AUGMENTED AND VIRTUAL REALITY

Opportunities and Trends, Use Cases, Accelerators, and Barriers

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ENTERPRISE IS MATURING, CONSUMER IS COMING

Enterprise usage of smart glasses has slowly but surely grown over the past 5 years to be a dominant talking point for digitization. Quick Return on Investment (ROI) is possible with relatively simple to implement use cases, such as remote expertise and step-by-step instruction. This value can be expanded dramatically with additional features like machine vision and spatial recognition real-time knowledge capture.
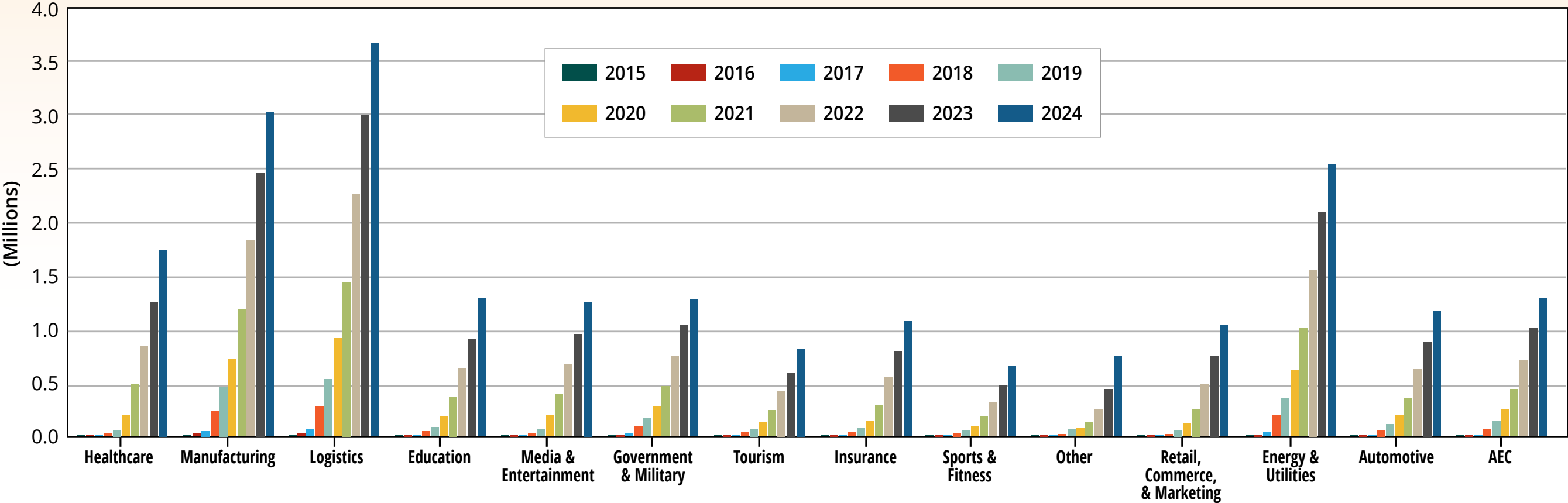
Shipment forecasts:

- More than 20 million Augmented Reality (AR) smart glasses shipments in 2024

- More than 55 million Virtual Reality (VR) shipments in 2024

AUGMENTED REALITY SMART GLASSES SHIPMENTS BY VERTICAL
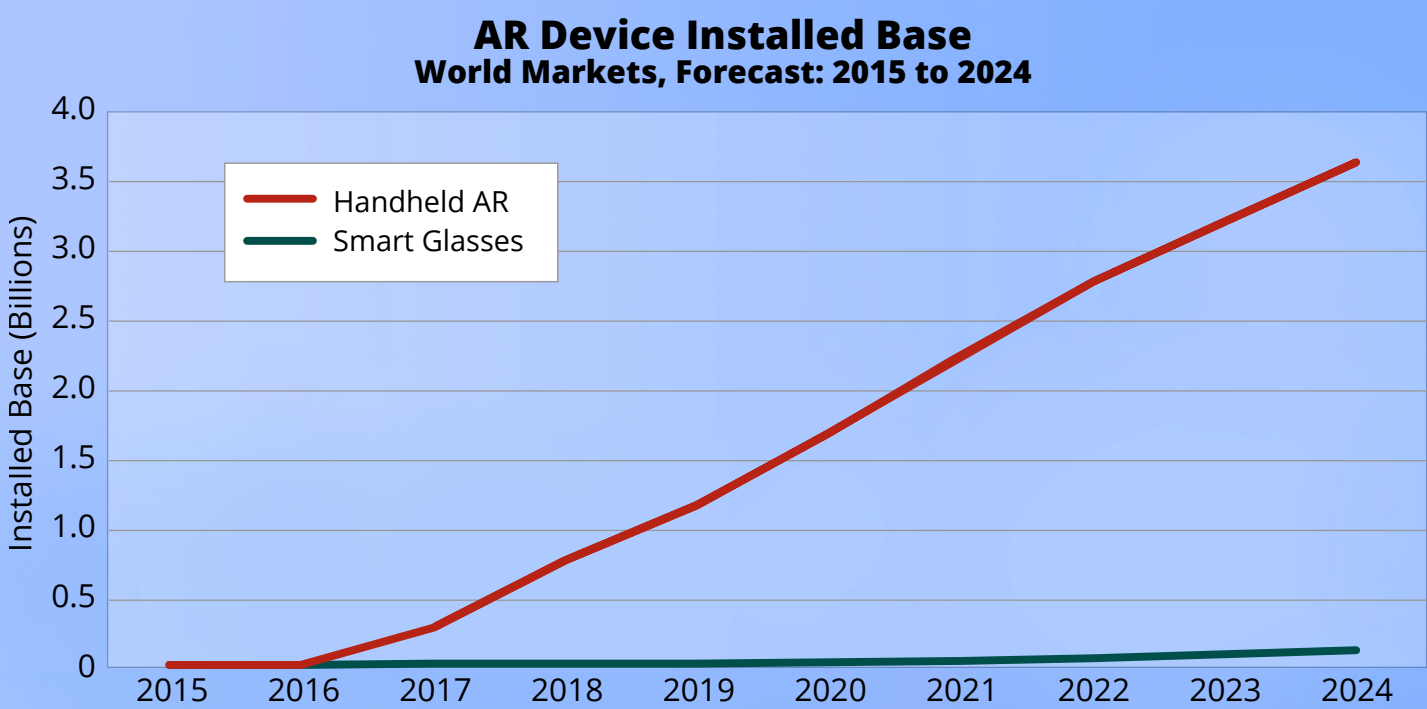## World Markets, Forecast: 2015 to 2024

