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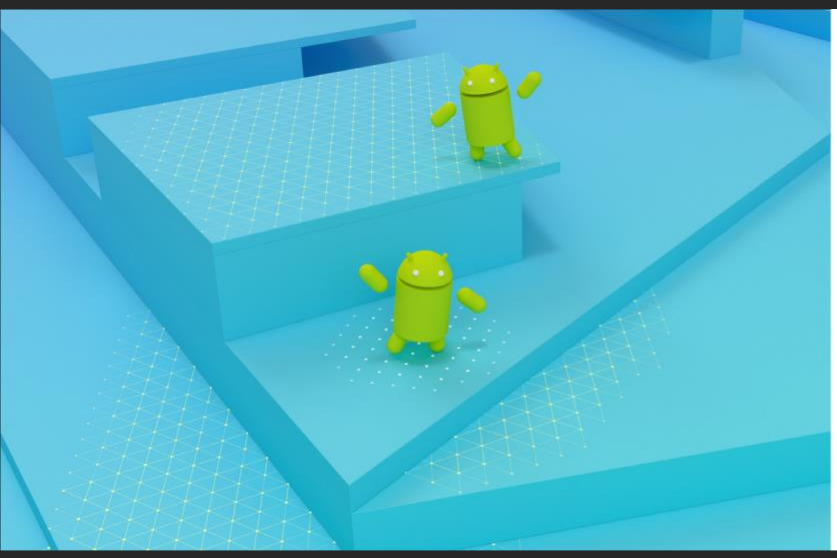

ARTILLRY INTELLIGENCE BRIEFING

ARCORE AND ARKIT: ACCELERATING MOBILE AR

OCTOBER 2017

ARtillry

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Executive Summary

Over the past six months, the tech sector has reined in its initial excitement about glasses-based augmented reality (AR). This includes realigned expectations on the time horizon to consumer ubiquity. But in the meantime, the AR world is keeping busy with another opportunity: mobile AR.

Beyond specs (battery life, field of view, etc.), AR glasses' detriment is form factor: It needs to be sleek and cheap enough to sway consumers to reconcile a key point of friction: personal style. The bar is set high for anything people are asked to put on their face, as Google Glass taught us.

This concern goes away in enterprise contexts (the topic of another report) but is a sizeable barrier in consumer markets. And we're a few years from marketable formats. The good news is that the stepping stone — or gateway drug as we like to call it — is mobile AR. And there's a lot happening.

Going by the numbers, mobile AR's addressable market isn't the low-millions of headsets: it's the 3.2 billion global smartphones today and 4.6 billion by 2020. Those aren't all AR compatible in terms of optical and processing components, but most will be over the next replacement cycle (2.5 years).

Google's AR development kit ARCore will become compatible with 3.6 billion global android devices during this time frame, and Apple's ARkit will reach 673 million iPhones. Both achieve AR through software, utilizing the standard smartphone RGB camera, thus lowering the barrier to "true AR."

Compared to graphics that simply overlay a scene, true AR infuses graphics that interact with physical objects in dimensionally accurate ways. ARCore and ARKit apply simultaneous localization and mapping (SLAM) through a surface detection approach that doesn't require advanced optics.

The result is an overall democratization of advanced AR capability. This starts with the massive installed base mentioned above, which in turn incentivizes developers with a larger addressable market. Then the content they create entices more users to engage, enacting a virtuous cycle.

Looking forward, we can expect several AR apps as ARCore and ARKit gain footing. But more impactful will be years of third-party innovation with both SDKs. That could rival in creativity and advancement, the app economy itself, which kicked-off ten years ago with the first iOS SDK.

But several questions remain: How quickly will this happen? What are the pros and cons of each AR toolkit? What will be best practices in building, distributing and marketing AR apps? And what does it all mean from where you sit? These questions are tackled throughout this report.

Questions and requests for deeper analysis can be submitted at **https://artillry.co/contact/.**

Key Takeaways

- Competition between Google and Apple has intensified over the last decade's "mobile OS wars."
  - Now those OS' respective AR development kits represent the next competitive battleground.
  - Like the mobile OS wars, mobile AR will force platform decisions from developers and users.

- Disappointing AR & VR headset adoption has shifted attention and investment to mobile AR.
  - There are 3.2 billion global smartphones today and ARtillry projects 4.6 billion by 2020.
  - ARCore will reach 3.6 billion smartphones during this time, and ARkit will reach 673 million.
  - This installed base will incentivize developers to place AR into the hands of billions.
  - Compatibility will start slow but grow fast over the next phone replacement cycle (2.5 years).

- ARCore and ARkit work with standard RGB cameras found in most smartphones.
  - Developers don't have to build AR technology from scratch, nor rely on physical barriers like markers or depth cameras. They can focus instead on end-user experiences.

- ARkit has a slight head start in developer interest and invested time.
  - ARkit also has technical advantages in its mapping and iOS development stack (i.e. Metal and Swift), which create more elegant integrations with ARKit.
  - Apple's classic vertical integration of hardware and software gives it greater control over things like camera optics and software updates.

- ARCore has a longer-run advantage in attracting developers, due to Android's greater scale.
  - ARCore is also more open, with a broader arsenal of lower-friction development tools (Tilt Brush and Blocks) and support from adjacent software (Daydream, Tango and Lens).
  - Google is banking on web delivery for AR, accessed through interlinked mobile websites instead of Apple's friction-heavy and siloed app approach.

- Regardless of platforms and the apps built on them, data will be the unsung hero of AR.
  - Geo-relevant data (store or product information) will be critical.
  - Object recognition data will let AR apps tap into previously chartered territory (area mapping), lessening the mobile compute burden for new AR experiences.
  - These data assets will be most effective if shared openly in a cloud repository.

- AR success will result from "native thinking." Build for the capabilities and limitations of the medium, rather than that of legacy formats (a classic pitfall of new technologies).
  - AR Success factors will also come from new modalities such as audio (sound "overlays").

- Attracting developers will be critical (between ARCore and ARkit, and from other sectors).
  - Due to mobile AR's capacity for scale, it will attract VR developers with transferable 3D design and modeling skills, or experience with game engines like Unity.
  - Yesterdays VR developers will be today's mobile AR developers and tomorrow's AR glasses developers – the ultimate AR endgame.

