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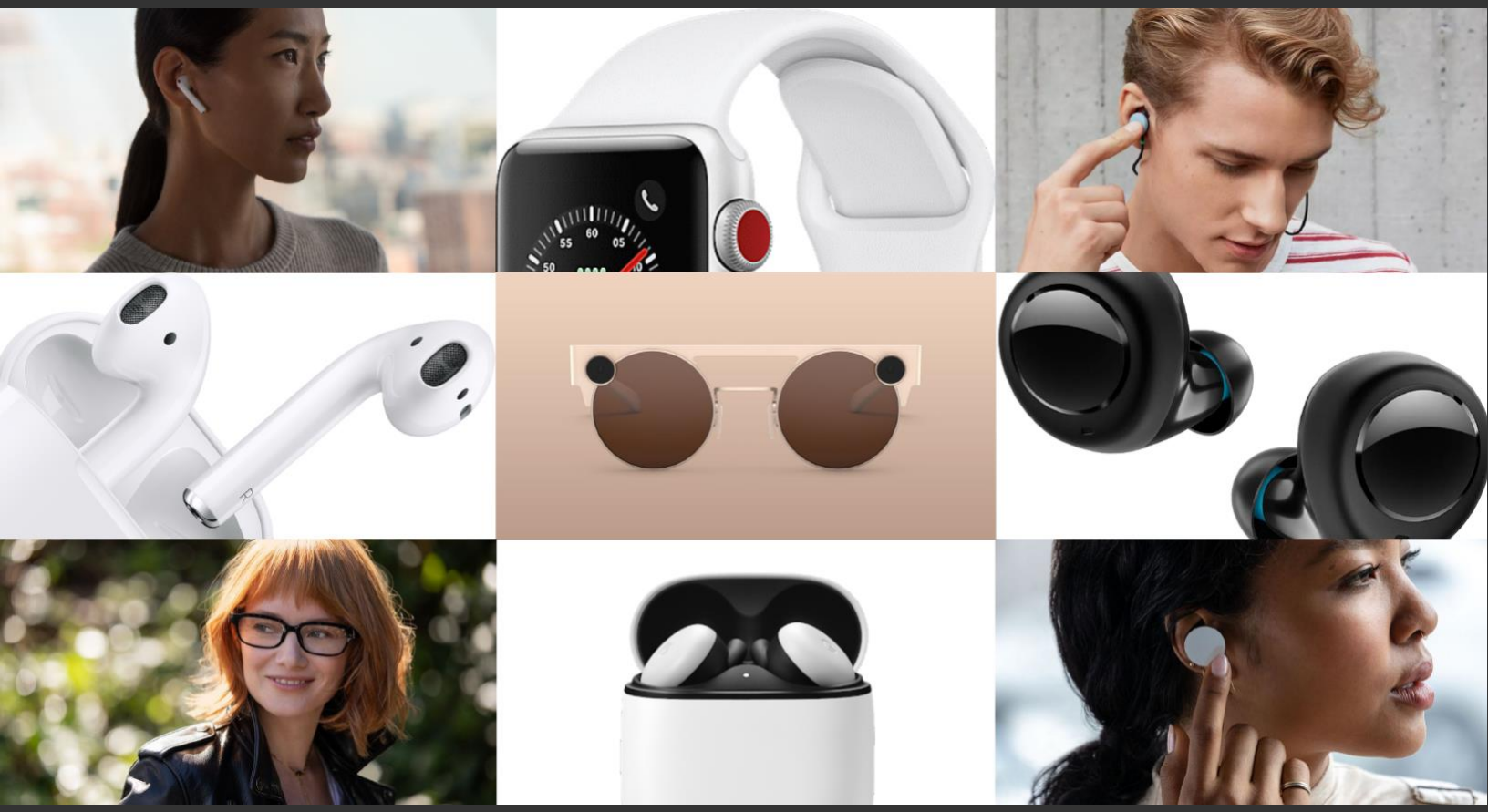

ARtillery Intelligence Briefing

Wearables: Paving the Way for AR Glasses

October 2020

ARtillery Intelligence

Executive Summary

A common AR industry sentiment is that the smartphone is the device that will pave the way for smart glasses.[i] The thought is that before AR glasses achieve consumer-friendly specs and price points, AR's delivery system is the device we all have in our pockets. There, it can seed user demand for AR and get developers to start *thinking spatially*.

This thinking holds up, but a less-discussed product class could have a greater impact in priming consumer markets for AR glasses: wearables. As we examined in last year's "audio AR" report[ii], AR glasses' cultural barriers could be lessened by conditioning consumers to wearing sensors on their bodies.

Meanwhile, tech giants are motivated toward wearables in varied ways. Like in our ongoing "follow the money" exercise[iii], they're each building wearables strategies that support or future-proof their core businesses, where tens of billions in annual revenues are at stake.

No one embodies this principle more than **Apple**. The company continues to double down on Watch and AirPods as they offset iPhone revenue deceleration in the near term; and future-proof the company's hardware-heavy profit machine in the long term.

In fact, Watch and AirPods could eventually converge with glasses in a holistic suite that augments reality from several angles. This could replace (or augment) the current suite of iThings. This outlook fits the profile for **Apple's** signature multi-device ecosystem approach.

The story is similar with **Google** in that its wearables ambitions are to create an additional touchpoint for **Google**-delivered content (and ads). This likewise "fits the profile" as the same rationale drove **Google** to invest in the Android operating system many years ago.

And the list goes on: **Amazon** launched its Echo Frames and other wearables to create a more direct touchpoint to shoppers... and thus stimulate more frequent and bigger shopping baskets. **Microsoft** meanwhile has launched Office-centric earbuds to further its mission to enable enterprise productivity.

And of course, there's **Snap**, with its famous Spectacles. Though the headlines have been more about the device's commercial performance, the more important story is the device's true mission to feel out cultural and social sensitivities for face-worn sensors. **Facebook** will do similar with its Project Aria, announced last month at **Facebook** Connect 7.

Though there are strong motivations in all of the above moves, wearables and "hearables" aren't for everyone. The much-vaunted Bose AR platform – delivered through the flagship Bose Frames – retracted from the market (for now). What signals or warning signs should we take from this retreat?

While we're asking questions, will wearables fulfill the above-stated goal to acclimate the world to face-worn sensors? And if so, will this pave the way for AR glasses? In this report, we embark on a data-driven narrative to answer these questions and others. The goal as always is to empower you with a spatially-smart position

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Key Takeaways

- **The smartphone is commonly identified as AR glasses' forbearer. But wearables could have more impact.**
  - Wearables like Apple Watch and AirPods are conditioning consumers to wear sensors on their bodies.
  - Given that AR's fully-realized modality is head-worn, wearables could pave the way through cultural acclimation.
  - AR glasses will need that "push," given the cultural paradigm shift required for face-worn tech acceptance.

- **Wearables' potential cultural impact could be amplified by their current sales momentum.**
  - Wearables continue to be one of the fastest-growing consumer tech segments in year-over-year growth.
  - Sales forecasts have been downgraded from pre-Covid estimates, but remain positive in terms of unit sales.
  - The strongest growth is seen in smart watches and "hearables" such as Apple AirPods and its equivalents.

- **Beyond consumer demand for wearables, tech giants are embracing the product category.**
  - Wearables align with tech giants' product road maps, and fit in various ways with their growth strategies.
  - These reasons vary by company, but have a common thread of protecting or future-proofing core products.
  - This once again invokes ARtillery Intelligence's *follow the money* exercise to predict tech giants' moves.

- **Apple is particularly motivated toward wearables because they offset iPhone sales declines.**
  - iPhone sales – and all smartphone sales – decelerate as the category matures and approaches market saturation.
  - Apple's wearables growth is almost to the point of offsetting year-over-year iPhone sales declines.
  - Wearables also represent a long-term strategy for Apple to maintain its multi-device ecosystem approach.
  - Smart Glasses will be central to a wearables suite that collectively achieves holistic sensory augmentation.

- **Google is motivated toward wearables to maintain direct (hardware) touchpoints to consumers.**
  - This was the same strategy that drove Google's investments in the Android operating system.
  - Just like with mobile devices, Google can position itself closer to users' bodies as a "Trojan horse" for search.
  - The front runner in Google's wearables line is the erstwhile-disappointing Pixel Buds and its Fitbit acquisition.
  - Though its hardware is inferior, Google's advantage is superior software through Google Assistant (versus Siri).

- **Amazon is similarly motivated toward wearables to boost its core product: e-commerce.**
  - This was the same strategy that drove Amazon's investments in Echo devices and other in-home hardware.
  - In-home devices only capture a share of user time and mindshare, whereas wearables are more persistent.
  - So far, Amazon's wearables offerings are limited but have promise, including its Echo Buds and Echo Frames.
  - Amazon tried and failed to market a smartphone (Fire Phone) and is now motivated to regain that user touchpoint.