Manufacturing, logistics, energy, and utilities are the largest markets. Healthcare has the strongest growth potential, along with retail and healthcare.

Note: plateau from market saturation and mobile cannibalization sits outside of forecast window with updated data.

AR DEVICE INSTALLED BASE

Value in hands-free data access is easy to understand and quick to realize, but handheld AR experiences still offer new ways to interact with content and collaborate with users. Smartphone AR also presents a lower barrier to entry when compared to smart glasses, both in direct hardware costs and in device enablement through content creation and distribution. Foundations have been laid in mobile AR, such as Apple ARKit and Google ARCore, that can be extrapolated outside of smartphones to eventually enable both phones and Head-Mounted Devices (HMDs). Ultimately, both smart glasses and smartphones can combine to serve any use case that may arise within AR, across both consumer and enter-prise segments.
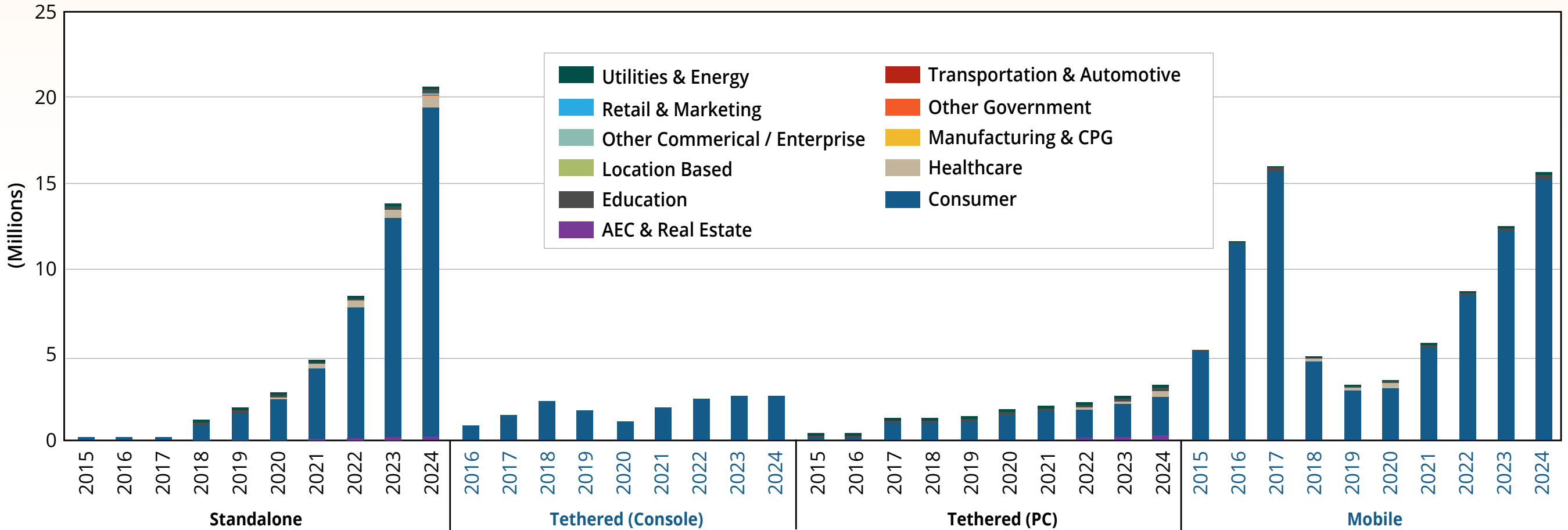