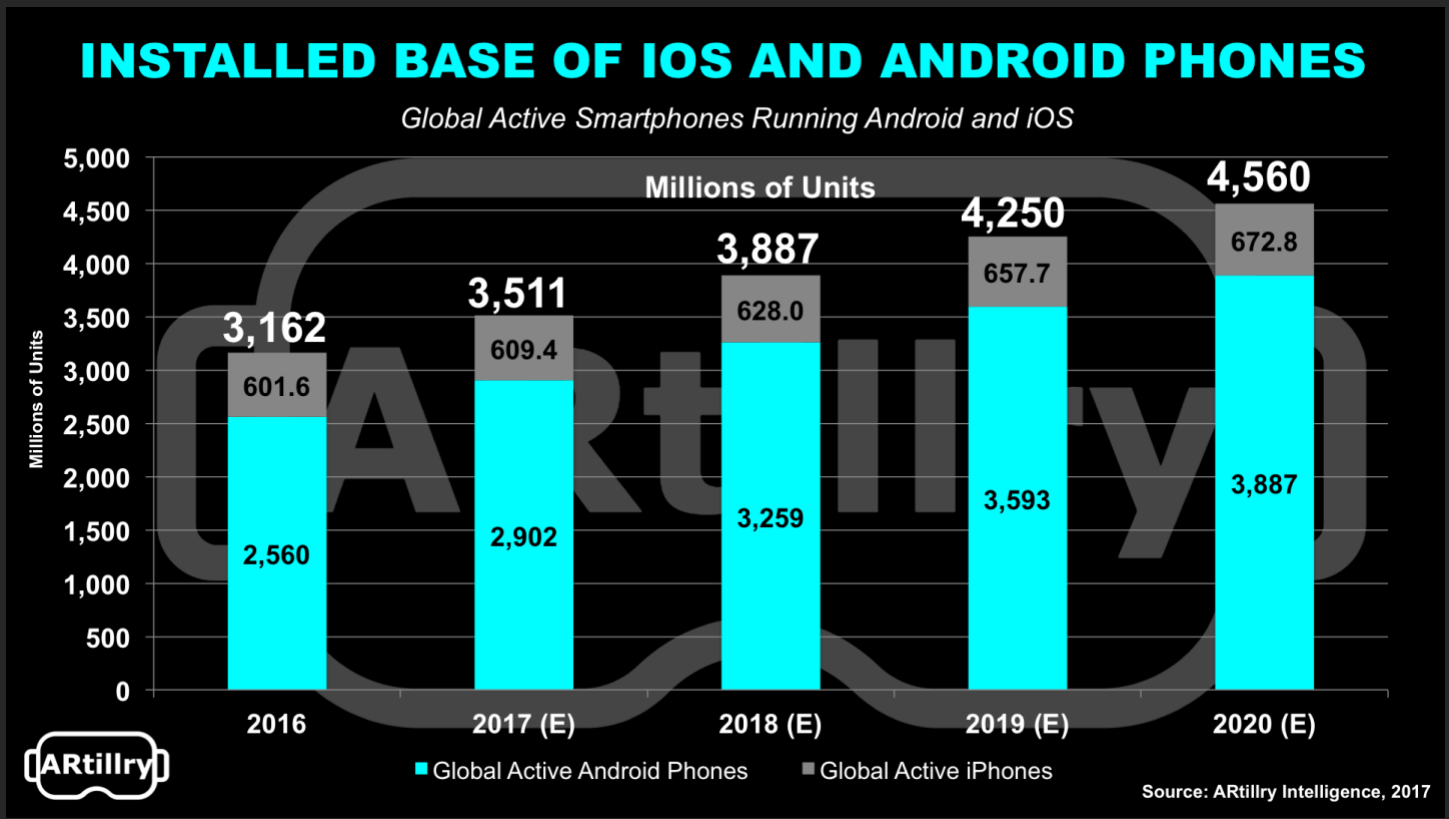
A Day That Will Live in Inferiority

September 12, 2017 will be a day that many remember for years. Or it will be quickly forgotten. The reason is similar for both outcomes: Apple's iPhoneX unveiling memorably disappointed AR-enthusiasts expecting an inspired glimpse of the future. To others, it was a forgettable product launch.

Among the iPhone X features trumpeted, AR was rather tepid. It's loosely related to new "Animoji," as well as more form-fitting selfie masks – both viewed by many as highly uninspired. There were few AR apps shown and the event altogether was devoid of Apple's characteristic feeling of "magic."

After initial disappointment, ARtillry realized that downplaying AR in the iPhone X was calculated and probably smart: Boosted AR-capability would mean an ARkit developer universe that's fractured between device tiers. Indeed, ARkit's edge is its compatibility with 355 million *existing* iPhones.

So in the end, it turns out that the day we were waiting for had already happened. It was June 5 2017, when Apple launched ARkit. On that day it kicked off the mobile AR era, continuing with iOS 11's September 19 launch, and the months and years of ARkit app development still to come.



As we've said before, this coming period could rival in creativity and advancement, the app economy itself, which kicked-off ten years ago with the first iOS SDK. Add Google's AR development kit, ARCore, and there's a total addressable market of 4.3 billion global devices over the next three years.

It will play out like this: A sizable installed base of compatible iOS and Android devices will incentivize developers to build AR apps. That scale plus Google and Apple's halo effect, especially the latter, will literally put AR into billions of peoples' hands over the next hardware replacement cycle (2.5 years).

100 Million: The Magic Number

There's something about the number 100 million — not just its symmetry and roundness but its historical significance in consumer tech products. It's the number that signifies a meaningful installed base, and network effect. And it will be a significant number for immersive computing adoption.

This is precisely what we saw with smartphones. Once 100 million units were sold globally, the mobile industry accelerated and could support an app economy and several other moving parts. This is due to the larger incentive for content creators and supporting tech vendors to enter.

100 million also supports network effect, and a key business/tech law that (for once) isn't Moore's Law. Metcalfe's law, coined by Etherent inventor Bob Metcalfe, states that networks increase in value exponentially for every node added. And an inflection point comes at… 100 million nodes.

Getting less technical, this happens through a snowball effect. The gravitational pull of 100 million units attracts new entrants who accelerate the industry's advancement and output. That further boosts unit sales, which in turn attracts more entrants. So 200 million units comes even faster.

Back to the world of AR & VR, industry leaders have likewise begun to look at 100 million units as a milestone. Most notable is Unity CEO John Riccitiello, who carries an admittedly cautious outlook for VR hardware penetration… and its current distance from the 100 million mark.

"If there isn't at least a near term probability of 100 million devices in the marketplace that can play it, [developers] won't build," he asserted at VRLA last Spring. "A hundred million devices creates an umbrella for the entire industry to flourish and I think we're a few years away from that."

According to ARtillry's calculations[i] we are indeed far from that goal: There are about 17 million VR headsets sold to date… and many of those are Google Cardboard. This realization has washed over the industry, and caused it to shift focus to the nearer term promise of mobile AR.

That promise is grounded in Mobile AR's accelerated path to mass-market scale. Collectively, ARCore and ARkit far exceed the 100 million unit installed base (figures below). And it's no mistake that Google's stated goal for compatible devices for ARCore's upcoming launch is… 100 million units.

Video Companion: The Democratization of AR

(Click URL)

https://youtu.be/qDJM6BrCOLU

By the Numbers

Drilling down into specifics, where are we now in terms of ARCore and ARkit compatibility? What's the installed base, and how will that grow? It's already significant – passing the 100 million test – and will expand rapidly as a function of standard hardware replacement cycles over the next few years.

Here are the breakdowns per AR development kit, and projected through 2020.

ARkit

The prevailing story line after ARkit's June 2017 launch was that it will accelerate AR's market penetration by creating the world's widest-reaching AR developer kit overnight. That premise is based on ARkit's software-centric approach that makes it compatible with lots of existing iPhones.

But how many is it? We've heard "tens of millions," "hundreds of millions" and other guesses. So to ease the suspense, ARtillry did the math. The verdict: there are 355 million ARkit-compatible iPhones active today, 434 million projected by the end of 2017, and about 673 million by 2020 (chart below).