- **Microsoft is motivated toward wearables to create deeper user integrations for enterprise productivity.**
  - This includes its Surface Buds which create deeper integrations to Office products, thus boosting engagement.
  - Features include advancing slides with voice commands, language translation and voice dictation.
  - Like Amazon, Microsoft failed to gain pole position in the smartphone era with its Windows Mobile OS.
  - After losing ground early to Android, Microsoft is now motivated to regain that mobile user touchpoint.

- **Facebook is motivated toward wearables to gain consumer insights and acclimation for its AR Glasses**
  - Facebook's project Aria will test AR glasses to feel out social dynamics and considerations for design purposes.
  - Given the importance of AR glasses in Facebook's road map, testing wearable behavior is a sizeable priority.

- **Snapchat is also motivated toward wearables to gain consumer insights and acclimation for AR glasses.**
  - Snap Spectacles have been mostly judged on commercial metrics such as units sold, which misses the point.
  - Spectacles' true purpose will be to feel out consumer behavior and design insights for face-worn tech.

- **All of the above factors and tech-giant motivations will accelerate wearables and (eventually) AR glasses.**
  - Covid-19 global lockdowns and supply chain impediments will impact the sector, but only in the near term.
  - By the end of 2021, the wearables sector will be back on track and continue to pave the way for AR glasses.

Introduction: High Stakes

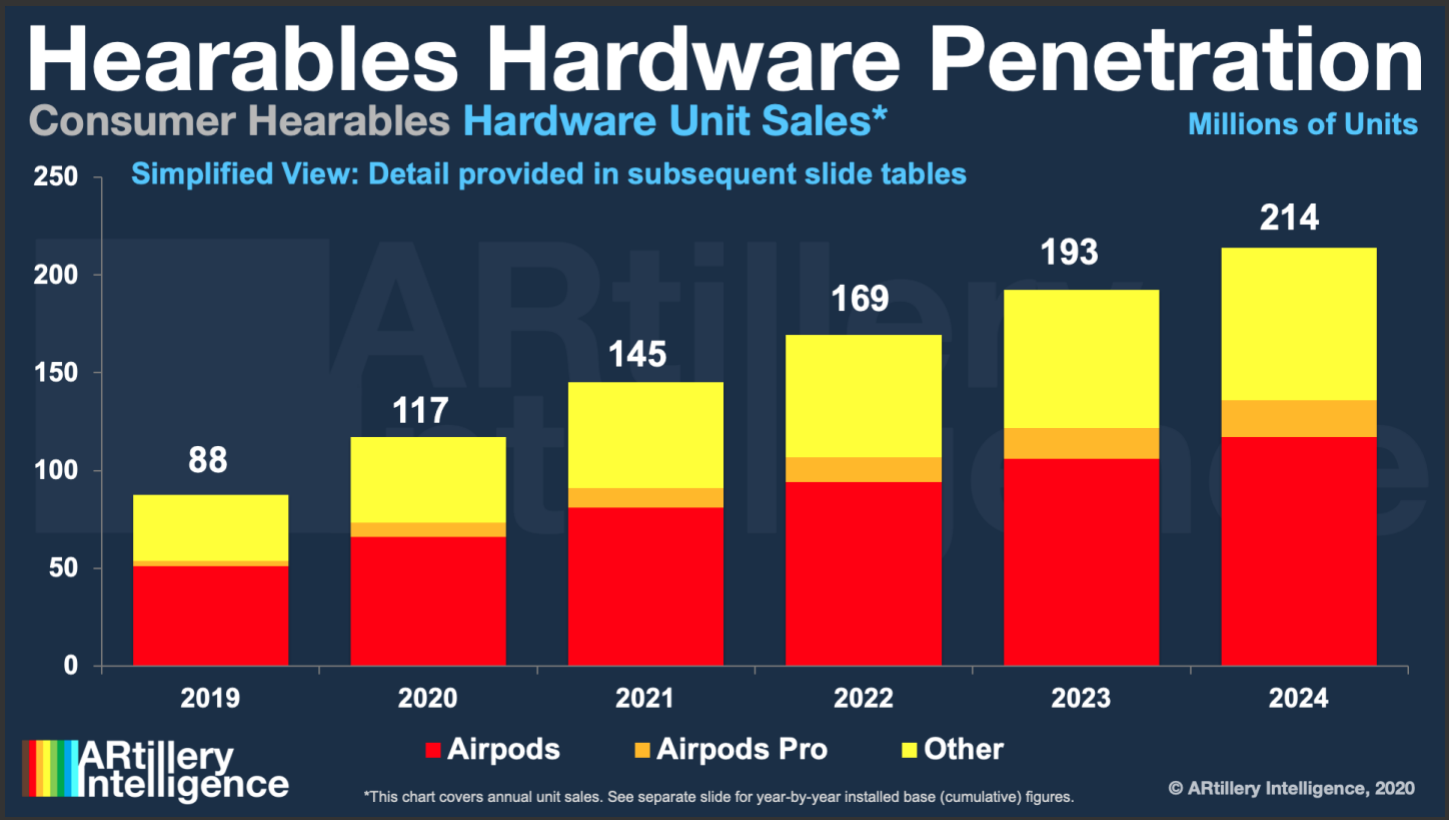
The wearables sector is inflecting. Though not a new tech category, activity levels are escalating per several signals we track. For an AR-focused research firm, this is noteworthy because of wearables' potential to accelerate AR cultural adoption.

In other words, given that AR's endpoints are head worn, the question is if wearables can acclimate consumers to putting sensor-based tech on their bodies. Beyond any logic-driven answer, wearables sales momentum puts larger stakes on the question.

In fact, wearables are one of the fastest-growing consumer tech sectors today. Canalys reports that smartwatch unit shipments grew **12 percent** year-over-year in Q1 2020 (pre-pandemic) to **14.3 million**. Strategy Analytics meanwhile reports **20 percent** smart watch growth, reaching **13.7 million** units in Q1 2020.

ABI Research has a similar take, projecting that wearables unit shipments will be up **5 percent** in 2020. This signals wearables' resilience, even during a pandemic, though the category's growth has certainly slowed along with all hardware businesses.

Lastly, ARtillery Intelligence projected in its recent Headworn AR forecast[iv] that hearables annual base will grow from **88 million** in 2019 to **214 million** in 2024. Hearables are defined as devices such as **Apple** AirPods that could someday house textured and intelligent "audio AR" content, as we'll explore later in this report.



Halo Effect

So what's driving the above wearables growth? Part of it is the popularity and product/market fit that **Apple's** AirPods and Watch have accomplished. This has created a classic **Apple** "halo effect" on the wearables sector.

Further propelling growth are tech-giant motivations. That's especially true for **Apple**, which continues to double down on Watch and AirPods. It sees wearables offsetting near-term iPhone revenue deceleration; and future-proofing its hardware-heavy profit machine.

One theory is that Watch and AirPods could eventually converge with glasses in a holistic suite that augments reality from several angles. This could replace (or augment) the current suite of iThings, which notably fits the profile for **Apple's** ARPU-driving multi-device ecosystem approach.

Wearables also continue to perform well financially, which emboldens **Apple's** motivations to continue investing in the product category. Watch and AirPods are rising stars in Cupertino, whose revenue growth comes close to offsetting iPhone revenue declines as the global smartphone market continues to mature.

This revenue reconciliation is just one task that wearables have at **Apple**. The other is to buttress the iPhone succession plan, where **Apple** has a lot riding. There won't be a single iPhone replacement but rather an iPhone-dependent wearables suite, including smart glasses.

