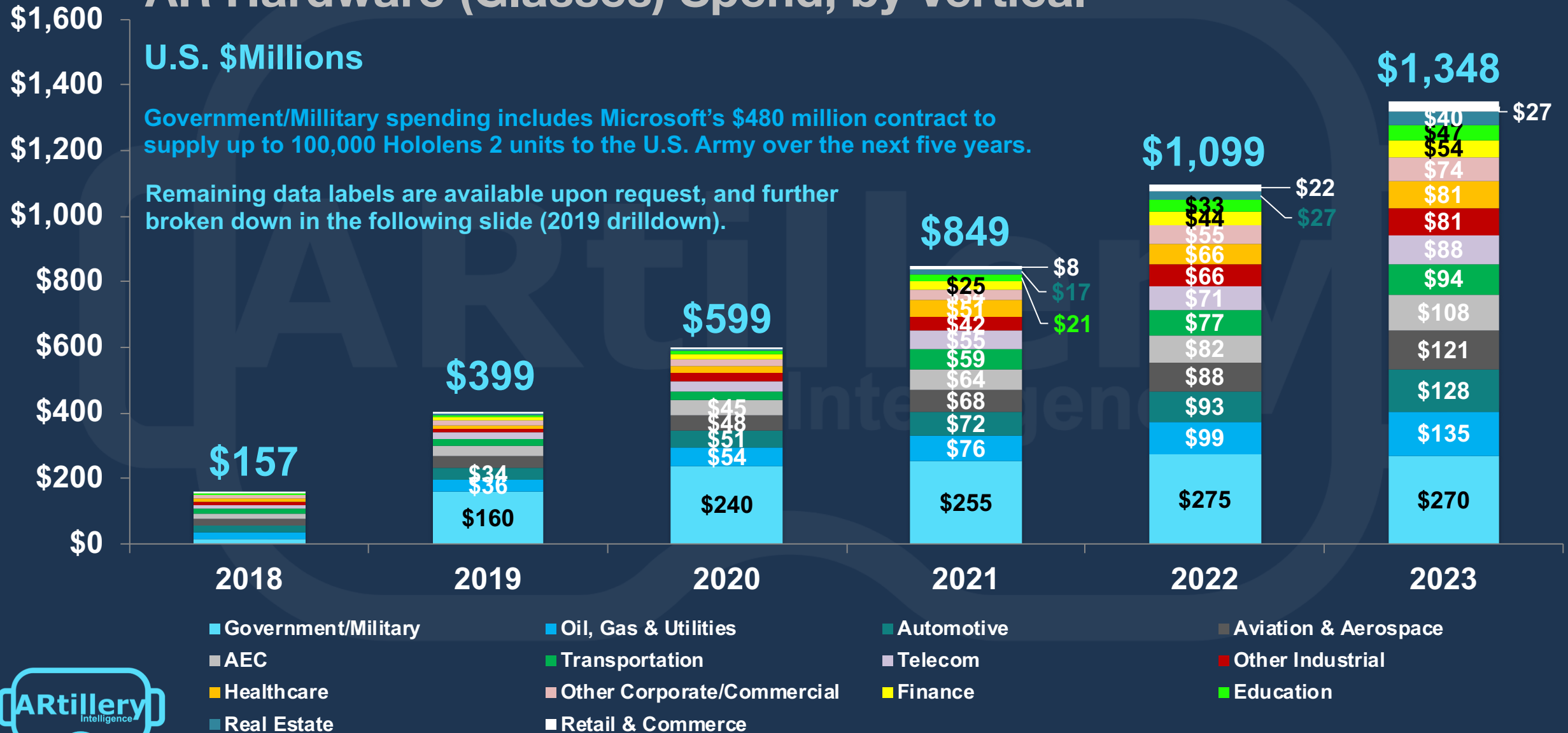
Enterprise AR Hardware

2019 Enterprise AR Hardware Spend, by Vertical

U.S. $Millions

Government/Millitary spending includes Microsoft's $480 million contract to supply up to 100,000 Hololens 2 units to the U.S. Army over the next five years. This spending total is amortized over the full contract period.

2019

Legend:
- Retail & Commerce
- Real Estate
- Education
- Finance
- Other Corporate/Commercial
- Healthcare
- Other Industrial
- Telecom
- Transportation
- AEC
- Aviation & Aerospace
- Automotive
- Oil, Gas & Utilities
- Government/Military

Pie chart values:
- $3.6
- $4.4
- $6.0
- $10.0
- $12.0
- $14.0
- $10.0
- $20.0
- $20.0
- $32.0
- $37.9
- $34.0
- $36.0
- $159.8

ARtillery Intelligence
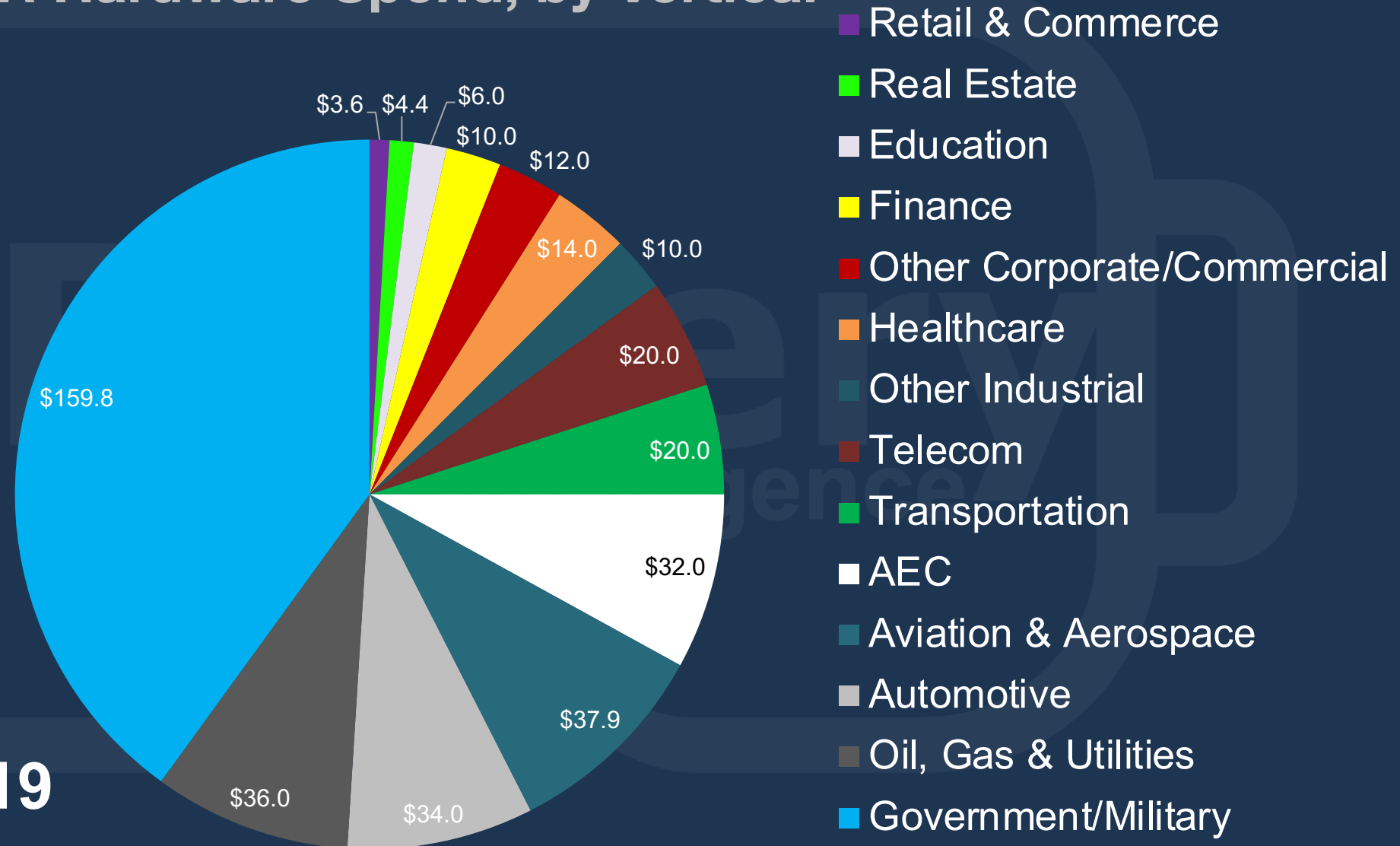
Enterprise AR Software