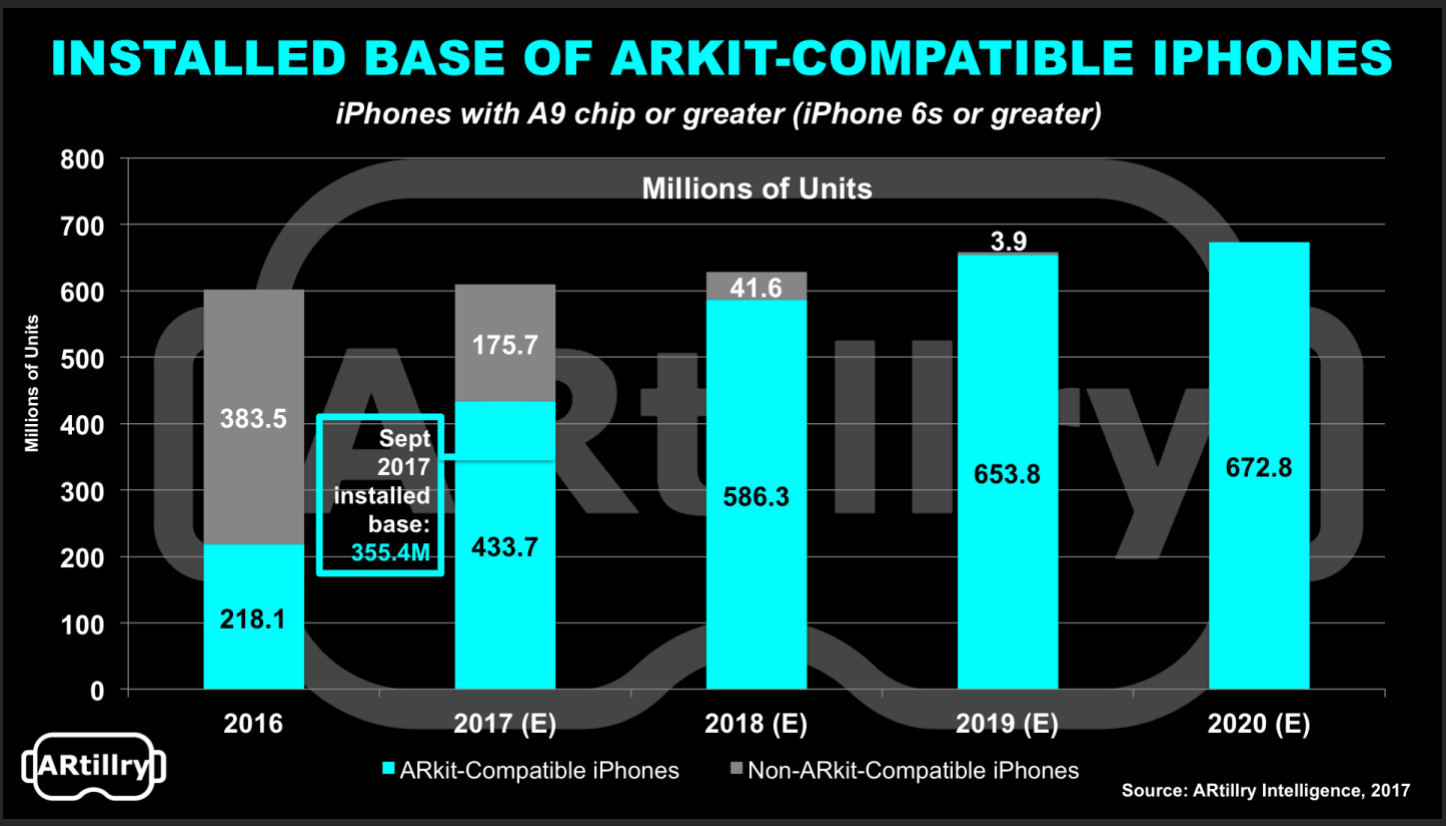
Not including iPads, this is the installed base of iPhones that have an A9 chip or greater. That translates to the iPhone 6s or greater. Taking into account its September 2015 launch, and the 2.5 year replacement cycle for iPhones, we built a model to calculate the figures above.

But perhaps more interesting than the current snapshot is its future projection. As noted, we project almost half of a billion units by year-end, or 71 percent of total iPhones. This will be driven by holiday-quarter sales that tend to move 75 million units, now accelerated by the draw of the iPhone X.

By the end of 2018, replacement cycles will wipe out all but 42 million non-ARkit-compatible phones in active use. Moving towards 2020, nearly all 673 million iPhones we project to be in active use will be ARkit-compatible, considering a very small portion of (second-hand) devices older than 4 years.

But the takeaway isn't just AR-compatible devices' share of the iPhone universe. It's also the degree to which that universe itself could grow. Year-over-year iPhone sales have been somewhat flat; AR features could make the iPhone sexy again and give it the long-term sales resuscitation it needs.

As for iPad, we project 32 million ARkit-compatible units by the end of 2017. The smaller total is due to components like processing and optics. AR apps on the iPad could also be narrower, based on weight, range of motion and portability, but we'll see at least some bigger-screen use cases develop.



ARCore

ARkit has a slight advantage in being first to market with a head start in developer interest and invested time. But the lifespan of AR will eventually diminish Apple's three-month head start. Greater developer attraction will ultimately come from platform reach. And that's where ARCore has the edge.

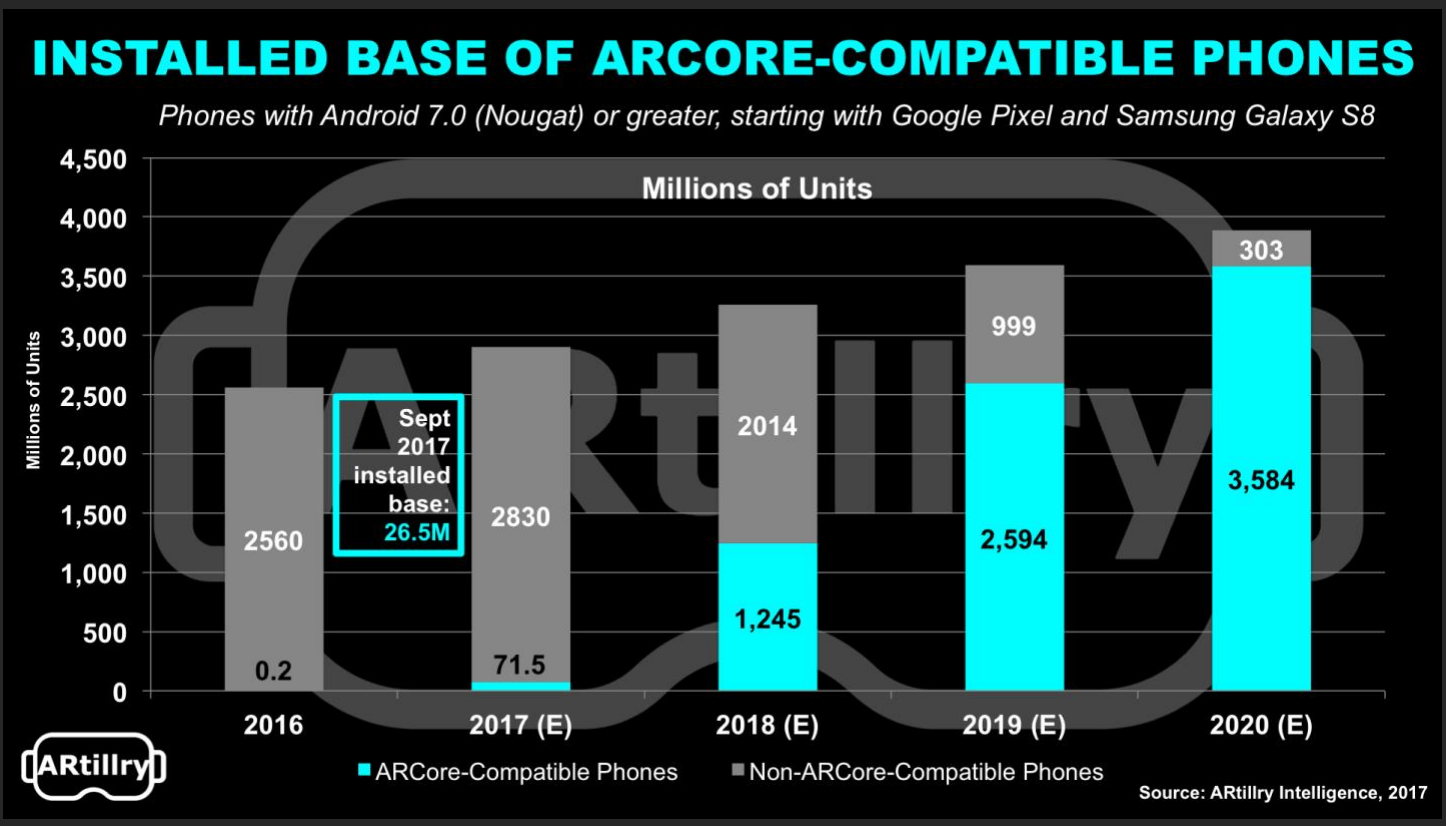
Though Apple has a near-term advantage in the installed base of ARkit-compatible iPhones outlined above, one hardware replacement cycle (2.5 years) will give most smartphones AR-compatible optics and processing. And the overall Android universe exceeds iOS by more than two billion units.

In short, ARkit holds a near term reach advantage, but ARCore will quickly catch up and exceed that, given Android's larger base. ARCore compatibility today is limited to Google Pixel and Samsung S8 handsets – with Huawei, Asus and LG to come next – that run Android 7.0 (Nougat) or greater.

Doing the math, that comes to global total of 26.5 million ARCore-compatible phones today, growing to 71.5 million by the end of the year. Again, based on the size of the Android universe, this will quickly accelerate over the next few years, eventually reaching 3.6 billion units by 2020.