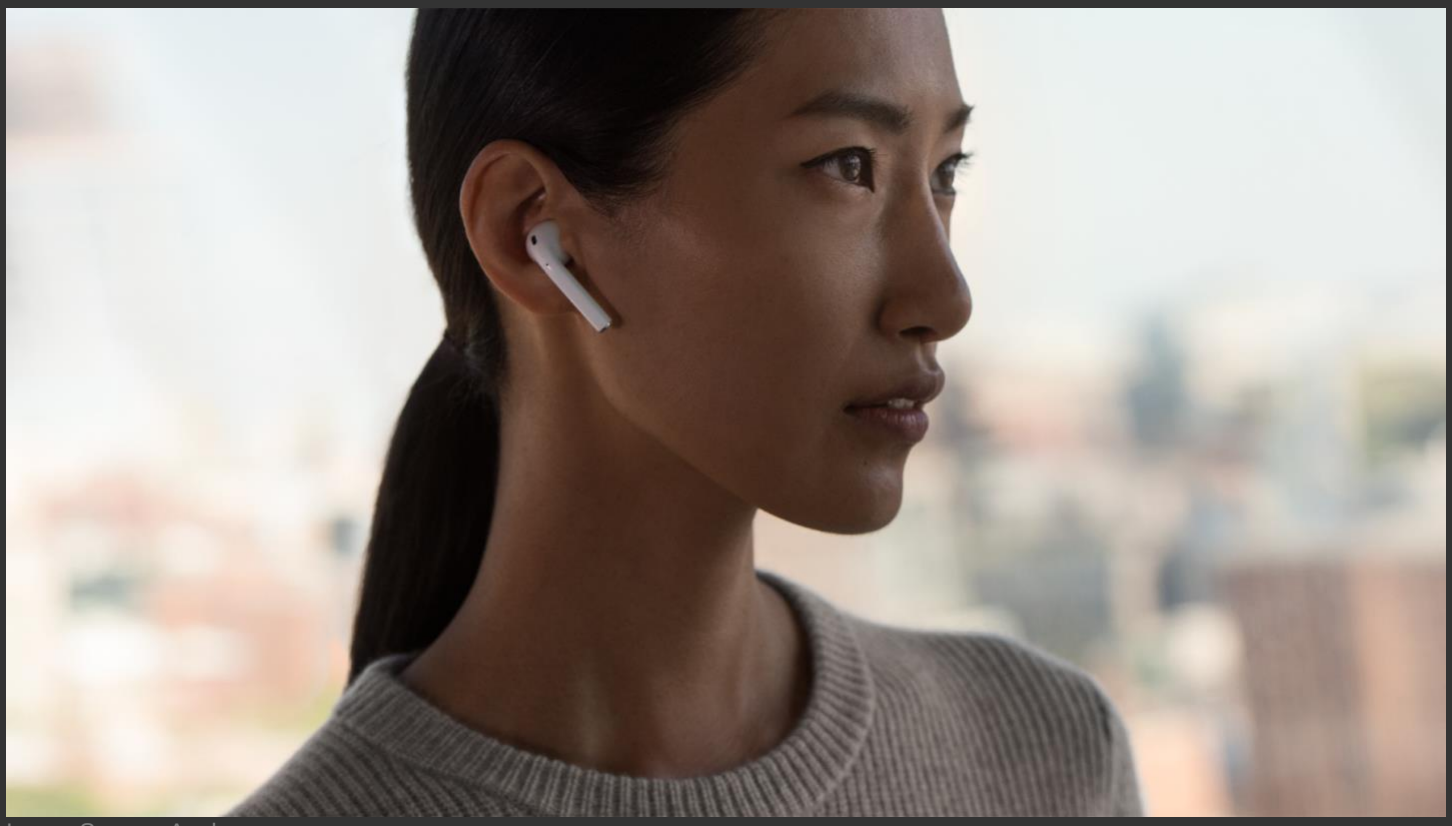


Image Source: Apple

Follow the Money

The above **Apple** analysis applies one of our favorite pastimes to *follow the money*. This is all about extrapolating product roadmaps based on tech giants' massive financial motivations. They're driven to future-proof their core businesses; or – like Apple – to diversify revenue in the face of maturing cash cows.

Applying the same exercise to **Google**, it acquired **Fitbit** to accelerate its lingering WearOS platform by having its own hardware. Its motivation, beyond wearables' rising tide, is the same that drove its Android mobile OS: to maintain a direct mobile touchpoint with consumers to drive its core search business.

Speaking of direct consumer touchpoints, **Amazon** blitzed the wearables market late last year as a delivery system for Alexa. Its Echo Buds are AirPod-like Bluetooth earpieces; Echo Frames are audio-enabled glasses. And Echo loop is a small ring with a mic and speaker.

Its motivation? When it failed to market the Fire Phone last decade, it lost a consumer touchpoint, and ceded years of pole position to **Google** and **Apple**. It now sees smartphone and wearables trendlines on intersecting paths and wants to redeem that mistake for the next era of hardware.

The situation is similar with **Microsoft**. Its Windows Mobile OS licensing model quickly lost share to Android's more compelling price tag (free) last decade. It thus missed out on that coveted position in the mobile revolution, which it now wants to redeem with a more vertically-integrated approach.

That approach can be seen in Surface laptops (a vessel for Windows and Office products), as well as the Hololens enterprise AR headset. More recently, **Microsoft** exhibited this hardware-forward approach with its Surface Earbuds which have native integration with MS Office productivity functions.

Meanwhile, **Facebook** wants to test the waters for AR glasses' social dynamics with its Project Aria, which will test AR glasses' social dynamics. Given the importance of AR Glasses on **Facebook's** roadmap, it's driven to gain insights in socially uncharted territory. And it's not the first company to do this: This also describes **Snap** Spectacles' playbook.

Speaking of **Snap**, it will be a key player in the wearables race. Its advantages include high engagement, product focus, and it's not afraid to experiment with hardware in the wild. It's zeroing in on an elegant UX with Spectacles 3, pursuant to feeling out and advancing consumer comfort levels for camera glasses.

And the trend stretches beyond these tech giants. **Samsung** has its own wearables play. And the strength of the category will attract commodity hardware players to fill gaps at the lower end of the market, as often happens, thus scaling up global access and adoption.

We'll also see specialty players such as **Bose**. Though it shuttered the Bose AR platform, it still markets audio-enabled glasses. Congruent with the theme of this report, **Bose** will work first on user acclimation for simpler wearables before someday returning to intelligent and sensor-informed "audio AR".

Naming Names

Having surveyed the landscape in the preceding pages, we'll now dive deeper into a sample of tech giants and their wearables moves... starting with the wearables king, **Apple**. For the sake of focus and brevity we've chosen a handful of representative examples and will mean no disrespect nor value-judgment towards omitted players.

Apple

Examining **Apple's** wearables strategy requires getting into its head. And one way to do that is to look at its financial motivations, as noted earlier. Wearables revenue performance could signal **Apple's** continued financial motivations to lessen revenue dependence on a maturing iPhone.

Breaking that down, **Apple's** fiscal Q2 earnings show "wearables, home and accessories" revenue growing **24 percent** (**$1.2 billion**), while iPhone sales fell **6.7 percent** (**$2.1 billion**). The former doesn't fully redeem the latter, but the offset is clearly valued by **Apple**.

Moreover, the wearables category by itself is now the size of a Fortune 150 company. Demand is greater than **Apple** can even fulfill, as it's supply-constrained (pre-Covid) for the **Apple** Watch Series 3 and AirPods Pro. This is a good problem to have and indicates long-term strength in the category.

Perhaps most interesting and less-discussed, **75 percent** of **Apple** Watch purchases were from users that are new to the device. Given **Apple's** penchant for platform lock-in and increased ARPU through multi-device ownership, new users at the beginning of that journey are music to its ears.

Image Source: Apple

iWear

Bringing the discussion back to AR, **Apple's** wearables category is where its AR glasses will live. That bodes well, given that they're born into a division that's graced — for all of the above reasons — with political capital and investment. They'll inherit the drive to diversify revenue and offset iPhone losses.

As for what AR glasses will do for **Apple's** revenue growth, it could both prop up and succeed the aging iPhone. The former happens as it creates reliance on the iPhone for local compute. In other words, the iPhone gains importance — and user incentive to upgrade — if it powers your glasses.

Early glasses functions could include things like an ambient "notification layer" that replaces some of the content and alerts you currently look down for. Moreover, glasses could join a suite of wearables that augments your life from several angles, and with several devices that support each other.

That will include line-of-sight graphics from your AR glasses to accompany the audible cues from your AirPods, and the biometric micro-interactions from your Watch. This "constellation" approach is classic **Apple** (again, considering its motivations) in supporting a multi-device ecosystem play.

Lite AR

Going deeper on what **Apple's** AR glasses could be and do, it's evident that **Apple** likely won't launch a set of AR glasses — at least in version one — that involves "heavy AR." This term refers to fully-realized world-immersive AR that has geometric and semantic understanding of its surroundings.

To achieve these functions, there are design tradeoffs such as bulk and heat. In the sliding scale between sleek glasses that power "light AR"; and bulky hardware that powers "heavy AR," **Apple** will likely lean towards the former, as sleekness and style are core **Apple** design principles.

Apple also needs to think big. Because eyeglasses and sunglasses are much larger markets than AR glasses, it could enter the prescription eyewear market, infused with **Apple** magic. In other words, it could add digital cohesion to regular glasses through the aforementioned "notification layer."

Moreover, **Apple** will broaden the concept of "augmentation" beyond the AR world's current connotations. So instead of **Pokémon** characters, digital layers will be things that generally help people see better; or brighten their day through mood-altering filters; or bring them utilities such as commerce.

The latter is one direction hinted by **Apple's** Project Gobi, which will place visual markers in retail partner locations, such as **Starbucks**. **Apple** could enable fast transactions for getting your coffee or paying your parking meter with a combination of computer vision, AR glasses and **Apple** Pay.

These features could go beyond **Apple** glasses to other wearables. The spatial audio functions announced at this year's WWDC[v] have notable implications for audio interactions. Through all of this, **Apple** will lead and define society's connotations with AR, rather than follow them. This is what **Apple** does.

Acclimation Play

It's also notable that prospective AR glasses won't just round out **Apple's** wearable master plan, but they'll also benefit from it. Back to a central theme of this report, one of the byproducts of the rise of wearables will be acclimating consumers to wearing gadgetry on their bodies.

