

HOW TO MAKE MONEY FROM MIXED REALITY

AR

Whitepaper

1.1 Introduction

i. Augmented Reality

For Juniper 'mobile augmented reality', or mobile AR, is information or digital goods, such as video and games, which are seen as an overlay to the view from the device's camera. The download of this data to the device is triggered by real world data, such as physical location or a marketing poster, which is detected by the device.

Taking all the above into consideration, Juniper defines AR as:

'A technology that overlays a computer-generated image on a user's view of the real world, through a mobile device such as smartphones, tablets and smart glasses, to provide a composite image of the real world and overlapped digital images.'

Juniper Research stresses that AR should be considered an enabling technology and, as a result, the final product should not be AR itself, but an enhancement that has been made possible through the introduction of the technology.

This research aims to report on both the consumer and enterprise market; focusing on the future monetisation strategies and platforms that are most likely to be successful.

a) Mixed Reality

Mixed Reality, or mobile MR, builds on AR technologies to display digital objects that co-exist with the overlaid physical object with the ability to interact in real time. Advances in mapping technologies over consumer mobile devices has enabled those devices to detect flat surfaces, on which digital images are available for interaction.

Figure 1: Android AR Stickers



Source: Android Authority

ii. Future AR Trends

With hardware vendors and mobile OS frameworks firmly focusing on including AR-enabling technology in the device, content development must increase in order to fulfil the promise that smartphone AR holds.

The most notable success story is *Pokémon Go*. Developed by Niantic, the application was first released in July 2016. The application is available free, with an in-app purchasing system revolving around the acquisition of virtual coins that could be used to purchase various game items. Juniper Research believes that AR games apps, such as *Pokémon GO* are likely to find the greatest success with in-app purchases, rather than any other form of revenue stream, as consumers are likely to be discouraged by an initial purchase price and the diminishing of the user experience from in-app advertising.

a) Service Consolidation

With the exception of smartphone AR games, Juniper believes that the market is ripe for consolidation for services. The introduction of AR frameworks for Android OS and iOS will provide the platforms needed for new entrants to move directly into the AR and MR market when development is out of their key competency areas.

In the future, Juniper anticipates that larger companies will become increasingly involved in the AR space, in order to leverage the technology to enhance their own services.

Figure 2: The Augmented/Mixed Reality Ecosystem



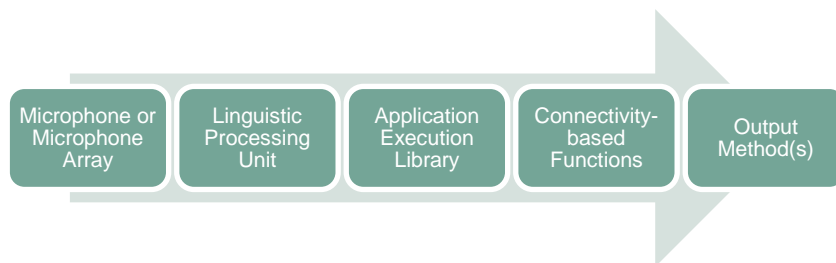
Source: Juniper Research

b) Virtual Assistants – The Future AR Interface

All voice assistants require some form of ML (machine learning) to process user command in 2 forms. These are a voice-to-text engine and a natural language processing ability, which gives the words contextual meaning. The latter of these is becoming the most important element, with an emphasis placed on conversational commands and flexible processing.

In the future, Juniper believes that voice assistant technologies will become the primary method of controlling head mounted AR devices. Indeed, Vuzix has already integrated Amazon's Alexa into its development platform. Commands through voice assistants will require insignificant amounts of data, however including the required hardware may remain an issue.

Figure 3: Elements of Digital Voice Assistant Technology



Source: Juniper Research

Manufacturers have developed systems in which the same command prompt can be attributed and detected by the device it was intended for. To avoid multiple devices processing and relaying the same command, voice assistant vendors have built in the ability to detect which device is

being spoken to, through a variety of means. This is either through directional microphones or a form of linguistic programming. Both of which are designed to detect the direction a command is issued from and that only the most appropriate device responds to it. However, in the context of AR, this presents a problem for hardware developers, especially those who are focused on reducing the form factor of consumer AR devices.