You may have noticed that the share of Android devices projected to be ARCore-compatible by 2020 (92 percent) is less than Apple's share of iOS devices projected to be ARkit compatible (nearly 100 percent). This is due to Android's fragmented OS upgrade cycles across several devices.

About 16 percent of Android devices usually run the latest operating system, while 32 percent run OS versions older than one year, 29 percent older than two years and 15 percent older than three years. About 8 percent run OS versions older than four years, hence ARCore's lack of full coverage in 2020.



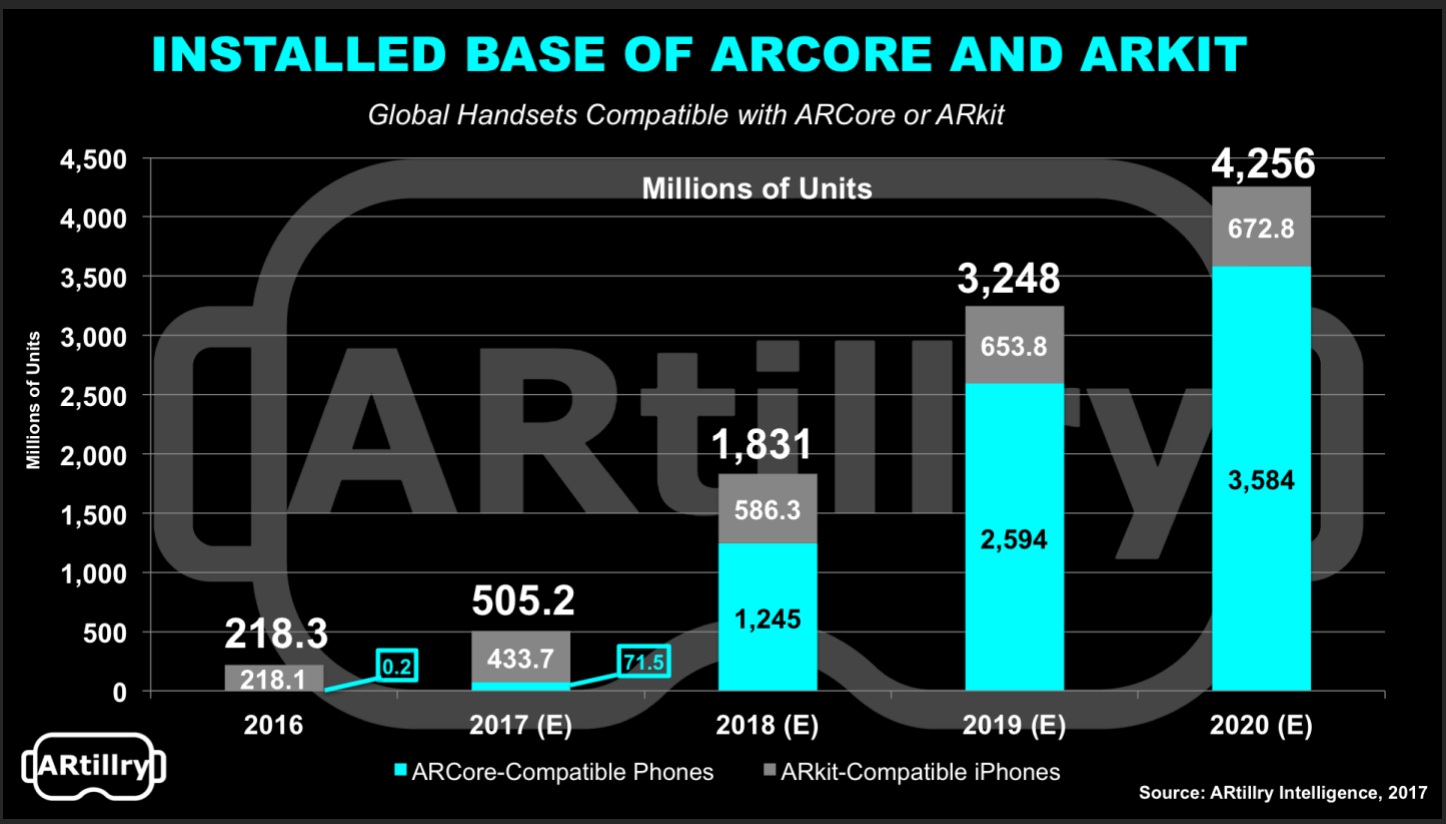
Combined

Combining ARCore and ARkit provides a more holistic view of mobile AR's growth in the next three years. There we see the addressable market of AR-compatible devices grow from 505 million this year, to 4.2 billion in 2020. That eventual total will comprise 93 percent of global smartphones.

One question that arises from these figures is why are they growing so rapidly. They over-index for growth rate, when compared to several growth-phase industries in the forecasting trade. For both ARCore and ARkit, they go from zero to billions over a five-year period, which should raise questions.

One reason is that we're talking unit-compatibility, not dollars. Another reason is average mobile hardware replacement cycles, which follow a set pace. At the risk of marginalizing our own forecasting: Though it required some interjection of insight, the growth model is fairly straightforward.[1]

It also goes back to the 100 million "magic number." As we saw with the smartphone, once the 100 million threshold is passed, things accelerate. The sector attracts developers, content creators and supporting technology vendors. So the march to 200 million and then 2 billion happens faster.



[1] *See explanation of methodology in end section*

Stacking Up

Besides scale, what are ARCore and ARkit's qualitative attributes? Their biggest value is perhaps democratizing advanced AR. Developers don't have to build AR technology from scratch, nor rely on physical barriers like markers or depth cameras. They can focus instead on end-user experiences.

ARCore and ARkit employ similar computer vision technology for mapping (the "M" in SLAM), which scans an area on which to infuse graphics. That includes horizontal plane detection, localization, motion tracking and light metering for realistic shading. These work in tandem to achieve true AR.

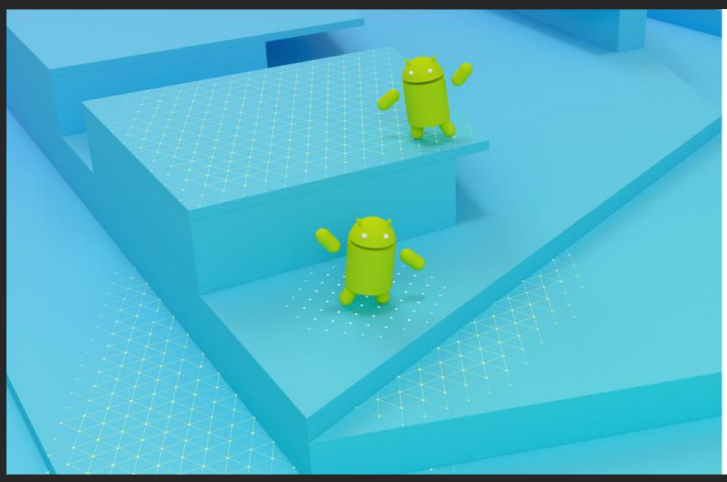
These methods approach the AR capability found in the industry-standard Tango platform (ARCore's forbear), which requires depth-sensing cameras. ARCore and ARkit instead use surface detection software with single-lens RGB cameras, allowing them to reach the market scale explored above.

But perhaps more important than their similarities, how do ARCore and ARkit differ? That question applies to technical strengths, as well as go-to-market strategies and positioning. On both counts, ARCore and ARkit each carry its parent's DNA, and each advance its parent's core business.

For example, Apple's app-centric paradigm is reflected in ARkit's delivery, while Google's web-orientation will shape ARCore's stated web delivery goals. Meanwhile, Google has a technical head start with the years of work it's invested in Tango, but Apple has more control over the hardware.

That software/hardware integration has always been Apple's strength. In this case it can directly govern the camera optics and sensor calibration that support ARkit apps. Google is hoping baseline smartphone standards evolve, but for now it's relying on the high-end S8 and Pixel (its own phone).

The following sections detail these differentiating factors, touching on technical factors but focusing mostly on strategic market positioning.