In that sense, **Apple's** wearables penetration today could be a step towards warming the world up to AR glasses. It's otherwise going to be a culture clash, à la **Google's** "glasshole" mishaps. Asking consumers to put things on their faces is a tough sell, but AirPods and Watch could at least take baby steps towards wearable sensor acclimation.

Image Source: Apple

Google

Speaking of **Google**, what moves is it making in wearables? So far, it has entered the wearables race in several ways including its Pixel Buds portable headphones. It also acquired **Fitbit** late last year as a move to buttress its lingering WearOS platform.

But as with **Apple**, a key question is 'why?'. And like **Apple**, **Google's** motivations for wearables are to protect and future-proof its core business. For **Google** that of course means *search*. So widening the funnel for bringing people into search is the name of the game.

Several **Google** moves over the past decade had that same underlying goal. That includes things as broad as Android (drives mobile search) to voice search (varied search formats). Meanwhile, **Google's** AR play is *visual search*, which similarly traces back to the goal of driving search volume.

With wearables, the same endgame is in play. But unlike the above software-based initiatives, wearables involve hardware. That means a literal touchpoint to users. Think of this like a trojan horse for positioning **Google's** core product closer to users' sensory nerves.

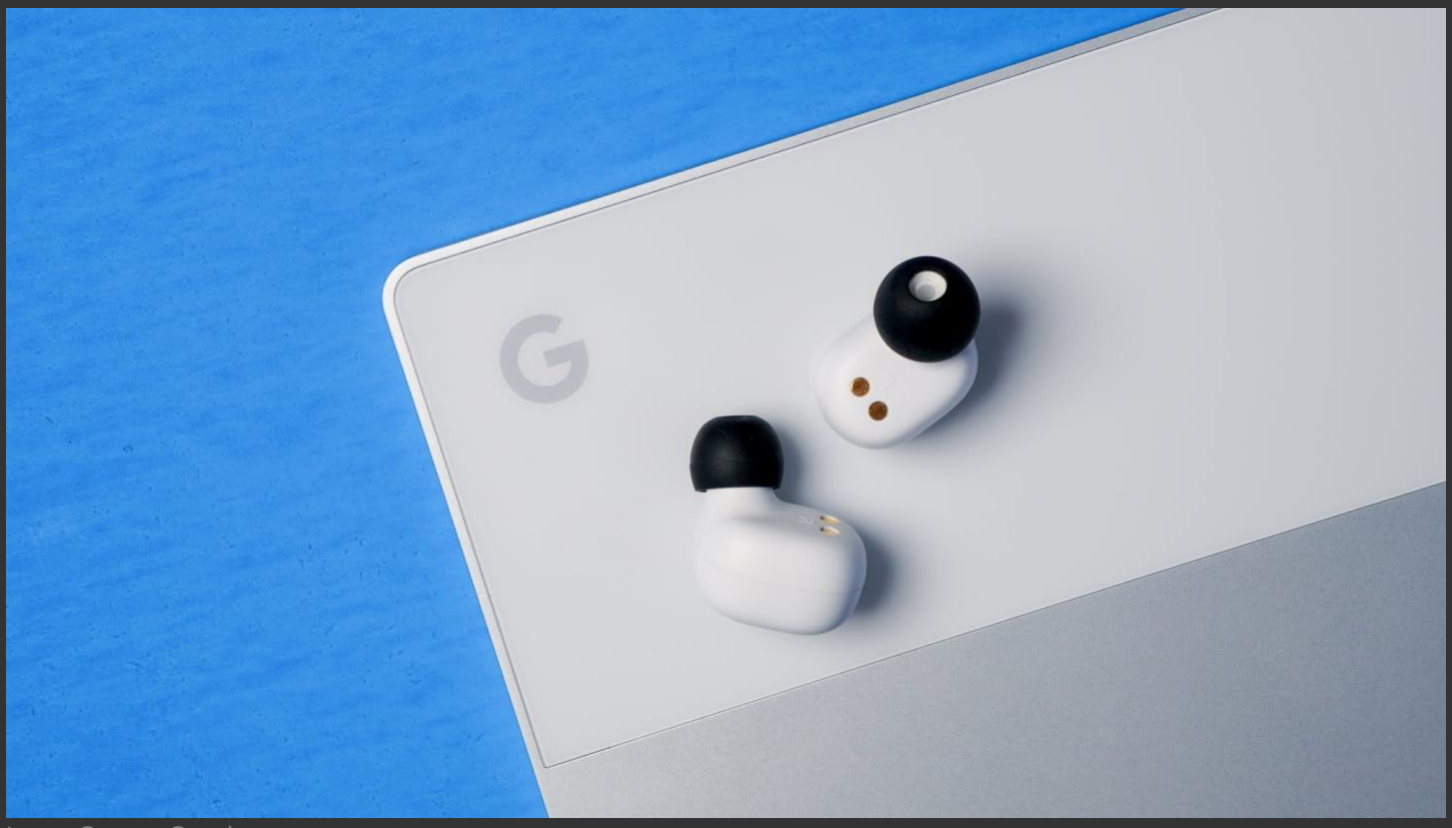


Image Source: Google

Sound Investment

So far, **Google's** most notable wearables investment is with hearables. Though **Apple** has a big head start, **Google** appears to be intent on a **hearables** future given its less-popular Pixel Buds. Though not as sleek as AirPods they're a vessel for a superior voice/AI engine: **Google** Assistant.

In fact, **Apple's** Achilles heel for AirPods is the famously inept Siri. **Google** Assistant will win the voice search and general-knowledge AI game, based on the extensiveness of **Google's** knowledge graph. It can process voice queries and answer questions with much greater reliability.

And this could be a winning factor. Hardware sleekness can be improved much easier than a quality AI engine can be built. So **Apple** will have to counterbalance Siri's detriments by creating more killer apps for AirPods; or by opening up innovation to developers like it's done with ARkit and other iOS-based SDKs.

Google also wins on sheer scale. **Apple's** AirPods have a total addressable market of about **900 million** global iPhones. Android however has a much larger global base of devices that is closer to **2.5 billion**. Most of those aren't yet compatible with Pixel Buds but it's a larger shell to eventually grow into.

Killer Audio Apps

So what will Pixel Buds do with that knowledge-graph backbone? This is where some of the potential “audio AR” killer apps come into the conversation. Hearables today are more about phone calls or music, but the real potential is in situationally-aware and intelligent notifications.

For example, AR can add lots of value in local discovery. This is an area **Google** has already cultivated with local search, given that proximity drives search intent.[vi] Audio AR will play into this with audio cues in commerce contexts such as a store aisle or finding a bar.

More broadly speaking, the vision is for an all-day ambient audio channel for personalized messaging. This can happen through traditional **Google** searches (in this case via voice); and through predictive alerts, which **Google** is already developing with Assistant.

Speaking of **Google** Assistant, a potentially compelling audio AR use case is real-time language translation. **Google** Assistant already does this, but when brought directly to your ear, this could be a true utility for seamless foreign language translation on the fly — a potential killer app for traveling.

Image Source: Google

Share of Ear

The above scenarios align with **Google’s** smartphone-era construct of “micro-moments.” These are the content snacking moments in the grocery line or subway — pulling out your phone for a quick fix of email, **Instagram** or **Twitter**. It created a media (and ad) delivery greenfield.

But audio’s advantage is discreetness. It’s less cumbersome than pulling out your phone. And because AR glasses are held back by cultural and stylistic factors, the subtlety of ambient audio could fill a key gap before they arrive. All-day use also creates lots of content “inventory.”

This raises another concept we’ve been toying with: *share-of-ear*. Given that we’re inundated with visual stimuli, there’s a zero-sum competitive landscape for capturing that attention. But ambient audible stimulus throughout the day is still a greenfield. This is where **Google** is salivating.

The place where share-of-ear gets the most attention is smart speakers, which is the wrong discussion. Smart speakers seem to be a favorite topic for the tech press, but the **200-million** installed base is dwarfed by a prospective all-day wearable accessory that piggybacks on **3.4 billion** smartphones.

Amazon

Speaking of smart speakers, what moves is **Amazon**, making in wearables and how do those moves compare to **Apple's** and **Google's**? Though it's not often mentioned in the same breath as wearables, **Amazon** is making moves with the emerging product class, congruent with its smart speaker initiatives and other orbiting factors.

This all started last September at an Alexa event where **Amazon** launched a full-scale hardware blitz. As you may remember, it announced a string of new products that further extend Alexa's reach to our ears, faces, hands and kitchens. The in-home integrations are notable, but the real story is wearables.

Specifically, its new Echo Buds are Bluetooth earpieces that compete with **Google** Pixel Buds and **Apple** AirPods. Echo Frames are microphone and speaker-infused glasses. And Echo loop is an odd little ring with a mic and speaker to summon Alexa on the go.

Stepping back, this fits Alexa's crafty and less-discussed purpose to boost user engagement, pursuant to **Amazon's** core e-commerce revenues. It's a sort of loss leader in the same way Gmail, **Google** Voice, and several other **Google** products are part of an ecosystem play that drives search.