AR Software Spend, by Vertical

U.S. $Millions

"Retail & Commerce" and "Media, Advertising & Gaming" include AR advertising, as well as software and enablement tools to create and distribute consumer-facing AR experiences (B2B2C).

Most other categories listed below include AR software for enterprise productivity (e.g. industrial visualization support).

Remaining data labels are available upon request, and further broken down in the following slide (2019 drilldown).

Chart: AR Software Spend by Vertical (U.S. $Millions)

Year	Total
2018	$390
2019	$1,207
2020	$2,441
2021	$4,051
2022	$6,143
2023	$8,895

Selected data labels:
- 2018: $28
- 2019: $357, $383, $307
- 2020: $937, $223, $513
- 2021: $1,919, $425, $512
- 2022: $3,398, $705, $510
- 2023: $5,462, $1,103, $466

Legend:
- Media, Advertising & Gaming
- Retail & Commerce
- Government/Military
- Oil, Gas & Utilities
- Automotive
- Aviation & Aerospace
- AEC
- Transportation
- Telecom
- Other Industrial
- Healthcare
- Other Corporate/Commercial
- Finance
- Education
- Real Estate

Enterprise AR Software

2019 Enterprise AR Software Spend, by Vertical

U.S. $Millions

"Retail & Commerce" and "Media, Advertising & Gaming" include AR advertising, as well as software and enablement tools to create and distribute consumer-facing AR experiences (B2B2C).

Most other categories listed include AR software for enterprise productivity (e.g. industrial "see what I see" support).

2019

Legend:
- Real Estate
- Education
- Finance
- Other Corporate/Commercial
- Healthcare
- Other Industrial
- Telecom
- Transportation
- AEC
- Aviation & Aerospace
- Automotive
- Oil, Gas & Utilities
- Government/Military
- Retail & Commerce
- Media, Advertising & Gaming

Pie chart values: $11.5, $7.7, $19.2, $23.0, $26.8, $19.2, $38.3, $38.3, $61.3, $72.8, $65.2, $76.7, $306.7, $83.4, $356.6
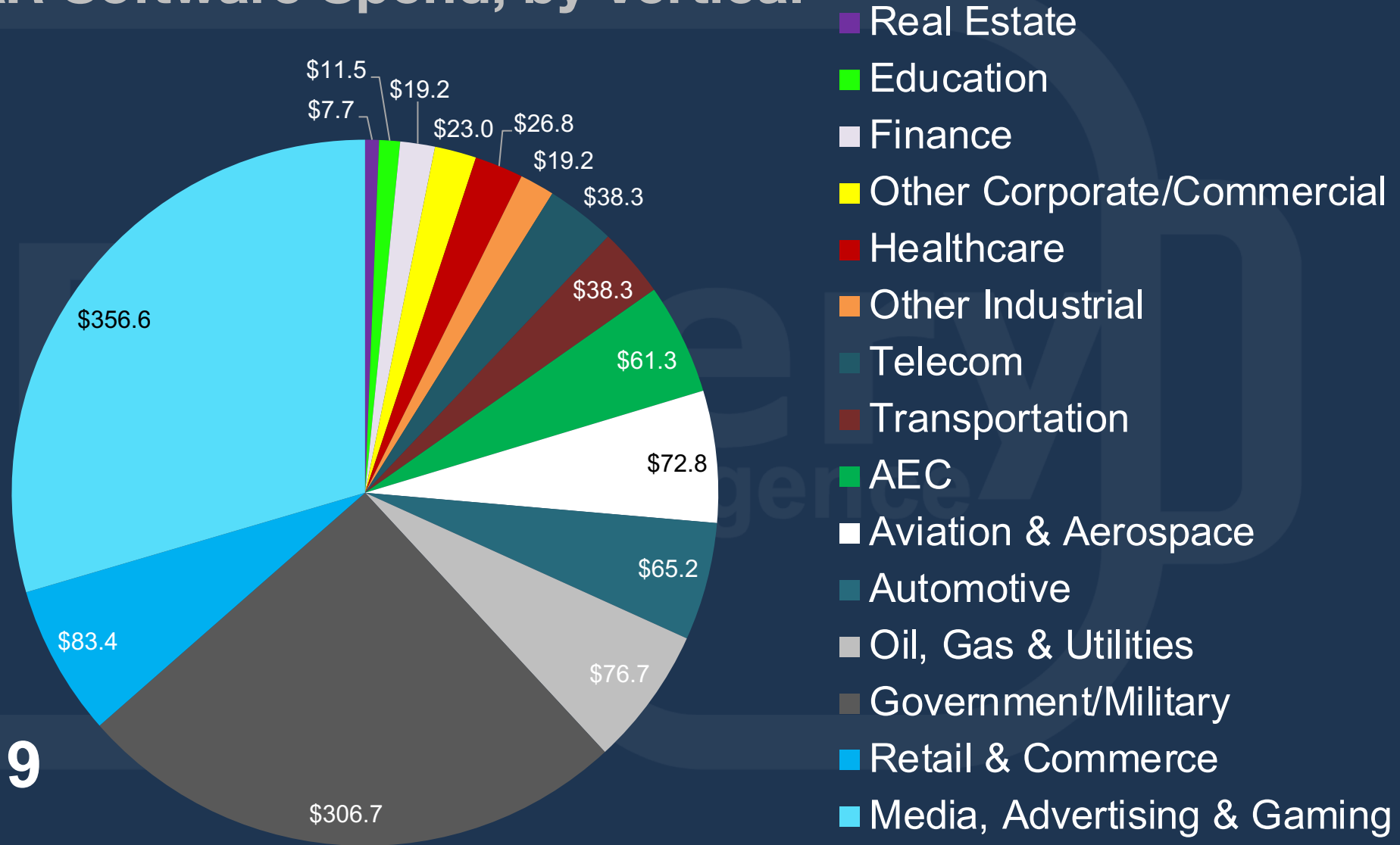
AR Adoption Factors, by Vertical