ARkit

On technical measures, ARkit's advantages include the vertical integration of hardware and software mentioned above. It can build hardware specifically to align with its software goals, and vice versa. It can also distribute software updates faster and to a smaller, more manageable range of devices.

This results in a greater portion of the iOS device base that runs the latest software, which has lots of advantages in terms of new feature adoption like AR, and security. That compares to the Android world, fragmented into several phones that rarely run the latest OS version, as quantified earlier.

Apple could also have greater appeal to VR developers – a key success factor as explored later. This could stem from Apple's app-approach. Compared to Google's web AR (explored below), apps can provide a more structured revenue model, such as app sales, advertising or in-app purchases.

ARkit also has a speed advantage in being first to market. Its June release predates ARCore's launch by months. Though that may be diminished by the long life span of mobile AR as mentioned above, there will be a slight early-mover advantage in attracting developers that become invested in ARkit.

Apple also owns an integrated software stack. This can limit developers to specific tools (though Unity has announced ARkit support). That development stack – including Metal and Swift – can create more functional and elegant AR graphics and experiences that run on ARkit.

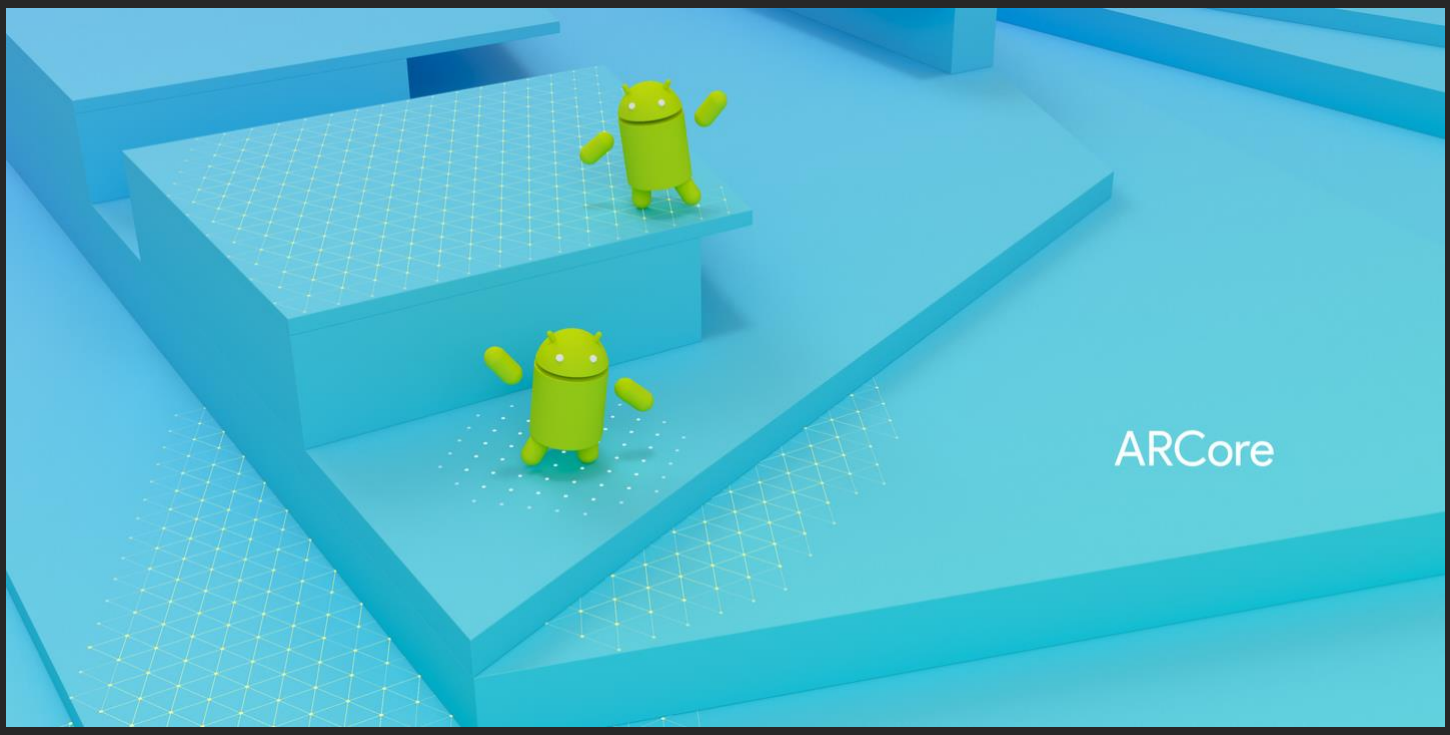
To be fair, Apple doesn't force these tools on developers but advises their use. This could still slow down ARkit app releases through a learning curve in the developer community. So a meaningful volume of ARkit apps could be 8-12 months away, partly negating Apple's early-mover advantage.

ARCore

Though ARkit has a slight advantage in being first to market with developers' interest and invested time, greater developer attraction will ultimately come from platform reach. There, ARCore has the long-term advantage. As quantified above, ARCore's installed base will start slow but grow fast.

ARkit's technical capabilities and requirements likewise have a flip side. Though superior in several ways, ARkit's technical chops could be challenged by ARCore's flexibility. Importing graphical assets to ARCore will be easier than ARkit, given a more open approach and arsenal of developer tools.

In addition to working with 3D modeling tools and game engines like Unity and Unreal, Google has internally built developer tools that will help populate its immersive computing product line (ARCore and Daydream). These include Tilt Brush and the low-friction 3D graphics engine Google Blocks.



Overall, the immersive computing assets Google has assembled — more extensive and tenured than Apple — will support ARCore. Its visual search tool Google Lens will assist in object recognition. More importantly, Tango's IP and human talent will be advantages realized and integrated over time.

Speaking of Google assets, one of its biggest advantages goes back farther than the last few years of VR and AR development. It's the web itself, where Google has rooted itself for 15 years as the world's search engine. That includes building a knowledge graph and search index.

This could play into an AR strategy by creating capabilities that are grounded in — and delivered by — the web. In fact, part of ARCore's unveiling included discussion of "WebAR," under which users don't have to download apps, but rather visit mobile websites to summon AR experiences.

This notably departs from Apple's content architecture that's rooted in apps. There is some evidence that an app-centric approach to AR could be disadvantaged, due to user friction. We've hit peak app-fatigue, given that most consumers' monthly app install rate is zero, according to ComScore[ii].

"You effectively have all the same problems that a mobile app has," Presence Capital partner Amitt Mahajan told ARtillry recently. "You have to convince someone to download it, and convince them to come back every day. All of the friction to get to that experience is still pretty high."

Beyond friction for users, apps are disadvantaged by their lack of interoperability compared to the link-structured web. This has always been the case in the app era, leading to movements like deep linking, but it could really handicap AR functionality by forcing it into non-linked silos.