That's not a new notion, but it's important to acknowledge as an underlying motivation for **Amazon's** newfound interest in wearables. Like in the previous sections on **Apple** and **Google**, examining motivations and the question of "why" can help triangulate tech giants' product roadmaps.

Image Source: Amazon

Costly Mistake

Examining **Amazon's** wearables motivations also requires looking at its recent history. One of **Amazon's** first hardware moves was the Fire Phone in 2014. But charging too much for a phone that had no discernable edge over iOS or Android caused it to die on the vine.

This turned out to be a costly mistake. Along with **Facebook**, **Amazon** was left with no direct hardware contact with consumers. It was now at the mercy of **Google** and **Apple**, whose devices represented an indirect conduit for **Amazon's** consumer mobile engagement.

This led **Amazon's** drive to release Echo devices as a direct consumer touchpoint and a beachhead into the home. The Echo line became successful in that respect and a market-share leader for smart speakers.

But as a home-only access point, Echo ceded lots of user mindshare to out-of-home activity where users are glued to their phones. Not only do **Apple** and **Google** own that hardware, but **20 percent** of mobile searches are voice-based — a query volume that dwarfs smart speaker searches.[vii]

Backing that up, there are about **118 million** smart speakers in the U.S. where **Amazon** leads. But there are **3.4 billion** global smartphones and **120 billion** annual mobile voice searches, where **Amazon** has zero market share. That's where **Google** Assistant and the inferior Siri have the pole position.

Beyond penetration, there's the matter of user intent. Purchase intent is greater on mobile devices than stationary ones, and few people buy products through voice searches on smart speakers. Moreover, a far greater portion of consumer spending happens with local offline shopping than in-home e-commerce.[viii]

But despite the tech press's misguided focus on smart speakers for voice search, **Amazon** knows where the scale is. So its latest wearables are meant to bust out of the home and become part of our daily travels. This represents **Amazon's** direct play at your senses if it can't be in your pocket.

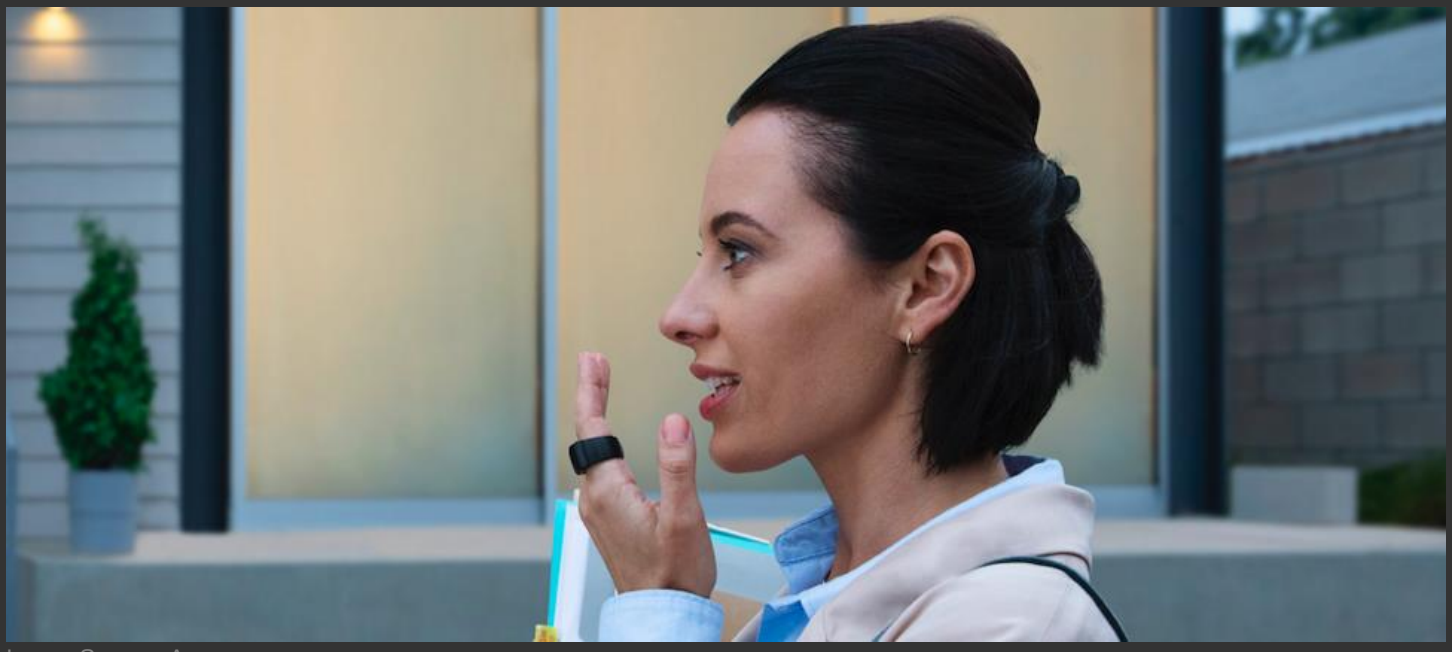


Image Source: Amazon

Leapfrogging

Amazon is also smart with timing. As mentioned earlier, smartphones are reaching market saturation and experiencing decelerated revenue growth. But wearables are on the rise as a product class, and could be a sort of successor to the smartphone (though reliant upon it) as a primary input.

Amazon's timing is strategic if you also consider the advent of 5G, which will generally fuel the capability and connectivity of IoT and smart devices, especially wearables. Beyond faster speeds, 5G's low-range, high-frequency signal will enable millimeter-level accuracy in positional tracking.

That unlocks functionality for wearables like smarter earbuds. This could include textured audio content such as local discovery ("look to your left"), with precise UI inputs such as head nods. This is what we've been calling "audio-AR" as an alternate and less-invasive modality than graphical AR, as noted earlier.

Clues for this vision can already be seen in **Amazon's** Sidewalk network – a project to create mesh networks from various **Amazon** devices. This will include its wearables, home devices and other IoT gadgets that can share and optimize connectivity by working with each other on a home, neighborhood or city level.

But most of all, **Amazon** wants to be on your body. After failing to market a smartphone, it sees the device's maturation as an opportunity to leapfrog to the next growth hardware, as validated by the growth of **Apple's** wearables division. It's currently experimenting with several form factors, but among them, its Echo Buds have marketability that's worth watching.

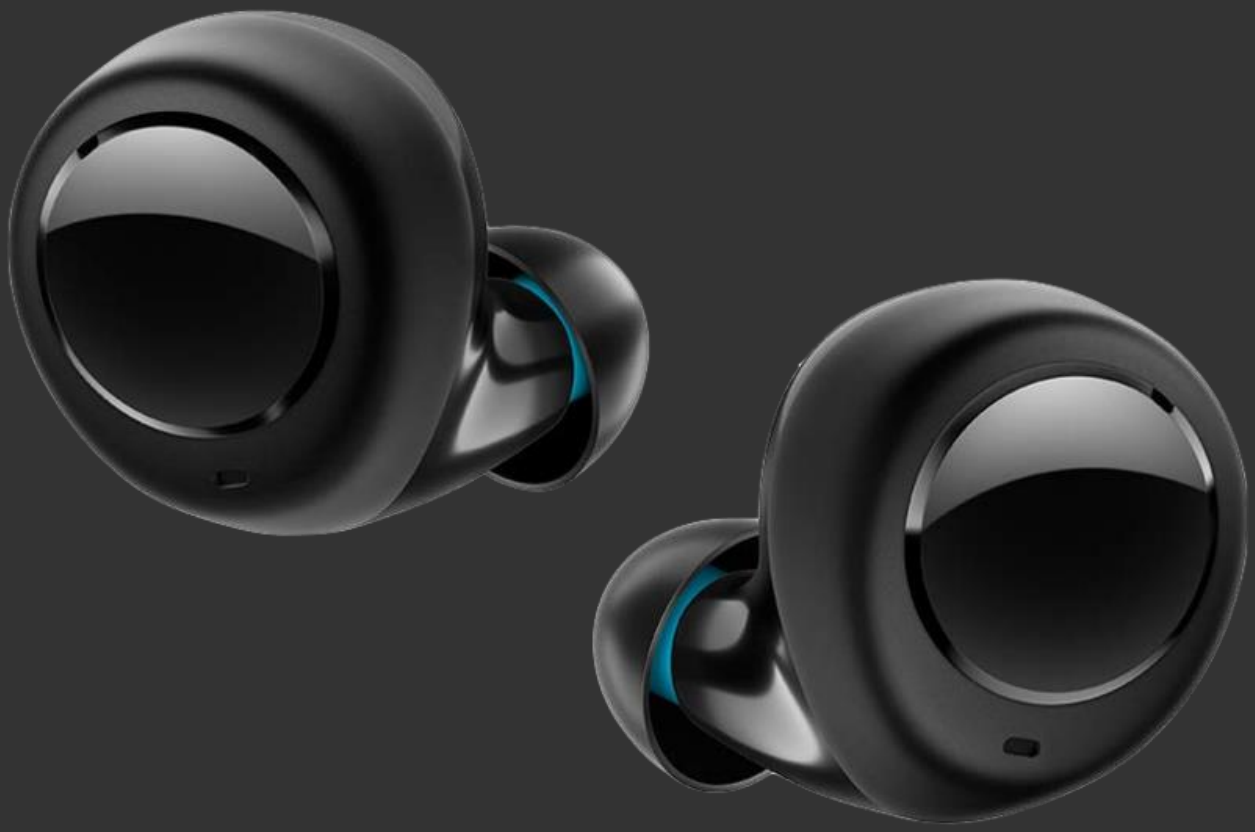


Image Source: Amazon

Microsoft

Moving on to **Microsoft**, what does its wearables play look like? Late last year, the company entered the wearables race with its Surface Earbuds. In addition to standard audio fare like music and phone calls, they're meant to integrate natively with **Microsoft** products like Office programs.