Need/Urgency/Fit (vertical axis)

Spending Power and Regulatory Freedom (horizontal axis)

- Education
- Government/Military
- Automotive
- Healthcare
- Oil, Gas & Utilities
- Media, Advertising & gaming
- Aviation & Aerospace
- AEC
- Retail & Commerce
- Transportation
- Telecom
- Finance
- Real Estate

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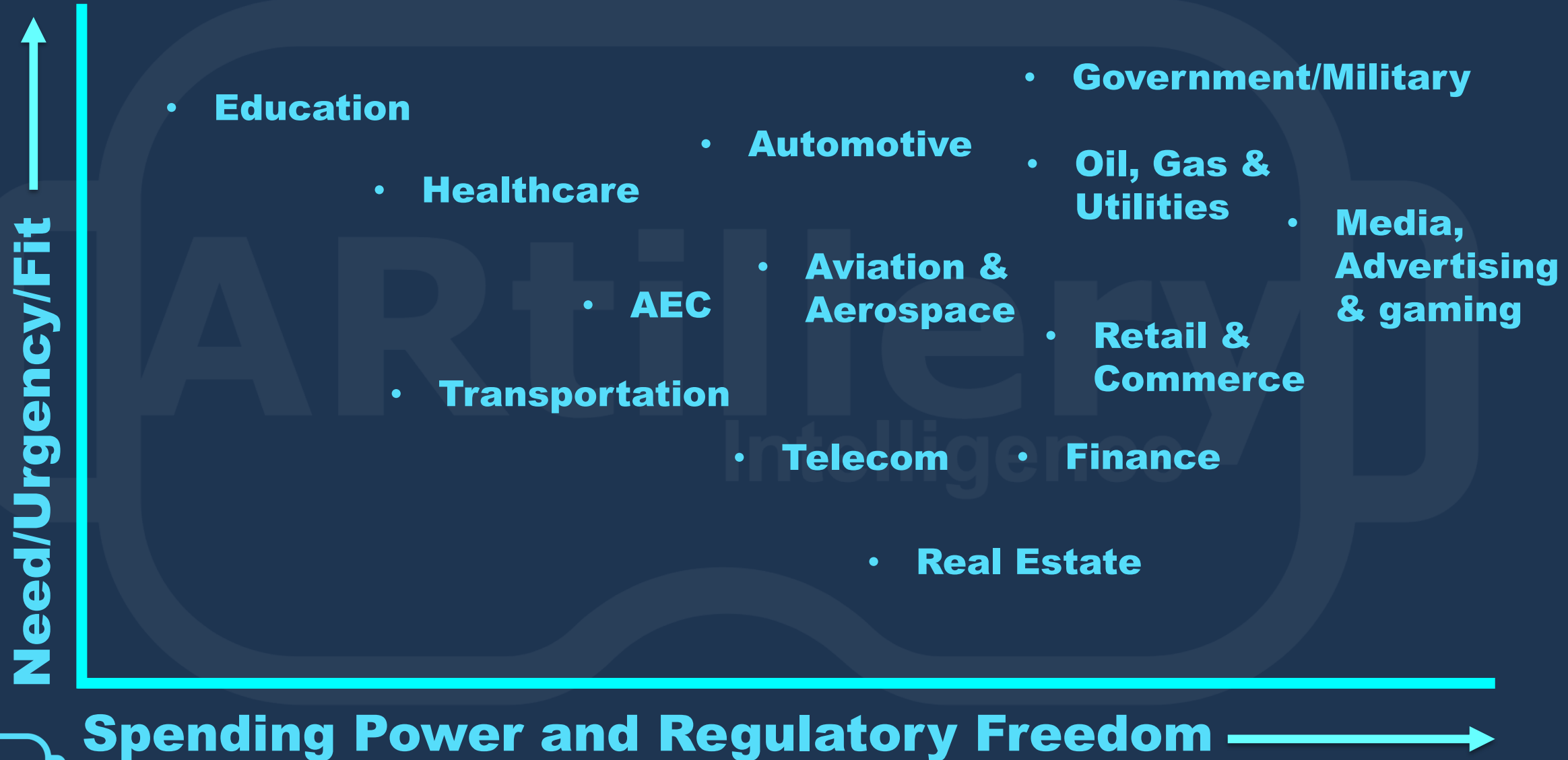
Global AR Creative Professionals

Creative professionals engaged in AR development (e.g. ad creative, media & commerce)

Millions

Year	Global Creative Professionals (M)	Global AR Creative Professionals (M)
2018	16.00	0.72
2019 (E)	16.55	1.16
2020 (E)	17.10	2.05
2021 (E)	17.60	3.17
2022 (E)	18.00	4.50
2023 (E)	18.30	6.04
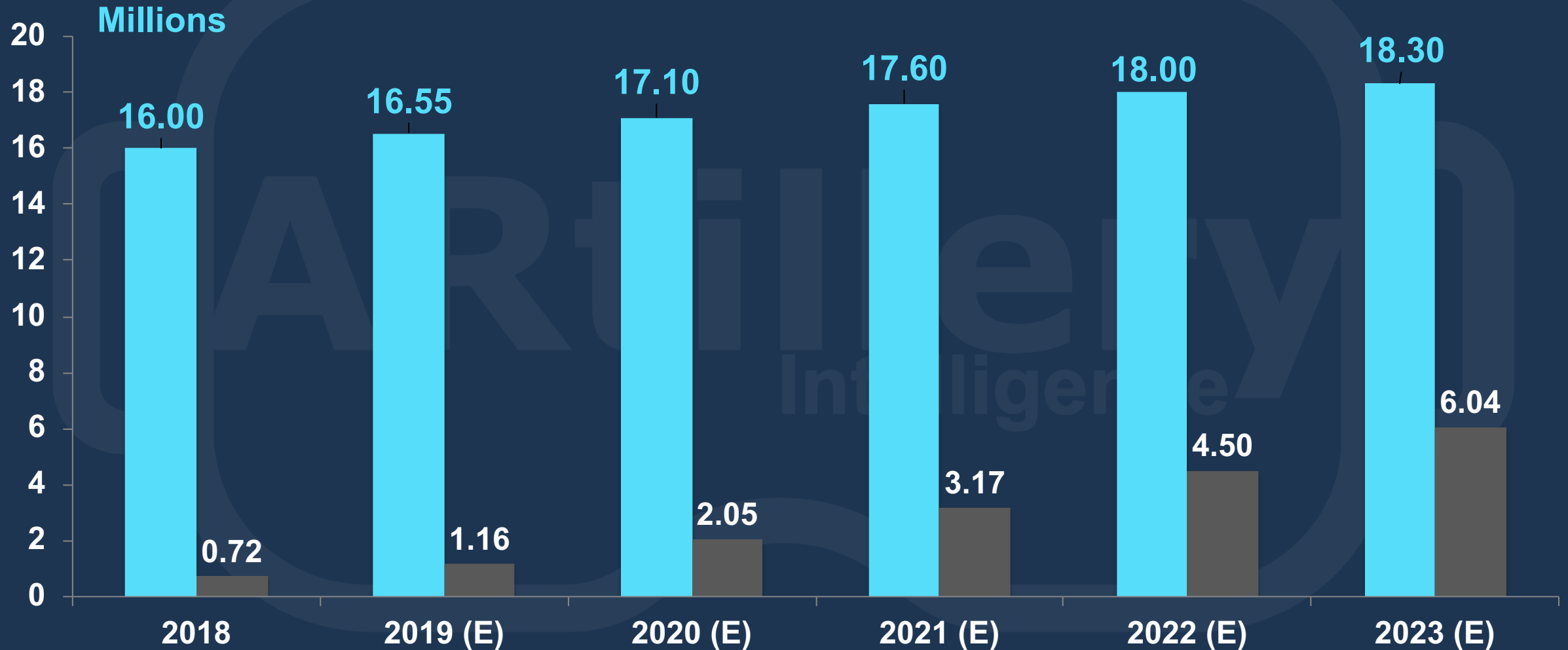
■ Global Creative Professionals (M)   ■ Global AR Creative Professionals (M)