Video Companion: ARkit vs. ARCore

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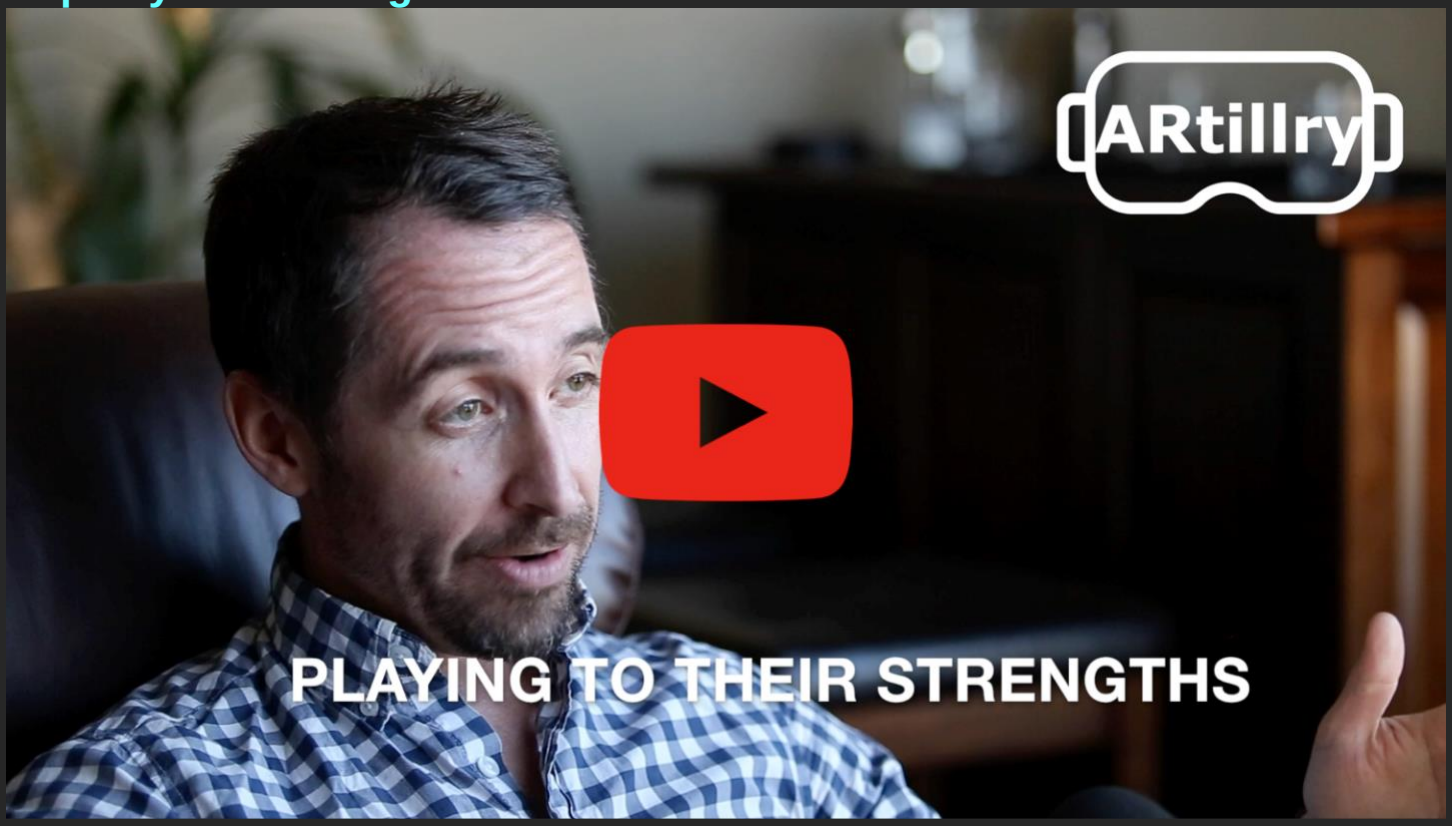
https://youtu.be/angUM2cNCF0



Content is King, Data is God

Regardless of platform, there are other factors that represent key parts of the AR value chain. Beyond the underlying mobile operating system (Android or iOS), AR developer kits (ARCore or ARkit), and content (apps), data and shared cloud intelligence will sit in the background as AR's unsung hero.

For example, geo-relevant data will play an important – though often overlooked – part in AR user experiences. It's not widely recognized that Pokémon Go was built on the architecture of Niantic's Ingress game, whose location tags were set over years and made the whole thing work.

As background, rudimentary AR such as Pokémon Go often uses geo-tagged data to position graphics. More advanced AR, such as ARkit, conversely uses object recognition to map and "register" objects before applying relevant and dimensionally accurate graphics or informational overlays.

Though the latter is certainly a more advanced form of AR, it will still benefit from location data such as business/product details or coordinates. This one-two punch will especially be additive in apps for navigation, local discovery, tourism, retail and several other location-relevant use cases.

Fortunately a few startups have spent years building systems that collect, clean and optimize geo-data. Examples include Aisle 411 for store layouts and product data. Companies like Foursquare and Yext validate lat-long coordinates for businesses, and things like customer reviews and menu items.

These data will come in handy with local discovery AR apps like Google Lens, which lets users point their phone at a storefront to get useful info. Google currently accomplishes this through a combination of object recognition using Street View imagery, and its local business data.

Google's visual positioning service, VPS, is probably a better example. Its unveiling included a controlled-environment demo for an AR-assisted screwdriver search at a Lowes store. But in practice, that requires product and blueprint data, as well as 3d scans of hundreds of store locations.

Google of course has the deep pockets and computational muscle to pull this off. But the question is whether or not AR developers will have access to such product or area mapping data. Without that access, AR apps risk the fate of Apple Maps' famous launch fail: having lots of flash but little function.

Video Companion: AR and Local Data

(Click URL)

https://youtu.be/T8c1VDGd4s0

The AR Cloud

One solution is what Super Ventures partner Ori Inbar calls the AR Cloud.[iii] It's a shared library of meta data to serve as an informational backbone for AR apps. It will particularly be useful in mapping data -- a key component in AR apps' ability to identify, learn and augment their environments.

As background, ARCore and ARkit perform well in individual sessions of mapping a given space, using surface detection and other functions explained earlier. But to map large or outdoor areas, or to come back to previously mapped areas, requires more computational muscle than smartphones offer.

An AR cloud can assume that burden, while also assisting AR devices that enter *new* areas, rather than exhaust computational muscle (and battery life) on already-chartered territory. It could register devices' location dynamically, then serve mapping and object recognition data tagged to that location.

Altogether, an AR cloud gives AR apps more functionality, and advances the industry. Think of it like crowdsourcing to build an AR map of the world. Inbar likens it to Waze, in which drivers get valuable real-time routing information in exchange for traffic and speed data collected by their phones.

Speaking of driving, autonomous vehicles (AVs) will be a key component of the AR cloud. The computer visions that let's AVs "see" the world relates to AR's area mapping. So well-funded advancements in AVs will support AR technology, including lots of mapping data for the AR cloud.

Bottom line: The AR cloud gives app developers the capability of a Google (which will likely develop its own AR cloud), such as mapping data for Lowes Hardware. Developers can instead focus on user experiences and business models – the same "democratization" principle behind ARCore and ARkit.

But it will also come with some challenges and considerations. Privacy safety is a must for any location data that people share (a different report). And who owns the AR cloud? How is the data made available and platform agnostic? These questions will be answered as mobile AR itself evolves.