As with all of the companies examined above, a key question is 'why?' Here, **Microsoft's** motivations are similar to **Amazon's** in that wearables represent a way to redeem its longstanding position without a direct hardware touchpoint (smartphone) to consumers.

Stepping back, **Microsoft** had a similar fate as **Amazon** in the smartphone era. Though it wasn't hardware, Windows Mobile OS was meant to be its wedge into the smartphone stack as a revenue center and a way to position its apps (Office, etc.) in mobile workflows. But Android swallowed its market share as a free alternative.

Now, just like **Amazon**, **Microsoft** wants to market a mobile accessory that leapfrogs the smartphone in achieving a direct touchpoint to consumers. Leapfrog is the key term as wearables are a quickly growing category, as quantified earlier, while smartphones are decelerating as they reach market saturation.

Image Source: Microsoft

Vertical Integration

So how do wireless earbuds better position **Microsoft**? Just as **Amazon's** Echo Buds provide a vessel for on-the-go Alexa interactions, **Microsoft** Surface Earbuds can deliver on-the-go **Microsoft** experiences.

For example, Surface Earbuds have native integration and frictionless pairing with **Microsoft** products such as Office apps. That may sound strange at first but could create natural and valuable interactions in enterprise contexts. Think: smart audio cues and inputs during presentations.

For example, using voice input and automatic PowerPoint pairing, users can forward slides using voice commands. Other compelling use cases include voice transcription in Word, or live language translation — a potential "audio AR" killer app that **Google** has already launched with Pixel buds, as noted earlier.

These scenarios also carry similar advantages to **Apple's** vertical integration with AirPods. As AirPods users know, a chief benefit is automatic pairing, which can only be accomplished if you own the hardware and software stack (AirPods + iPhone + iOS). **Microsoft** is following the same playbook.

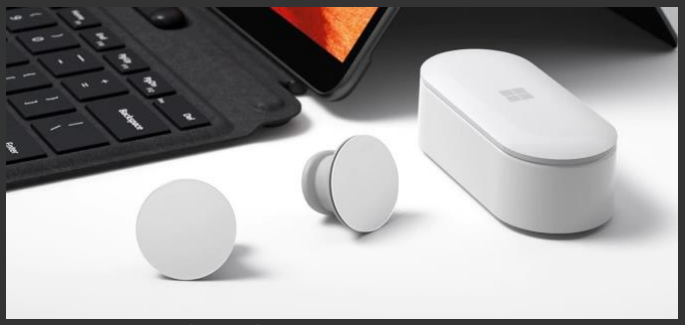


Image Source: Microsoft

Full-Stack Approach

Vertical integration isn't new for **Microsoft** as its been moving in this direction with Surface laptops and other hardware. For example, HoloLens is a vertically-integrated play that utilizes **Microsoft's** full-stack approach to AR with the OS (WMR), application layer (Spatial Anchors) and secure AR cloud (Azure).

Speaking of HoloLens, wearables like Surface Buds could play into **Microsoft's** eventual AR strategy. As examined a few times in this report, Audio AR augments experiences using the more-natural and less-obtrusive medium of sound instead of (or in addition to) visuals.

For **Microsoft**, sights and sounds could come together in ways that extend HoloLens use cases. That could include integration of textured audio with graphical overlays. But as is a key theme of this report, those longer-term AR outcomes require the wearables seeds that are being planted today.

In summary, wearables advance **Microsoft's** interests on a few levels. They can enhance Office products and enterprise productivity in the near term; while cultivating additional dimensions of its long-term AR play.

Facebook

Moving on to Facebook, it has several orbiting initiatives that comprise its spatial computing master plan. Before getting into how wearables fit in, let's take a quick look at that entire picture. For one, it includes the thing that kicked off the current AR & VR era: Oculus.

But though Facebook's VR moves are most prevalent, they're just one piece of the puzzle. The eventual endpoint is for VR to future-proof Facebook's social graph with another modality for people to connect. Starting with its social VR app Horizon, the goal is for immersive human interaction.

Facebook is also investing in mobile AR which takes form in the Spark AR lens development platform. This is a stepping stone to AR's next era whose job is to get users and developers acclimated to spatial experiences. And it doesn't hurt if it generates real revenue in the process, as Facebook's sponsored lenses do.[ix]

Lastly, Facebook has its eye on AR glasses, including explicit proclamations that it's developing them. This includes supporting pieces such as Live Maps for AR-cloud support, and lots of deep research around the unchartered territory of spatial interaction.[x]

Social Experiment

That brings us back to wearables. The above AR endpoints are predicated on the assumption that people will comfortably wear AR glasses in public. As Google Glass learned the hard way, there are deep-rooted cultural barriers that stand in the way of sensor-infused glasses from gaining social acceptance.

Enter Project Aria. Unveiled at the recent Facebook Connect event, this program will test the waters for AR glasses' social dynamics. How do glasses wearers behave, and how do non-wearers react? These questions can only be answered through field testing.

As we'll examine in the next section, this is the same driving principle behind Snap's wearables moves. With its Spectacles (which aren't AR glasses), it's likewise feeling out the social dynamics of camera glasses. From that, it will gain key insights around how AR glasses should eventually be designed.

Project Aria will also work to collect spatial maps for Live Maps.[xi] The challenge in any AR cloud initiative is that the world is a big place. So getting comprehensive spatial maps to support AR experiences can benefit from a crowdsourcing approach. This traces back to Facebook's recent acquisition of Scape Technologies.[xii]

Image Source: Facebook, Inc.

Perceptual Superpowers

Yet another vector in Facebook's AR development is *sound*. Facebook Reality Labs is investing heavily in research to unlock the promise of spatial audio. Similar to Apple's work, this could take form in standalone hearables and "audio AR" devices; or as a component to its AR glasses.

Using beamforming, this research uncovers ways to selectively optimize soundwaves based on where you're looking, along with some machine-learning magic. Goals include things like hearing your friend in a noisy bar by eliminating background noise and amping up the important parts.

Facebook calls this "perceptual superpowers," which could work in corrective ways for some people and optimize experiences for others -- all in tandem with AR glasses to process signals like eye gaze. This could also work toward Facebook's broader social goals by "defying distance."

"The only reason we need for virtual sound to be made real is so that I can put a virtual person in front of me and have a social interaction with them that's as if they were really there," Facebook Research Lead Philip Robinson wrote in a blog post. "And remote or in person, if we can improve communication even a little bit, it would really enable deeper and more impactful social connections."

Snap

To continue examining the wearables landscape, what about **Snap**? Its Spectacles camera glasses have had ups and downs. But the understated genius of the product might be more about conducting a market experiment than distributing a product whose success is measured in traditional sales metrics.

In other words, though Spectacles aren't AR glasses, **Snap** is gaining insights about consumer demand signals and proclivities for what AR glasses should someday look like. This is a nascent area where no one has answers, so **Snap** is investing to gain product intelligence for AR's next era.

If this sounds familiar, it's because **Facebook's** motivations for Project Aria covered above, are similar. AR glasses represent a key component of **Snap's** product road map. So it wants to make sure it gets the social dynamics right... especially for a socially-oriented company.

Meanwhile, **Snapchat** is already primed for an AR glasses era in other ways, such as developing the market's leading playbook for mobile AR lens interactions.[xiii] But it knows it needs to marry that software competency with the hardware that will represent AR's fully-realized form in a "heads-up" modality.

Snap's Carolina Arguelles revealed as much at last year's AWE Europe:

"We believe that in order to envision this future of computing overlaid on the world, you really need to take the screen away that's cutting you off from the actual physical world, which the mobile phone does […] Our investment in Spectacles is because we want to test, iterate and understand what it means to interact with cameras when they're on your face. We want to know what good content is… How people interact with it… What they like… What should the UX be? … What should the creative experiences be? … And ultimately how can we start to build out a content repository? […] AR is just starting to be introduced into this product and is eventually something that you'll see more and more of."