AR Advertising & Commerce

AR Advertising & Commerce

- AR advertising will grow from $453 million in 2018 to $8.8 billion in 2023, an 81 percent compound annual growth rate.
  - This total is included in enterprise AR revenue (previous section) but also deserves its own examination as the leading revenue source in 2023.

- AR advertising shows strong ROI and advertiser interest, due to its ability to demonstrate products in immersive ways.
  - It has proved high performance, relative to non AR benchmarks.
  - Advertisers are attracted to "full-funnel" capabilities – from high-reach impressions to measurable transactions prompted by product "try-ons."
  - Snap and Facebook AR ad revenues have motivated further investment.

- Visual search (e.g. Google Lens) identifies real-world objects with a smartphone camera. Associated advertising will carry "high-intent" value.

AR Advertising & Commerce

- Other ad channels will continue to develop as vehicles for AR advertising (product visualization), such as gaming and email.
  - Unity has begun to serve AR ads in its extensive in-game ad network and is worth watching closely for revenue growth and best practices.

- Messaging apps could be opportune channels for AR product visualization, parallel to their growth as commerce and customer service channels.

- Direct commerce (product transactions) will correlate to AR advertising, totaling $12.7B in consumer purchases and $404M in affiliate revenue* by 2023.
  - Some of this will flow from paid AR ads, while some will be organic.
  - Transaction value of AR-driven purchases isn't counted as "AR revenue," but AR commerce-enablement tools* that drive transactions are counted.

*Affiliate revenue (AR commerce enablement) includes performance-based revenue share or software licensing.

Consumer AR Commerce

Transaction Value of Goods Bought Through AR Interfaces

U.S. $Millions

- Product Visualization Apps*
- Visual Search**
- Social AR Lenses**
- Other (In-Game, Email, Messaging)

The transaction value of goods bought through AR interfaces is tracked and provided here for perspective, but these figures do not count towards "AR revenue."

AR commerce enablement (revenue share or software licensing) paid to AR startups that drive commerce is counted as AR revenue. Seen next slide.

Year	2018	2019	2020	2021	2022	2023
Total	$98	$491	$1,342	$3,012	$6,423	$12,748
Product Visualization Apps*	$3	$19	$43	$83	$154	$269
Visual Search**	$59	$337	$663	$1,130	$1,880	$2,993
Social AR Lenses**	$23	$93	$329	$993	$2,640	$6,306
Other	$14	$43	$307	$806	$1,749	$3,180

*Includes apps and web
**Includes organic and paid media

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Consumer AR Commerce

Transaction Value vs. Affiliate Revenue

U.S. $Millions

■ AR Commerce Transaction Value*   ■ AR Commerce Enablement**

The transaction value of goods bought through AR interfaces is tracked and provided here for perspective, but these figures do not count towards "AR revenue."

AR commerce enablement (revenue share or software licensing) paid to AR startups that drive commerce is counted as enterprise AR revenue.

	2018	2019	2020	2021	2022	2023
Transaction Value	$98	$491	$1,342	$3,012	$6,423	$12,748
Enablement	$2	$7	$30	$83	$195	$404
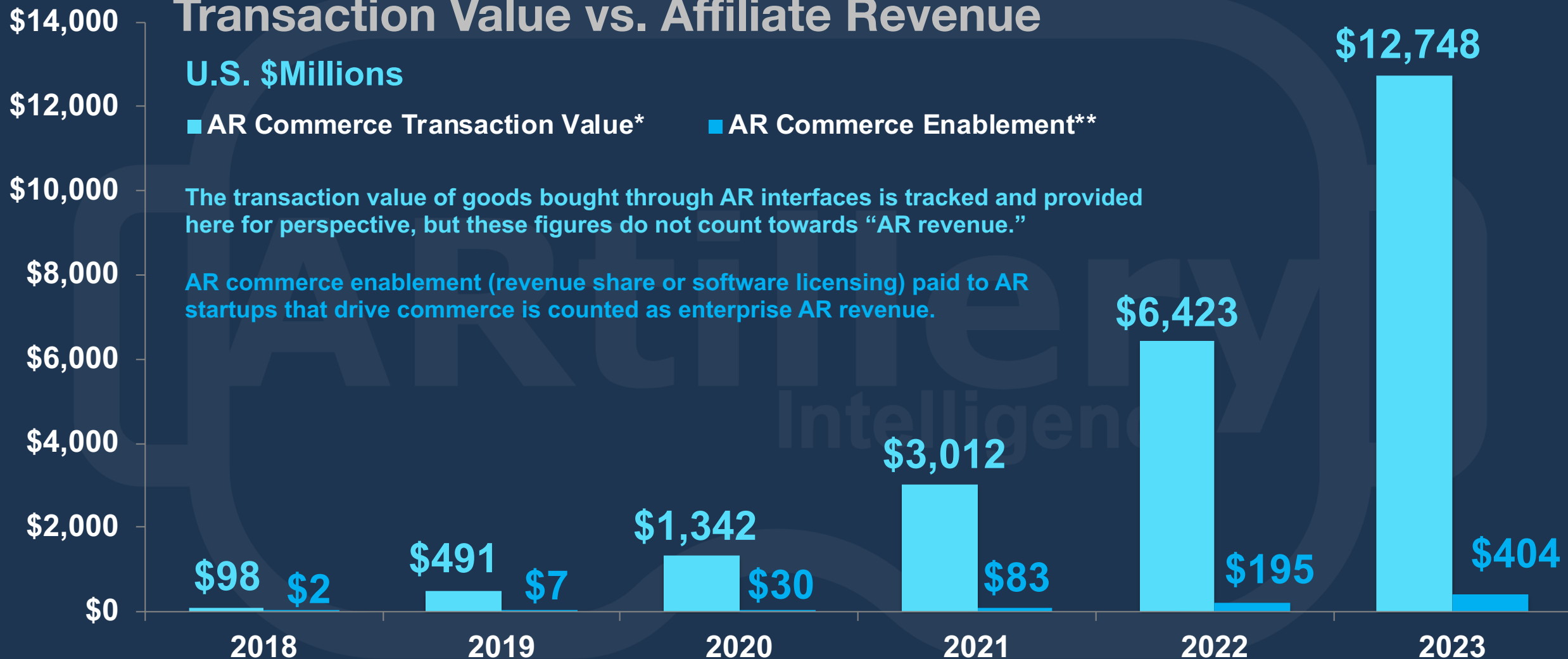
*Includes organic and paid media

**AR commerce enablement revenue includes performance-based revenue share or software licensing.

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Drilling Down: AR Devices

AR Device Forecast

- Beyond revenue forecasting throughout this report, it's worth diving down on the unit sales projections for AR devices.