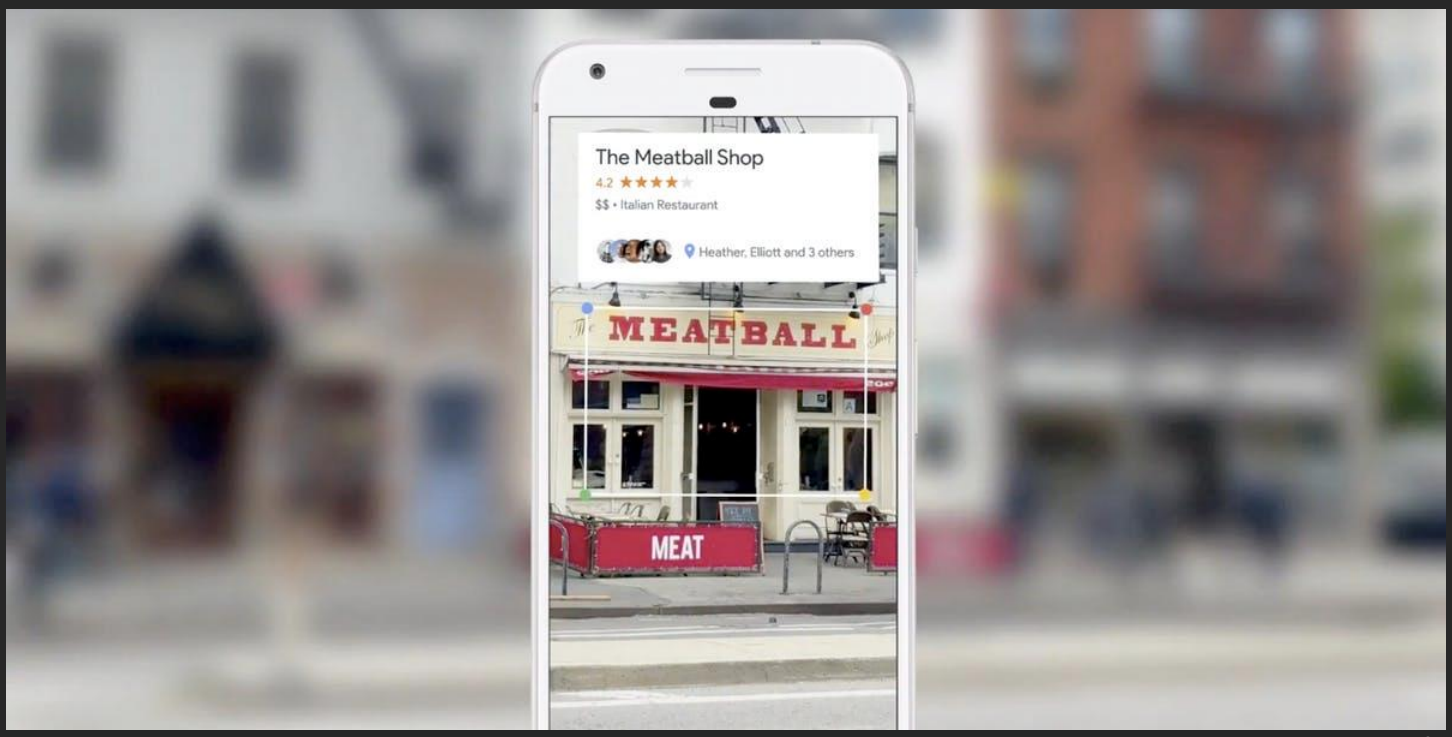


Image source: Google

Beyond Graphics

It often surprises people when we say that one of the most successful AR products so far (in terms of reach and impact) are… Apple's AirPods. That statement sounds strange because they aren't often classified as AR. But they could represent an important but unsung AR modality: sound.

Broadening AR's definition to technology-augmented perception, it should absolutely include sound. AirPods and other devices (see Here One.) will not only replace the tangled nest of white rubber in our pockets and purses, but will carry this new audible modality for informational "overlays."

Jokingly, we often say that the original form of AR is radio. It augments and enhances your perception as you experience the world – whether that be driving, jogging or the (diminishing) times you tune in. The format has shifted to podcasts and streaming audio but the overall principle remains.

"True AR audio" (analogous to "true AR") will be more textured and customized. It will include things like details about an upcoming business meeting or someone you're shaking hands with at a conference. LinkedIn could develop an app that delivers those audible stats subtly and on the fly.

The way it could play out: Airpods' sleekness and portability will condition a use case to leave them in your ears all day. That engenders a new channel for delivering ambient audio. From there it's up to app developers – as with ARkit – to develop content and use cases like the above LinkedIn example.

This vision brings to mind Google's smartphone-era construct of "micro moments." These are the user-prompted content snacking moments in the grocery line or subway — pulling out your phone for a quick fix of email, Facebook or Snapchat. It created lots of opportunity for media delivery.

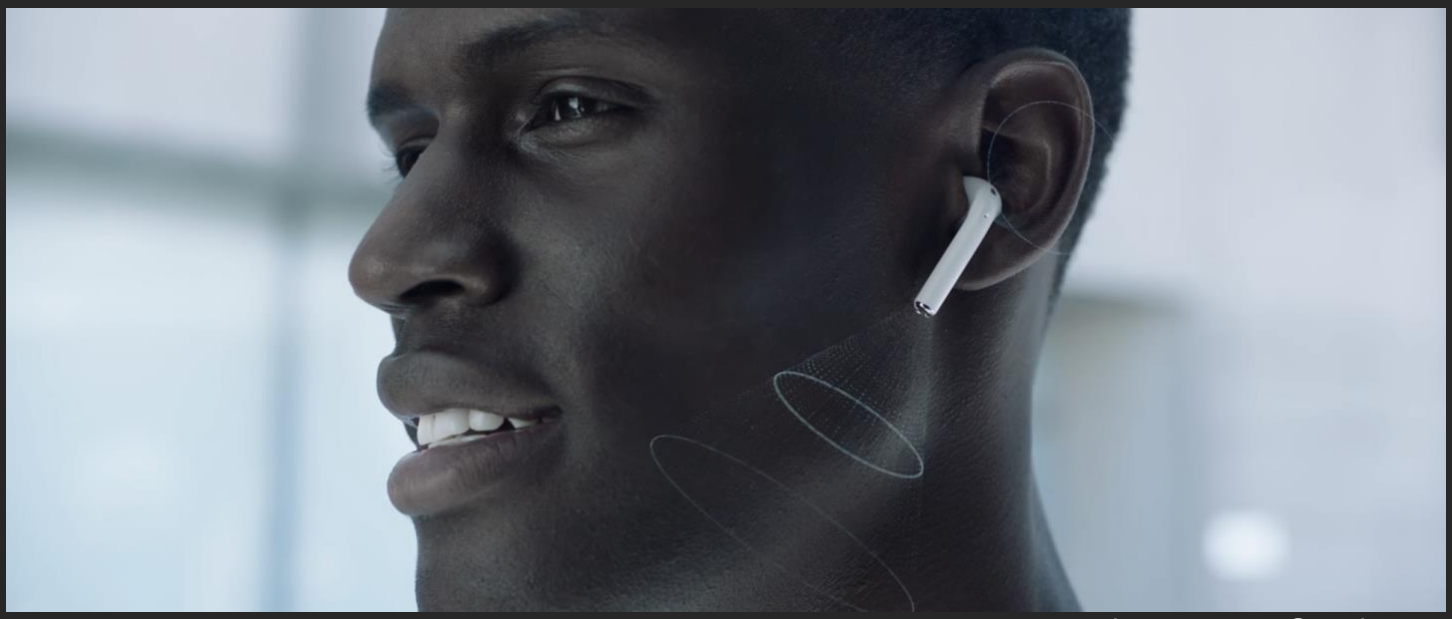


Image source: Getty Images

But audio's advantage is its 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 an important gap. All-day use also creates a massive addressable market (time) for content.

Of course visual media won't go away and is more conducive to several content formats. But audio could take over a certain share of micro-moments like getting informed about people or surroundings. Think: local discovery, news, shopping and social pings. We'll all become secret-service agents.

There's also a limited-market but altruistically-relevant use case: helping the visually impaired. Pervasive audible intelligence could enable anyone with vision impairment to operate with greater independence. There are already companies working on this, such as San Diego-based Aira

In all cases, the input will be voice, which aligns with the rise of personal assistant apps. The arms race between Siri, Alexa, and Google has accelerated voice processing innovation. So during the one to two years before AirPods gain ubiquity, voice interfaces will continue to get ready for prime time.

Add it all up and Apple is building a holistic AR arsenal: An audible play gives it yet another weapon. AirPods' need for a paired iPhone means Apple's installed base of devices further supports the opportunity, and further locks in users to its ecosystem. We expect Google will follow suit.

Think Native

In all of the above opportunities, whether it be ARCore, ARkit or "AR Audio," one success factor persists: Native thinking. This is the art of developing for the nuances of the form factor rather than shoehorning legacy formats. It's been an important lesson in past technological shifts.

Early television ads for example often showed someone standing and reading a script for Ovaltine or Lucky Strike (or insert 1940's quintessence). The reason: that's the way it was done in radio. It took a while for TV ads to grow into their own skin and develop optimal formats.

Going back further, the telephone was first devised as a way for telegraph operators to talk to each other in real time. But its true utility was eventually realized, thus replacing the medium it was designed to improve (then fittingly reverting back to transmitting "text" communication).

More recently, the smartphone era launched with a flood of dysfunctional apps that replicated websites. And ill-devised ad formats — predominantly banners — persist to this day. It took ten years to come up with truly native ad formats like Snapchat Stories or branded geofilters.

This all leads up to the question of how products will develop in AR & VR. Starting with AR, legacy formats like banner ads will be comically out of place. The 3 dimensional world doesn't occur in rectangles. And in early days, we'll see misfires just like we saw with early iPhone apps.