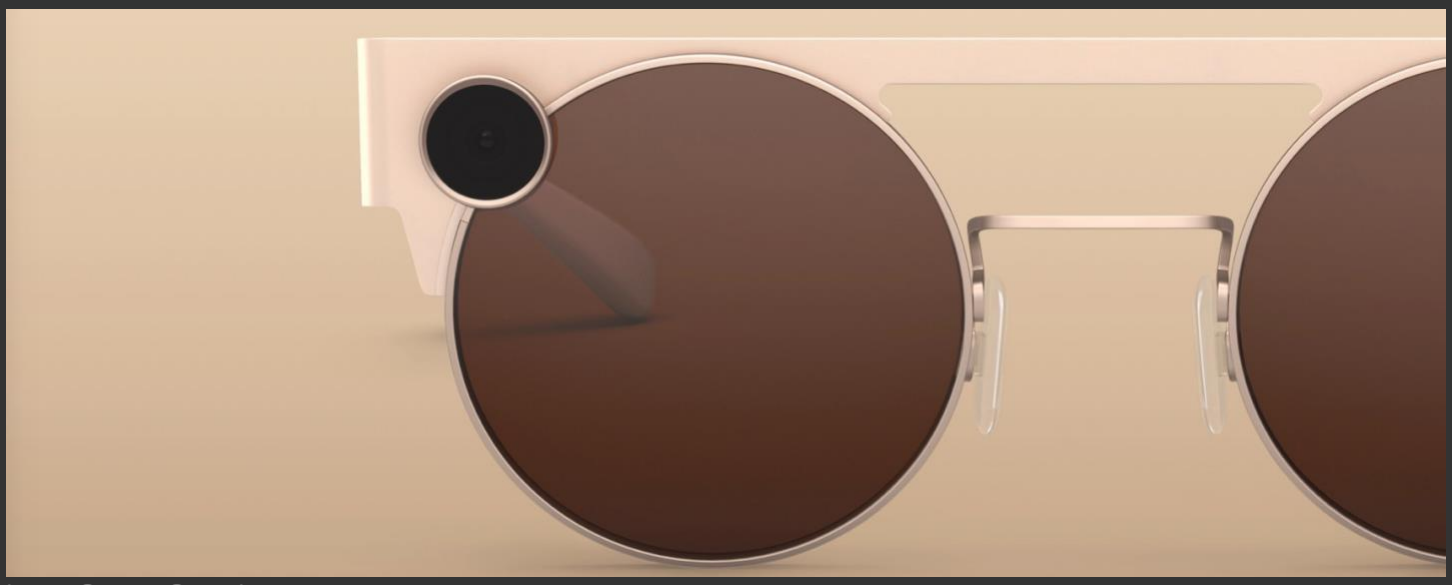


Image Source: Snap, Inc.

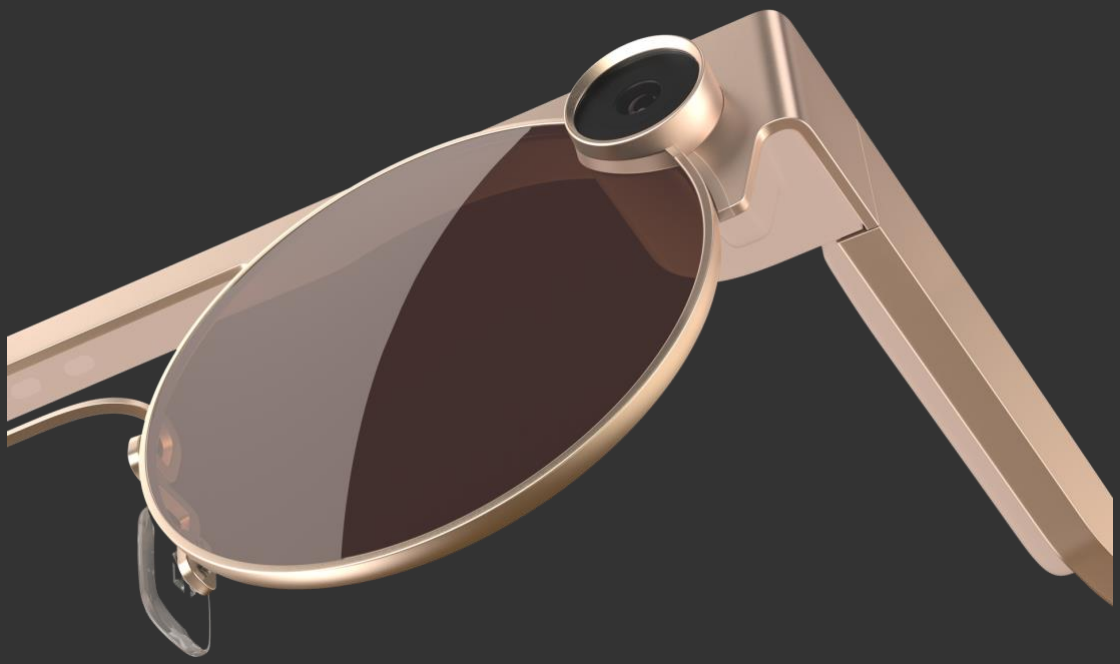
Sacred Territory

The other main goal for **Snap** Spectacles — true to the central premise of this report — is to acclimate the world to technology that you wear on your face. Because this is sacred territory and others have failed (such as **Google** Glass), it will be all about thoughtful and gradual approaches to ease consumers in.

"That's the secret strategy or the Trojan horse," said **Ubiquity 6** CEO Anjney Midha at a TechCrunch event. "How do you get enough sensors in people's hands at a cheap price or on their face. That sets [**Snap**] up for very immersive AR experiences or any kind of VR experiences a year or two years from now."

As examined earlier, **Apple** is conditioning users to wear sensors on their bodies to warm the world up for its looming smart glasses play. **Snap** is doing similar so that eventual AR glasses can hit the ground running. But its angle differs from **Apple's** signature top-secret R&D approach, says Evan Speigel.[xiv]

"Spectacles represent a long-term investment in augmented reality hardware," he said at a TechCrunch event. "So I think it'll be roughly ten years before there's a consumer product with a display that could be really widely adopted. But in the meantime, we've built a relationship with our community and all these people who love building [AR] experiences and we're sort of working our way towards that future, rather than go in a hole or in an R&D center, and try to make something that people like, then show them ten years later. We've sort of created a relationship with our community where we build that future together. So I think what's really cool about Spectacles 3 is, for the first time we have depth capability and if you're using Lens Studio, which are our tools for building augmented reality experiences, you can build AR directly for that spectacles content in 3D using our depth technology. So that's sort of an iterative step towards this AR future."



The Field

After examining a handful of tech giants and their varied wearables strategies, we'll admit that the story doesn't end there. We'll see wearables activity from other tech giants such as **Samsung**. And we'll see activity further down market as commodity players follow in the wake of premium brands.

As the wearables category continues to gain momentum, we'll also see specialty players move in to meet market demand. That will include players like **Bose** in the audio realm; **Ray-Ban** and others in the eyewear sector; and **Tag Heuer** and others in the high-end watch world.

Image Source: Apple

Demand Signals

One point that sticks out from the previous paragraph is **Bose**. The company has already launched well-known efforts in the hearables space with its Bose Frames. More importantly, it launched an audio AR platform known as Bose AR, which allowed developers to build experiences for its audio glasses.

However, **Bose** in June decided to discontinue the Bose AR platform. We believe that this could be due to a few specific factors. First, near-term consumer traction for Bose Frames – the hardware end of the Bose AR platform – was likely disappointing and not recouping or offsetting costs such as R&D overhead.

Second, **Bose** likely saw signals that **Apple** was working on spatial audio functionality in the AirPods Pro, subsequently launched at **Apple's** June WWDC conference. This functionality lays the groundwork for many of the use cases and consumer endpoints that Bose Frames, and the Bose AR platform, were targeting.

For these reasons and possibly others, **Bose** pulled the plug on its audio AR ambitions. But it's telling that it then launched audio-enabled smart glasses. Though they don't run on Bose AR – nor have textured and sensor-informed audio experiences – they do play music and other content.

This tells us that **Bose's** ambitions for smart glasses remain, but that its prioritizing marketable and mainstream-friendly smart glasses that eschew the "augmented" components of Bose AR. Once **Bose** gathers more consumer demand signals for audio glasses and senses cultural readiness for "audio AR" it will likely return to the space.

One lesson is that cultural acclimation and field testing are required before more advanced forms of wearable AR are possible – whether graphical or audio AR. That's a key theme of this report, as tech giants explored in the previous pages are currently engaged in that acclimation exercise and feeling-out process.

But this is a years-long process of investment and patience. The payoffs are potentially massive as examined in this report, but it requires long-term investment and deep pockets. Mid-market players like **Bose** may not have the same stomach for such a journey.

Final Thoughts: Covid Era

Another consideration is the global pandemic that currently clutches the global economy. Its requisite lockdowns and social-distancing especially impact hardware-based businesses due to impediments in the global supply chain. This clearly impacts the wearables sector, however hot it may be.

As noted earlier, many wearables forecasts have been downscaled (though they still show positive year-over-year growth). Covid-19 will indeed impact the wearables sector's momentum, though it will mostly be in the near term. We believe that by the end of 2021, the sector will be back on track.