- Starting with smartphones, AR unit compatibility is often cited as "1 billion."
  - This is true of ARkit and ARcore, but the market's grand total is larger.
  - The full installed base of mobile AR includes web AR (2.9 billion) Facebook Spark AR (1.6 billion) and Snap Lens Studio (190 million).*
  - But the more relevant figure is AR *active users* which total 334 million today, growing to 1.076 billion by 2023 (de-duplicated across platforms).

- AR glasses' installed base will grow from 130,000 in 2018 to 5.03 billion by 2023 (correlated to annual sales of 2.89 billion)
  - Enterprise leads 2019 glasses sales (led by Hololens) at 160,000 units, but consumer will eclipse it (led by Apple**) with 2.4 billion units by 2023.

*Excludes platforms endemic to China (separate calculation)

**See hardware revenue breakdowns in the consumer AR section of this report

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Mobile AR Global Penetration

AR-Compatible Devices & Active Users, Across Platforms

(Detailed View)

Millions of Units

Legend:
- Global Smartphones
- Web AR (Devices)
- Facebook AR (Devices)
- Visual Search (Devices)
- ARkit (Devices)*
- ARCore (Devices)
- Snap AR (Devices)
- Total AR Active (De-Duped)
- Snap (Active)
- Visual Search (Active)
- Facebook AR (Active)
- ARkit (Active)*
- ARCore (Active)
- Web AR (Active)

**Includes iPad
*Excludes platforms endemic to China (separate calculation)

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Mobile AR Global Penetration

AR-Compatible Devices & Active Users, Across Platforms*

(Simplified View)

Millions of Units

	2018	2019	2020	2021	2022	2023
Global Smartphones	3,379	3,391	3,404	3,420	3,428	3,436
Total AR Active (De-Duped)	204	334	460	626	834	1,076

Legend:
- Global Smartphones
- Web AR (Devices)
- Facebook AR (Devices)
- Visual Search (Devices)
- ARkit (Devices)**
- ARCore (Devices)
- Snap AR (Devices)
- Total AR Active (De-Duped)
- Snap (Active)
- Visual Search (Active)
- Facebook AR (Active)
- ARkit (Active)**
- ARCore (Active)
- Web AR (Active)

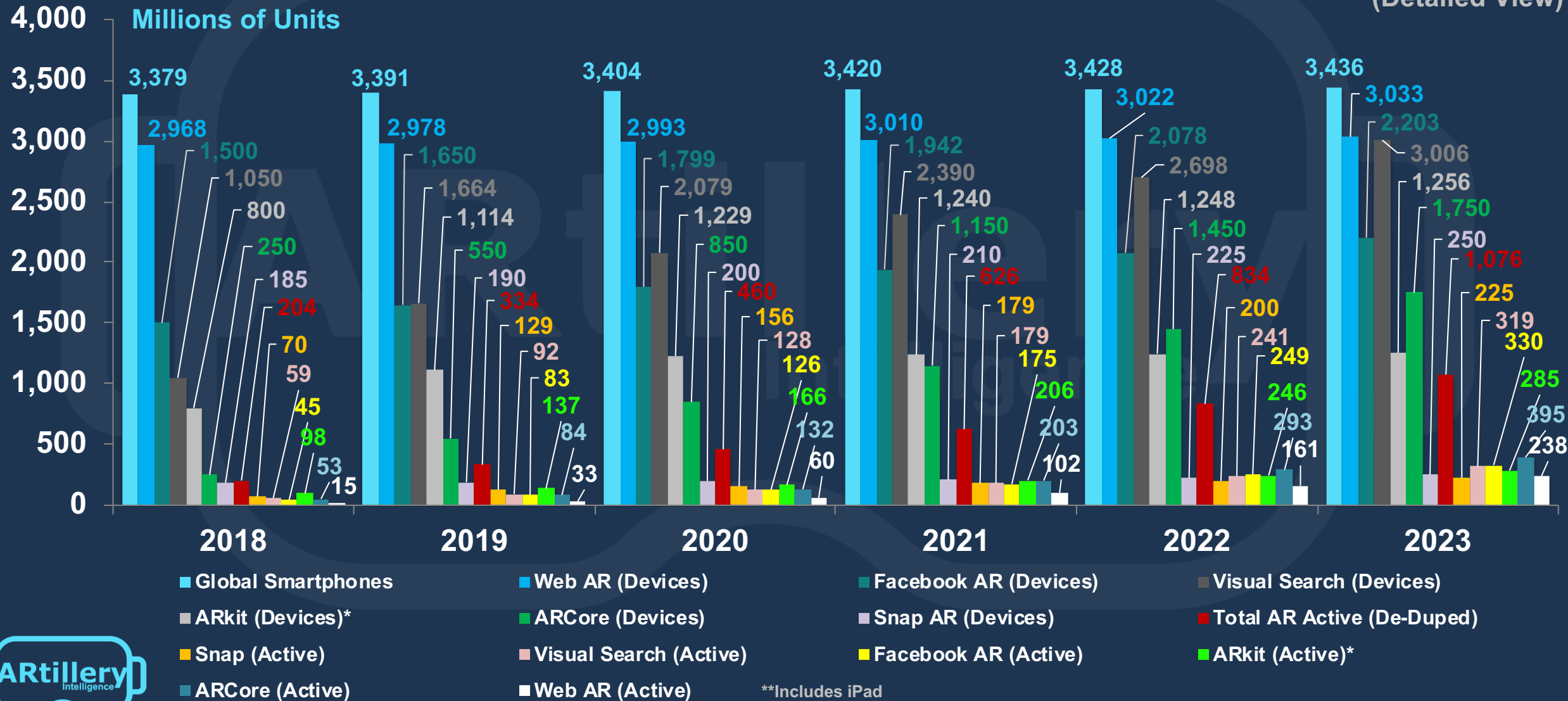**Includes iPad
*Excludes platforms endemic to China (separate calculation)

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Mobile AR Global Penetration

2019 AR-Compatible Devices & Active Users, Across Platforms*

Millions of Units

Devices ← ← → → **Active Users**

3391

2978

1650   1664

1114

550

190

334M Active Mobile AR Consumers (de-duplicated)

334

129

92

83

137

Web AR has the most growth potential & headroom

84

33

- ■ Global Smartphones
- ■ Web AR (Devices)
- ■ Facebook AR (Devices)
- ■ Visual Search (Devices)
- ■ ARkit (Devices)**
- ■ ARCore (Devices)
- ■ Snap AR (Devices)
- ■ Total AR Active (De-Duped)
- ■ Snap (Active)
- ■ Visual Search (Active)
- ■ Facebook AR (Active)
- ■ ARkit (Active)**
- ■ ARCore (Active)
- ■ Web AR (Active)