1.1.2 Smartphone AR & MR Sector Analysis

By 2022, Juniper anticipates that the largest addressable sector for smartphone applications will be mobile AR games, representing 44.9% of all installed mobile applications.

Juniper has considered 3 primary methods of monetisation for the 8 sectors considered in this section. They are as follows:

- **PPD (Pay per Download)** – The primary historical means of monetising apps across all current app stores has been the single price paid at the point of purchase. App stores in general (and Apple's App Store in particular) offer simple, one-click billing procedures for PPD, which is arguably much more user friendly than many other methods, in particular the Premium SMS option beloved of many off-portal service providers.

Juniper Research believes that primary value of the AR games market will come from PPD and in-app purchases, with little variation across the regions. As noted before, regions such as South Korea and Japan are likely to benefit from higher revenues from PPD applications, as consumers view the applications on the same level as current devices.

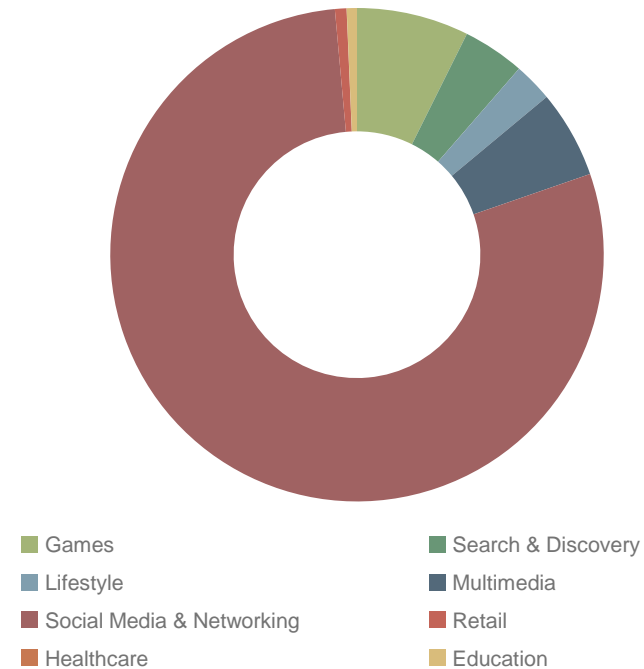
- **In-app Advertising** – At present, the vast majority of applications offered on leading app stores such as the App Store, Google Play and Amazon Appstore are free to download. Many of these free downloads, if they have a revenue stream, have one that is wholly dependent upon in-app purchases.

Search will be the most popular category of mobile AR app in the short and medium term; advertising is the predominant means by which search services and apps are funded, both in the fixed and mobile space. Location-based search providers will seek to provide exhaustive directories of the items within their remit; these will be supported by relevant advertising in the digital overlay, including text and banner advertising.

Furthermore, AR allows major brands to geotag any physical objects, ranging from their high street stores to physical advertising such as billboards. Thus, a consumer could view a passer-by wearing geotagged clothing, read information about the brand through the camera viewfinder, click through onto that brand’s website and purchase that same item.

- **In-app Purchases** – One model that has gained increasing popularity is that of offering ‘Lite’ versions of apps which provide consumers with a taster of the content available via their premium version. Upgrades can occur in 1 of 2 ways; either downloading a separate application, or else downloading additional content to the app that has already been installed on the handset.

Figure 4: Total Number of Smartphone Augmented Reality Applications Split by Category (m) Split by 8 Key AR Categories in 2022



Source: Juniper Research

1.2 AR & MR – Industry Movers & Shakers



Nikhil Chandhok

Facebook

Director of Product for Camera/AR

Nikhil Chandhok is founder of Bento Labs and serves as its CEO. Additionally, he has acted as Director of product for Camera/AR at Facebook since 2018. Chandhok was an Entrepreneur in Residence at GV (Google Ventures) after being with YouTube, where he was Director of Product Management. Chandhok spent 6 years at YouTube and 9 years at Google. At Google, he was responsible for YouTube's Music and Paid Subscription services. Before joining Google, Chandhok joined Microsoft as a Product Manager. He has an MSc in computer science from Ohio State University.