Moreover, the concepts examined in this report hold up despite the near-term supply chain constraints. Impediments will impact the sector's timing more than anything – which again will be felt more acutely in the near term. This report conversely examines wearables' long-term effects.

On that note, AR will be formulated and accelerated by myriad forces. That includes 5G (connectivity) self-driving cars (computer vision) and other converging technologies. Wearables will be just one piece of that puzzle – gradually warming up mainstream users to wearing technology on their bodies.

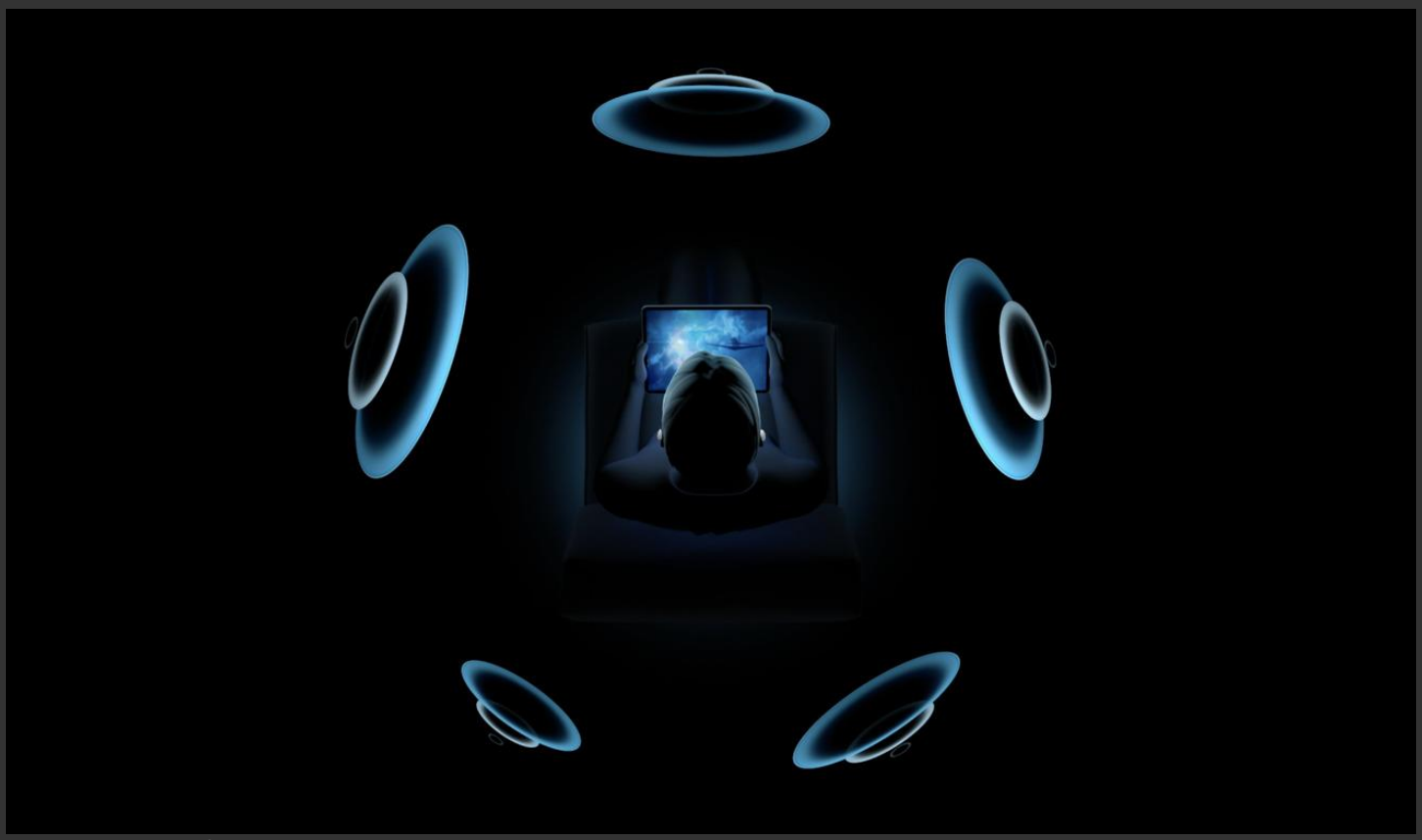


Image Source: Apple

Key Takeaways

- **The smartphone is commonly identified as AR glasses' forbearer. But wearables could have more impact.**
  - Wearables like Apple Watch and AirPods are conditioning consumers to wear sensors on their bodies.
  - Given that AR's fully-realized modality is head-worn, wearables could pave the way through cultural acclimation.
  - AR glasses will need that "push," given the cultural paradigm shift required for face-worn tech acceptance.

- **Wearables' potential cultural impact could be amplified by their current sales momentum.**
  - Wearables continue to be one of the fastest-growing consumer tech segments in year-over-year growth.
  - Sales forecasts have been downgraded from pre-Covid estimates, but remain positive in terms of unit sales.
  - The strongest growth is seen in smart watches and "hearables" such as Apple AirPods and its equivalents.

- **Beyond consumer demand for wearables, tech giants are embracing the product category.**
  - Wearables align with tech giants' product road maps, and fit in various ways with their growth strategies.
  - These reasons vary by company, but have a common thread of protecting or future-proofing core products.
  - This once again invokes ARtillery Intelligence's *follow the money* exercise to predict tech giants' moves.

- **Apple is particularly motivated toward wearables because they offset iPhone sales declines.**
  - iPhone sales – and all smartphone sales – decelerate as the category matures and approaches market saturation.
  - Apple's wearables growth is almost to the point of offsetting year-over-year iPhone sales declines.
  - Wearables also represent a long-term strategy for Apple to maintain its multi-device ecosystem approach.
  - Smart Glasses will be central to a wearables suite that collectively achieves holistic sensory augmentation.

- **Google is motivated toward wearables to maintain direct (hardware) touchpoints to consumers.**
  - This was the same strategy that drove Google's investments in the Android operating system.
  - Just like with mobile devices, Google can position itself closer to users' bodies as a "Trojan horse" for search.
  - The front runner in Google's wearables line is the erstwhile-disappointing Pixel Buds and its Fitbit acquisition.
  - Though its hardware is inferior, Google's advantage is superior software through Google Assistant (versus Siri).

- **Amazon is similarly motivated toward wearables to boost its core product: e-commerce.**
  - This was the same strategy that drove Amazon's investments in Echo devices and other in-home hardware.
  - In-home devices only capture a share of user time and mindshare, whereas wearables are more persistent.
  - So far, Amazon's wearables offerings are limited but have promise, including its Echo Buds and Echo Frames.
  - Amazon tried and failed to market a smartphone (Fire Phone) and is now motivated to regain that user touchpoint.

- **Microsoft is motivated toward wearables to create deeper user integrations for enterprise productivity.**
  - This includes its Surface Buds which create deeper integrations to Office products, thus boosting engagement.
  - Features include advancing slides with voice commands, language translation and voice dictation.
  - Like Amazon, Microsoft failed to gain pole position in the smartphone era with its Windows Mobile OS.
  - After losing ground early to Android, Microsoft is now motivated to regain that mobile user touchpoint.

- **Facebook is motivated toward wearables to gain consumer insights and acclimation for its AR Glasses**
  - Facebook's project Aria will test AR glasses to feel out social dynamics and considerations for design purposes.
  - Given the importance of AR glasses in Facebook's road map, testing wearable behavior is a sizeable priority.

- **Snapchat is also motivated toward wearables to gain consumer insights and acclimation for AR glasses.**
  - Snap Spectacles have been mostly judged on commercial metrics such as units sold, which misses the point.
  - Spectacles' true purpose will be to feel out consumer behavior and design insights for face-worn tech.

- **All of the above factors and tech-giant motivations will accelerate wearables and (eventually) AR glasses.**
  - Covid-19 global lockdowns and supply chain impediments will impact the sector, but only in the near term.
  - By the end of 2021, the wearables sector will be back on track and continue to pave the way for AR glasses.

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, 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 spatial computing analysis. They synthesize original data to reveal opportunities and dynamics of spatial computing sectors. 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 XRDC. 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 the *Huffington Post*.

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

Further background, history and credentials can be read **here.**

Methodology

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

For market sizing and forecasting, ARtillery Intelligence follows disciplined best practices, developed and reinforced through its principles' 15 years in tech-sector research and intelligence. This includes the past 5 years covering AR & VR exclusively, as seen in research reports and daily reporting.

Furthermore, devising these figures involves the "bottom-up" market-sizing methodology, which involves granular revenue dynamics such as unit penetration, pricing and growth patterns. More on ARtillery Intelligence market-sizing research and methodologies can be read **here.**

Disclosure and Ethics Policy

ARtillery Intelligence has no financial stake in the companies mentioned in this report, nor was it commissioned to produce it. With respect to 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 Intelligence's disclosure and ethics policy can be seen in full **here.**

Contact

Questions and requests for deeper analysis can be submitted **here.**

Reference

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