**Includes iPad
*Excludes platforms endemic to China (separate calculation)

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AR Glasses Annual Sales

Unit sales growth for AR Glasses*, by Brand**

Millions of Units

Legend:
- Apple
- Magic Leap
- North
- nReal
- Vuzix (consumer)
- Other Consumer Glasses
- Hololens (I&II)
- Google Glass
- Realware
- Vuzix (enterprise)
- Epson
- Other Enterprise Glasses

Values by year:
- 2018: 0.13
- 2019: 0.26
- 2020: 0.40
- 2021: 0.55
- 2022: 1.59
- 2023: 2.89

2023 categories: Enterprise, Consumer
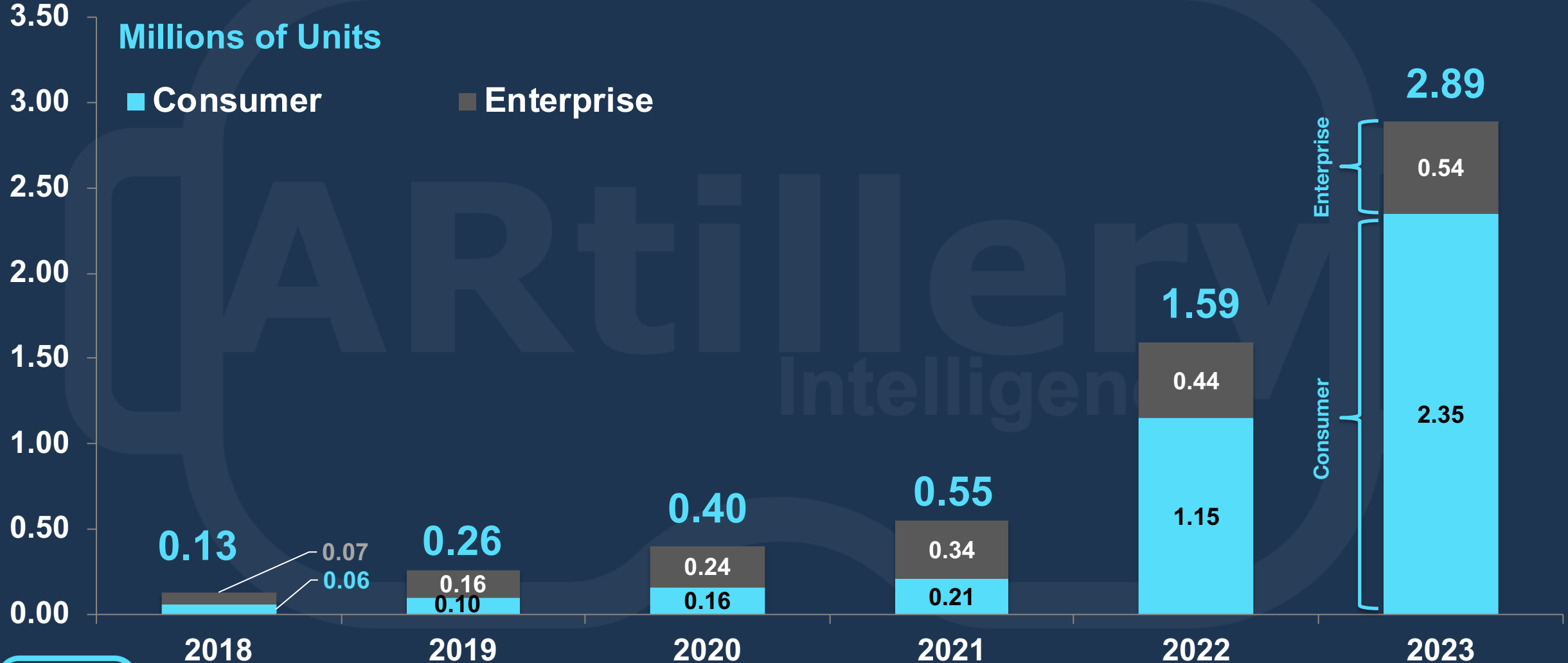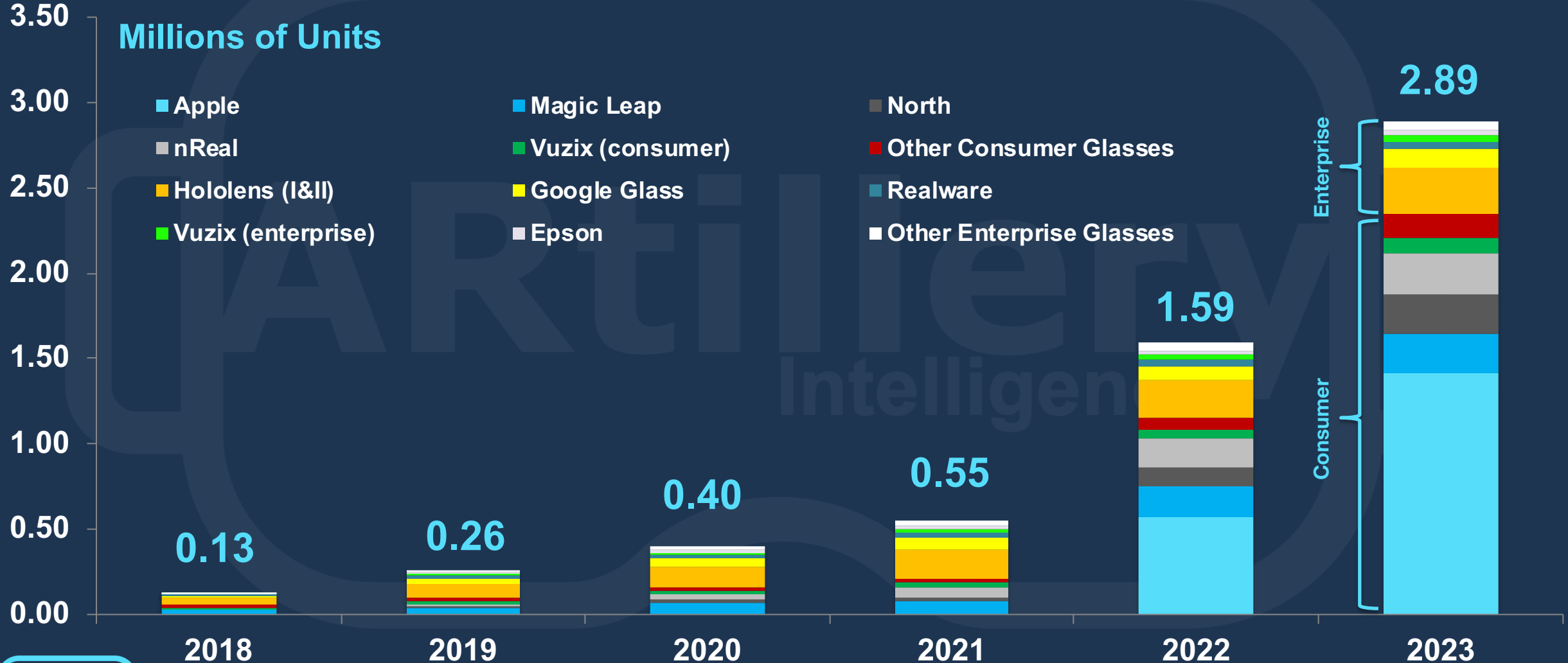
*This figure defines annual unit sales, not installed base (see separate slide).
**Data labels not included due to space. Base data available upon request.