Chandhok's experience in product management on YouTube will provide Facebook with the necessary content development processes to maximise the value of their platform by ensuring a constant stream of new content for Facebook users.



Kari Pulli

Meta

CTO

Prior to working at Meta, Kari Pulli gained engineering experience at Camera Technologies Group, first working as a Senior Principal Engineer before being promoted to CTO for the Division. Pulli has also led teams at NVIDIA, acting as a Senior Director, and Nokia Research where he was employed as a Research Fellow. Additionally, he headed up Nokia's graphics technology department.

Pulli holds CS degrees from University of Minnesota (BSc), University of Oulu (MSc, LicTech), University of Washington (PhD); and an MBA from University of Oulu. He has taught and worked as a researcher at Stanford, University of Oulu and MIT.

Pulli currently has over 20 years' experience in developing computer vision technologies, bringing a wealth of experience to Meta's AR platform



Evan Spiegel

Snap Inc

CEO

Spiegel is the co-founder and current CEO of Snap Inc and developer of the popular social media app Snapchat; an app he created alongside Bobby Murphy and Reggie Brown at Stanford University.

Spiegel majored in product design at Stanford and the prototype for Snapchat was a project for the university. Spiegel left university to focus on Snapchat shortly before he was due to graduate.

Spiegel has been instrumental in Snap's early success. Indeed, the company was one of the first social media applications to include AR content. Whilst its AR framework was only available to select technology, the company has announced the framework can now be accessed publicly. Combined with its recent surge in acquisitions, Juniper believes that Snapchat is now well positioned to capitalise on AR advertising revenue.



Alex Kipman

Microsoft

HoloLens creator and Technical Fellow of the OS Group

Alex Kipman graduated from Rochester Institute of Technology in 2001 and joined Microsoft immediately after graduating. In 2008, he created the Kinect motion camera that was compatible with Microsoft's Xbox gaming console. Additionally, he created the subsequent motion controller.

He currently holds the position of Technical Fellow at Microsoft. Kipman is also the creator of Microsoft's AR HMD, HoloLens, having personally demonstrated the unit for the first time in 2015.

Kipman was an early pioneer in AR technology. Juniper Research believes his efforts in developing HoloLens has been instrumental in giving Microsoft an early mover advantage in the AR space as it was one of the first companies to develop AR content.



Paul Boris

Vuzix

Chief Operating Officer and Director

Paul Boris current works as COO of Vuzix, having spent the previous 2 years at GE (General Electric) in various executive level positions, including Chief Information Officer. Boris was also responsible for the development of manufacturing and software technology whilst at GE. Additionally, Boris spent over 8 years in executive roles overseeing manufacturing and operations strategy at companies including SAP, where he held the position of Global Vice President of Enterprise Operations Management.

Boris' experience in the manufacturing sector is critical in developing the tools for Vuzix in the industrial sector, bringing knowledge of manufacturing processes that can best be addressed by AR technology.



Byron Han

Vice President, Software Engineering

DAQRI

Byron Han now heads the software development efforts at DAQRI, as their VP of Software Engineering. Before joining the company, Han spent 30 years at Apple, developing new technologies for the company, the resulting products of which include Siri and Touch ID. He was also responsible for building teams from acquired and integrated start-up companies.

Han's experience in developing a large array of new technologies will greatly assist Vuzix to achieve its goals in the AR space in the future. The consumer-focused nature of his products from his time at Apple will align with DAQRI's intentions to serve the consumer market.