Image source: Applikey

"In 2007 when Apple launched the iPhone, most of the apps were flashlights," said Escher Reality CTO Diana Hu at September's TechCrunch Disrupt. "People didn't know what to do yet. There's going to be this phase of learning… a genesis of any technology when people need to experiment."

The reason this is all important is to not miss the unique opportunities that AR offers. It has the potential to create truly novel search, discovery and social use cases that no one has dreamed of yet. But before we see AR find that native footing, there will be lots of misfires.

"As far as AR apps and consumer-based products, I think you're going to see a lot of crap over the next year or two," said Niantic CTO Phil Keslin during the same Disrupt panel. "But you'll see some nuggets of creative genuine things that will spark something that will truly be amazing."

Relying once again on historical analysis, the native opportunity is perhaps best characterized by looking at native success factors in mobile. And there, we see the most notable examples, such as Uber, carry a common trait: they each wouldn't have worked on a previous form factor, such as PCs.

"You couldn't make an Uber style app when it was on a PC," said Escher Reality CEO Ross Finman on the same panel. "It only made sense after a mobile platform came out. Now it's about understanding what are the new things you can do with the mobile platform for AR."

Final Thoughts: The Next Era

Competition between Google and Apple has intensified since 2009, when then-Google CEO Eric Schmidt resigned his Apple board seat due to a budding conflict of interest. That competition subsequently took many forms including the mobile OS wars between iOS and Android.

Now, a component of those operating systems – their respective AR development kits – represents the next competitive battleground. And like the mobile OS wars, mobile AR will force a similar decision from developers, startups, brands and media companies about where to build apps.

The answer will often be “both,” but finite resources will at least require a decision of where to develop first. The criteria for that decision should be platform capability (what do you want to achieve?), reach (the figures in this report) and audience alignment (platform demographics).

And these will be moving targets. ARCore and ARkit are in version 1.0, and their future evolution could match the progress we’ve seen over the last decade with iOS and Android. It will be especially opportune for Apple, given control over the hardware (possibly glasses) that integrates with AR apps.

Virtuous Cycle

Either way, the competition in this two-horse race will end up serving consumers and developers alike. Google and Apple will be in competition for market share which means they'll be driven to boost capability and lower pricing. As it goes with any "platform war," gaining early market share is critical.

That starts with an installed base of devices, which attracts developers who are incentivized by a larger addressable market. That then drives the content available on a given platform and thus its ongoing attractiveness to consumers, who in turn boost the installed base: A virtuous cycle.

AR will also attract developers from the VR world. As ARtillry predicted in June,[iv] an oncoming shakeout in the VR sector will incite a migration of developers to AR. That follows a sort of law of osmosis for talent to sectors with greater revenue potential. And VR developers' skills are adaptable.

"The VR game developers of today could be the AR app developers of tomorrow," Transformation Group (TG) partner Shel Israel told ARtillry. "The skill sets of Unity developers will be highly transferable."

Taking that a step further, today's mobile AR developers are tomorrow's AR glasses developers. Mobile AR faces an exciting growth phase, but it's a stepping stone to an AR-glasses world. More aptly, it's a cornerstone to its foundation. Israel's colleague and TG Partner Robert Scoble put it best.

"We need developers to learn how to build that kind of software using sensor fusion, using the new 3D sensor, using the new kinds of ways to see the world," he recently told CNBC.[v] "We need them to build a lot of software so when the glasses world does arrive, there's lots of things to do."

Image source: Ray Ban

Key Takeaways (Redux)

- Competition between Google and Apple has intensified over the last decade's "mobile OS wars."
  - Now those OS' respective AR development kits represent the next competitive battleground.
  - Like the mobile OS wars, mobile AR will force platform decisions from developers and users.

- Disappointing AR & VR headset adoption has shifted attention and investment to mobile AR.
  - There are 3.2 billion global smartphones today and ARtillry projects 4.6 billion by 2020.
  - ARCore will reach 3.6 billion smartphones during this time, and ARkit will reach 673 million.
  - This installed base will incentivize developers to place AR into the hands of billions.
  - Compatibility will start slow but grow fast over the next phone replacement cycle (2.5 years).

- ARCore and ARkit work with standard RGB cameras found in most smartphones.
  - Developers don't have to build AR technology from scratch, nor rely on physical barriers like markers or depth cameras. They can focus instead on end-user experiences.

- ARkit has a slight head start in developer interest and invested time.
  - ARkit also has technical advantages in its mapping and iOS development stack (i.e. Metal and Swift), which create more elegant integrations with ARKit.
  - Apple's classic vertical integration of hardware and software gives it greater control over things like camera optics and software updates.

- ARCore has a longer-run advantage in attracting developers, due to Android's greater scale.
  - ARCore is also more open, with a broader arsenal of lower-friction development tools (Tilt Brush and Blocks) and support from adjacent software (Daydream, Tango and Lens).
  - Google is banking on web delivery for AR, accessed through interlinked mobile websites instead of Apple's friction-heavy and siloed app approach.

- Regardless of platforms and the apps built on them, data will be the unsung hero of AR.
  - Geo-relevant data (store or product information) will be critical.
  - Object recognition data will let AR apps tap into previously chartered territory (area mapping), lessening the mobile compute burden for new AR experiences.
  - These data assets will be most effective if shared openly in a cloud repository.

- AR success will result from "native thinking." Build for the capabilities and limitations of the medium, rather than that of legacy formats (a classic pitfall of new technologies).
  - AR Success factors will also come from new modalities such as audio (sound "overlays").

- Attracting developers will be critical (between ARCore and ARkit, and from other sectors).
  - Due to mobile AR's capacity for scale, it will attract VR developers with transferable 3D design and modeling skills, or experience with game engines like Unity.
  - Yesterdays VR developers will be today's mobile AR developers and tomorrow's AR glasses developers – the ultimate AR endgame.

About ARtillry

ARtillry is a publication and research firm that examines augmented reality (AR) and virtual reality (VR). Through writings, data and multimedia, it provides deep and analytical views into the industry's biggest players and opportunities. It's about insights, not cheerleading.

Run by career analyst and journalist Mike Boland, coverage is grounded in a disciplined and journalistic approach. It also maintains a business angle: Though fun and games permeate VR and AR (especially the former) long-term cultural, technological and financial implications are primary.

Learn more at **https://artillry.co/**

About Intelligence Briefings

ARtillry Intelligence Briefings are monthly installments of VR/AR data and analysis. They synthesize original and third-party data to reveal the dynamics of VR and AR sectors, and their opportunities.

In addition to data, a layer of insights is applied to translate market events and raw figures into prescriptive advice. This takes form in a narrative story arc, grounded in market figures.

Questions and requests for deeper analysis can be submitted at:
https://artillry.co/contact/

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 ARtillry, covering emerging tech.

Mike is a frequent speaker at industry conferences such as VRLA, ad:tech and LeadsCon. He has authored in-depth reports on the changing tech & media landscape including social networking and mobile. He contributes regularly to highly read online 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*. Mike was previously a San Francisco-based journalist for business and technology print publications, such as *Red Herring*, *Business 2.0*, and *Mobile* Magazine.

Note of Disclosure

ARtillry has no financial stake in the companies mentioned in this report, nor received payment for its production. ARtillry's disclosure and ethics policy can be seen at:
https://artillry.co/about/disclosure-and-ethics-policy/

Methodology

ARtillry follows disciplined best practices in market sizing and forecasting, developed and reinforced through 15 years in research and intelligence. Most of this time was spent in adjacent industries such as mobile, while the last two years has been spent in deeper and focused coverage of immersive computing (AR & VR). Forecasting principles, methodologies and best practices apply across these areas of market coverage.

This report specifically applies a bottom-up forecasting methodology that examines the unit sales and trajectory of AR-compatible smartphones to project future growth and penetration. Factors such as iOS and Android installed bases, unit-sales growth trending, hardware replacement cycles and OS-version upgrade cycles were key inputs.

More about ARtillry's market-sizing credentials can be found here:
http://www.mikebo.land/forecasting

Sources

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