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AR Glasses Installed Base

AR Glasses Installed Base, by Type*

Millions of Units

■ Consumer   ■ Enterprise

Year	2018	2019	2020	2021	2022	2023
Total	0.13	0.39	0.79	1.21	2.54	5.03
Enterprise	0.07	0.23	0.47	0.74	1.02	1.32
Consumer	0.06	0.16	0.32	0.47	1.52	3.71
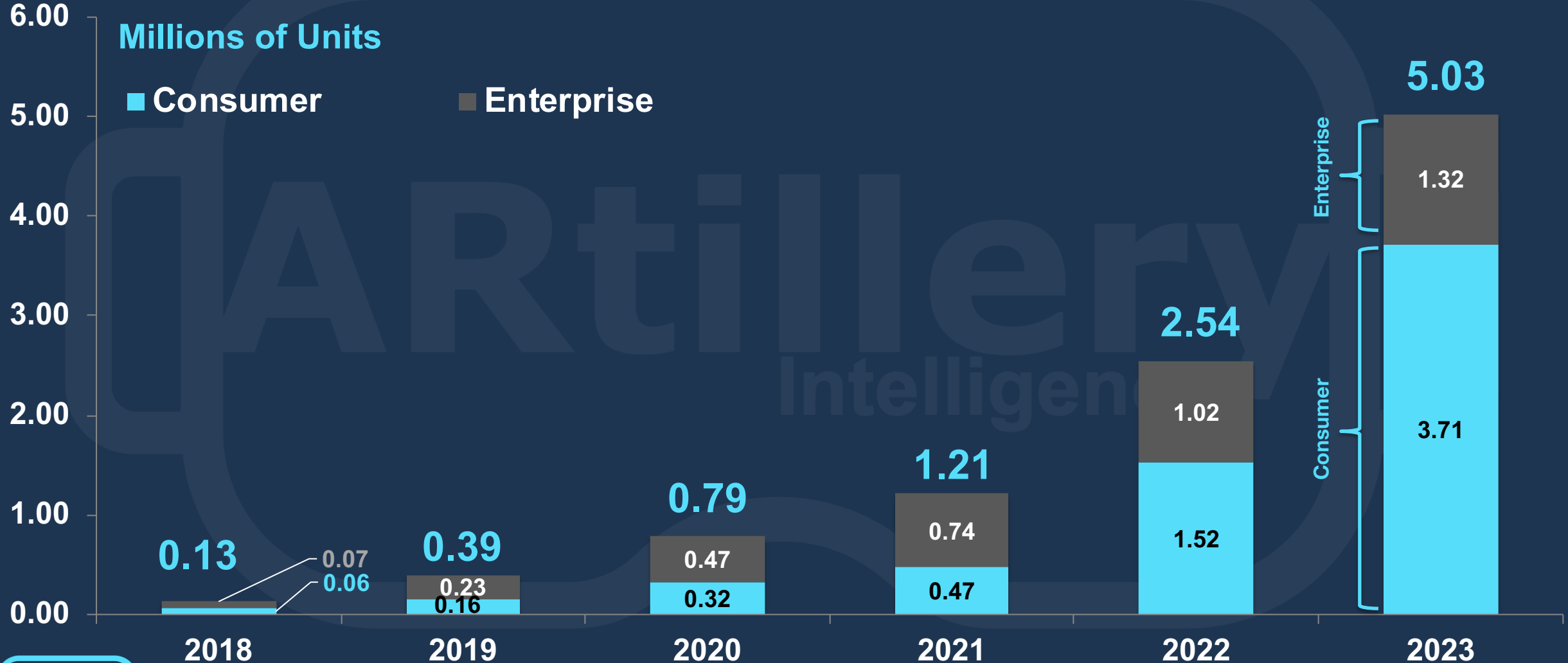
*This figure defines installed base, not annual unit sales (see separate slide).

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AR Glasses Installed Base

AR Glasses Installed Base*, by Brand**
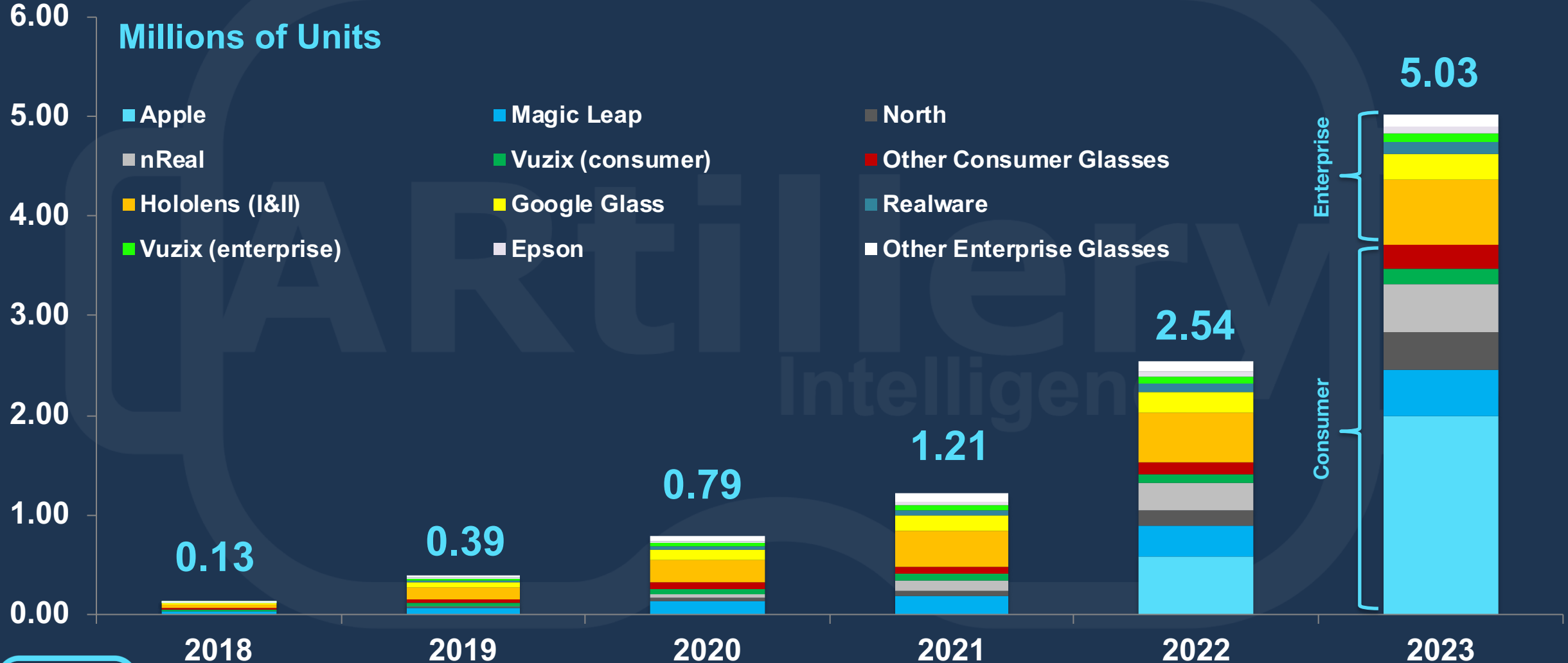
Millions of Units

Legend:
- Apple
- nReal
- Hololens (I&II)
- Vuzix (enterprise)
- Magic Leap
- Vuzix (consumer)
- Google Glass
- Epson
- North
- Other Consumer Glasses
- Realware
- Other Enterprise Glasses

Values by year:
- 2018: 0.13
- 2019: 0.39
- 2020: 0.79
- 2021: 1.21
- 2022: 2.54
- 2023: 5.03

*This figure defines installed base, not annual unit sales (see separate slide).
*Data labels not included due to space. Base data available upon request.