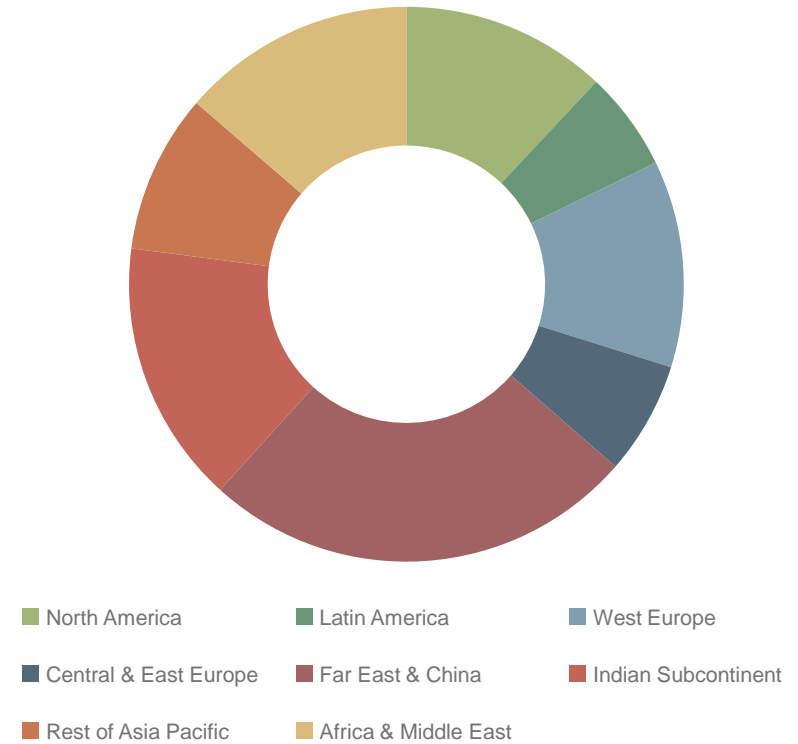
1.2.1 Augmented & Mixed Reality Forecast Summary

Juniper Research found that the total number of MR applications will reach 9 billion by 2022, rising from an estimated 3 billion in 2018, a growth rate of 212% over 4 years. MR applications display overlaid digital objects that co-exist with the physical world alongside the ability to interact in real time.

Juniper found that commitment to MR from Apple, Google and Facebook, will foster content development, propelling smartphone MR games market to reach a value of \$2.3 billion by 2022. It predicted that recent framework launches from these players, combined with new developer access to Google Maps, will accelerate the development of new location-based smartphone games.

In addition, we forecast that the number of social media applications offering AR services will exceed 6 billion by 2022, as platform providers seek new revenue streams. It also forecast that 98% of app revenues would be generated from advertising by 2022, as new models based on users' location, such as geolocation filters, become the most successful.

Figure 5: Total Number of Augmented Reality Applications (excluding Vehicles) (m) Split by 8 Key Regions: 9.2 billion



Source: Juniper Research

Order the Full Research

Juniper's **Augmented & Mixed Reality** research delivers pivotal use cases, trend analysis and competitive intelligence into on this high growth sector. The research is essential for hardware vendors, content developers and platform providers looking to understand the market prospects for both the consumer and enterprise sectors.

Key Features

- **Consumer & Enterprise Market Analysis & Impact Assessment:** Separate analyses for the impact of AR and MR technologies on the consumer and enterprise markets, aligned with insights and strategic recommendations for key stakeholders.
- **Juniper Vendor Positioning Index:** Offers a comparative assessment of 13 leading OEMs manufacturing AR and MR hardware, categorised in terms of the depth of their hardware offerings.
- **Augmented & Mixed Reality Sector Analysis:** Analysis of future market prospects across 8 key vertical markets.
- **Juniper Leaderboard:** 14 leading AR & MR platform vendors analysed, scored and positioned.
- **Forecast Suite:** Over 98,400 datapoints, forecasting the AR/MR market by region, country, device, content type and monetisation model.

What's in this Research?

1. **Executive Summary & Core Findings** – Top-level report summarising key trends, competitive analysis and market forecasts,

allied to a series of key takeaways and strategic recommendations for C-level executives. (PDF)

2. **Deep Dive Strategy & Competition** – Strategic analysis of market dynamics, drivers and trends, together with a detailed investigation of key AR and MR vertical markets and player analysis through the Juniper Leaderboard. (PDF)
3. **Deep Dive Data & Forecasting** – Augmented & Mixed Reality market prospects analysis together with 5 year forecasts for key metrics, including number of AR and MR apps installed, split by key vertical market and monetisation models, aligned with revenues. (PDF)
4. **Interactive Forecast Excel** – Highly granular dataset comprising over 98,400 datapoints, allied to an Interactive Scenario Tool giving users the ability to manipulate Juniper's data. (Interactive XL)

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