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Key Takeaways (Redux)

Key Takeaways

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

Consumer AR will grow from $957 million in 2018 to $7.9 billion in 2023, a 53 percent compound annual growth rate. Near-term revenues will be dominated by mobile AR. Revenues will also be software-centric during that time (mobile device sales aren't counted as AR revenue) and will include premium apps and in-app purchases. The latter will dominate software revenues in the near term, due to consumer resistance to pay upfront for AR apps,* as well as the in-app revenue model validated by Pokémon Go. Niantic will find success in its Harry Potter-themed follow-up game to Pokémon Go, and its AR developer platform built on PGO's architecture. A mobile AR killer app could emerge in 2020, likely built around a utility like visual search, or through viral growth of a native AR social/multiplayer app. Consumer AR revenue share will begin to shift towards hardware starting in 2022 as smart glasses, likely from Apple, approach consumer-friendly specs and standards. After that point, premium software share will grow as a corollary, as it's a model conducive to dedicated AR hardware (similar to how apps/games are purchased in VR). Until then, developers' work in mobile AR will be a training ground for an eventual glasses-dominant era beyond 2022. Mobile AR will likewise acclimate consumers to spatial experiences and seed demand for AR glasses in the long term. Hearables will be a wild card.**

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Key Takeaways

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

Enterprise AR will grow from $1.002 billion in 2018 to $19.45 billion in 2023, an 81 percent compound annual growth rate. This is subdivided between hardware, enterprise productivity software (e.g. visualization support in industrial settings), enterprise advertising, affiliate commerce revenue, and AR developer/enablement platforms. In industrial/productivity contexts, growth will result from wide applicability across enterprise verticals, and clear ROI (e.g. manufacturing efficiencies). Adoption is currently dampened by typical organizational inertia and risk aversion. ARtillery Intelligence believes these factors will continue to stunt enterprise AR growth but will be outweighed eventually by the momentum, support and ROI realizations currently building. A tipping point will come in 2020 or 2021, after which adoption accelerates in a pattern that's similar to historical enterprise smartphone adoption. Meanwhile, greater near-term revenues are seen in other enterprise software subsegments such as AR developer platforms (e.g. Unity, Niantic). These will see healthy growth during this forecast period through Saas-like (ARaaS) packaging/pricing. Value propositions for such AR enablement tools, or "picks & shovels," are aligned with early-stage enterprise demand. They'll be key ingredients to boost AR creation, democratize advance capability and accelerate time to market.

Key Takeaways

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

AR Advertising will grow from $453 million in 2018 to $8.8 billion in 2023, an 81 percent compound annual growth rate. Included in our classification of "Enterprise AR" (due to the spending source), this involves product promotions through AR interfaces. As proved by Snapchat and Facebook, AR lenses can demonstrate products in highly immersive ways. This has shown relatively strong ad performance, which continues to attract brand advertisers and reinforce return on ad spend (ROAS). AR advertising also has a rare ability to span the "purchase funnel" from awareness-based advertising to direct-response. The former is delivered with high-reach mediums like the Facebook News Feed, while the latter is accomplished through AR lens-based product try-ons (think: cosmetics). As a corollary, ARtillery Intelligence projects $12.7 billion in products to be purchased through AR interfaces by 2023 (not counted as "AR revenue"). This will drive affiliate revenue (counted as "AR revenue") for AR ad-tech startups and enablers to the tune of $404 million by 2023. All of the above is in the category of display advertising, but the next advancement will come with search advertising. Visual search, a la Google Lens, identifies real world objects using one's smartphone camera or AR glasses. As an ad medium, it will see strong performance and ad premiums due to high consumer intent (just like core search).

Key Takeaways

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

AR Headsets will grow in unit sales from 130,000 in 2018 to 2.89 million in 2023. That correlates to an installed base of 5.03 million units in market by 2023. This includes both enterprise and consumer, the former leading in early years with 160,000 units sold in 2019. Consumer AR glasses will pull ahead in 2022 with 1.15 million units sold. This will result from improving standards and specs for consumer-grade smart glasses (size, weight, style, etc.). It will be further accelerated through Apple's market entrance – both through its own AR glasses sales and the halo effect they create on the rest of the market. Meanwhile, mobile AR is where scale lies, especially in consumer markets. There, the installed base is often cited as "1 billion units." This is true if counting only Apple (ARkit) and Google (ARcore) device penetration. However, it's much more nuanced, given a fragmented set of platforms and delivery channels for mobile AR. That includes web AR (2.97 billion), Facebook's Spark AR platform (1.6 billion) and Snap's Lens Studio (190 million). But the number that matters most is active AR users. When tallying and de-duplicating active users across these platforms, the total comes to 334 million. ARtillery Intelligence projects this figure to grow to 1.076 billion active mobile AR users by 2023. These addressable and active use figures are detailed later in this report for all mobile AR platforms.

Resources & Referenes

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 AR 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 AR 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 multi-media, 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 AR Revenue Totals?

AR industry revenues totaled in this report include consumer and enterprise AR segments. These are each subdivided by several revenue sources, such as hardware (glasses and hearables), software (In-app purchases and productivity apps) advertising (social AR lenses), and commerce (affiliate revenue).

Though we track transaction value of consumer products purchased through AR interfaces, such as a new pair of shoes (AR visualization), we *do not* include them in AR revenue totals. Affiliate fees (revenue share or software licensing) for AR commerce tools that drive those transactions *are* included. AR hardware includes headsets, but *not* smartphone sales for mobile AR, nor network data fees. See more below.

Included

AR Hardware: e.g. smart glasses
AR Consumer Software: e.g. apps, in-app purchases
AR Enterprise Software: e.g. industrial visualization support, AR developer platforms
AR Advertising: e.g. Display (Snapchat Lenses), and Search (Google Lens) ad placements
AR Commerce Enablement: Affiliate revenue or software licensing for driving commerce through AR interfaces

Not Included

Smartphone Sales: e.g. iPhone to run ARkit apps
Hearables: e.g. AirPod sales*
Network Data: e.g. Telco-delivered data usage for AR
Professional Services: e.g. Enterprise AR consulting
App Creation Overhead: e.g. Developer salaries
Advertising Creation: e.g. Creative production, agency fees
Commerce (transaction value): Value of goods bought through AR interfaces (e.g. footwear, furniture).*

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We track these revenues (see breakdown later in this report) but do not count them towards AR revenues.

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