AR Device Installed Base
World Markets, Forecast: 2015 to 2024

AUGMENTED REALITY OPPORTUNITIES

6 MONTHS	12 MONTHS	18 MONTHS	24 MONTHS	
AR via mobile is a promising area that will continue to grow, especially in the consumer market, as it gains the interest of advertising companies, retail, and the tourism industry. ARCore and ARKit are key players in the mobile AR rise.	AR will reshape the landscape of data visualization and data analytics. Both individuals and enterprises can have real-time access and better understanding of the data that they need, in real time and often interactively.	The advancements in Artificial Intelligence (AI) and machine vision, in combination with big data and analytics will generate new AR opportunities. Face/object tracking improvements, voice recognition for input, etc., will improve and grow in usage for AR.	With the arrival of next-generation networks, 5G will bring radical changes in AR as higher speed and lower latency will enhance user experience and the efficiency of AR applications. Cloud providers will invest in edge cloud solutions for AR/VR. While 5G will not have a significant market-wide impact in this timeframe, the foundations of 5G growth should be realized with preparations for a broader 5G rollout.	**LARGE**
Potential to see large-scale enterprise rollouts of smart glasses, with the key point of hands-free usage. Massive adoption is expected in the next year as the cost for smartglasses will drop significantly. New hardware manufacturers and mass-scale production will contribute to price drop and wider adoption.	Democratization of AR content enables users to edit, share, and publish their own AR experiences, while better enabling professional developers. For high-quality results, professional experience is still necessary.	Improvements in device technical constraints regarding size, power consumption, and heat generation, especially for standalone devices (e.g., HoloLens). More opportunities for advancements in spatial/head tracking will enhance existing experiences.	Revolutionary 5G and AR use cases can begin to be seen, but are reliant on 5G infrastructure to see significant scale. A considerable number of hardware providers will leverage 5G, but mass adoption is expected to show in the long term due to high cost, difficulty of infrastructure rollout, and new device requirements.	**LIMITED**

VIRTUAL REALITY HMD SHIPMENTS
World Markets, Forecast: 2015 to 2024

The consumer industry currently dominates, but there is room for interesting enterprise growth, particularly in standalone. While mobile used to dominate forecasts, a total lack of activity from major Original Equipment Manufacturers (OEMs) signals the end being near. ABI Research maintains that there is inherent value in mobile VR and still forecasts growth once additional content becomes available and OEMs partner more broadly to onboard users. Standalone also dropped quickly in Average Selling Price (ASP), to better compete with mobile.

Legend:
- Utilities & Energy
- Retail & Marketing
- Other Commerical / Enterprise
- Location Based
- Education
- AEC & Real Estate
- Transportation & Automotive
- Other Government
- Manufacturing & CPG
- Healthcare
- Consumer

Y-axis: (Millions), scale 0 to 25

Categories (x-axis, years 2015 to 2024):
- Standalone
- Tethered (Console)
- Tethered (PC)
- Mobile

KEY TRENDS IN AUGMENTED AND VIRTUAL REALITY

Industry 4.0 and the Internet of Things (IoT)

Digitization is becoming more commonplace, with or without AR/VR.

AR/VR is poised to become an increasing portion of the wider digitization opportunity as a required visualization/interaction tool.

Workforce retirement and constant search for ROI will inspire swift movement into AR.

5G and Edge Compute

Hardware barriers with battery and processing power can be avoided with edge streaming as 5G permeates most markets, and as low latency requirements for some use cases necessitate 5G.

A natural transition from 4G to 5G on mobile devices is inevitable, and AR/VR will latch on.

Consumer AR Impact

Apple will play a significant role in AR in the next few years.

Efforts around mobile AR will transition seamlessly to HMDs, and potentially consumer HMDs will not be inherently consumer-only.

Mobile *Versus* HMDs

Mobile AR capabilities are growing quickly, making hands-free the only major difference between mobile and HMD usage.

Understood content development tools/platforms and publish environments are valuable in a market that can struggle with monetization.

FEATURED USE CASES

Data Collection/Logging

Natural integration of existing data logging methods (handheld notes, scanners, computer input, etc.) are being replaced with in-situ collection. They can be combined with step-by-step instruction, adding a layer of granularity to data.

This also introduces a visual component for the user ,as well as visual data collection with Red, Green, Blue (RGB) cameras and/or other sensors.

• Direct integration and improvement over existing methods

• Expands hands-free value of HMDs

Remote Assistance

AR remote assistant applications combine live streaming video and AR to connect remote employees with support centers or line managers. Thanks to live video and annotation tools, workers receive real-time guidance and instructions about the troubleshooting process at the same time they have access to data and documentation regarding equipment and machine status.

• Immediate and accurate response to problems

• Minimizes costs from downtime and travelling

• Enhances employee productivity and ensures safety

Training

AR and VR tools are becoming a part of business training offerings to trainees' practical simulations, realistic scenarios, and feedback based on performance. AR and VR training apps are available both for mobile devices and HMDs.

• Minimizes expenses for traveling, non-reusable training equipment, materials, instructors, or supervisors

• Allows multiple trials and repeats without extra cost and without stopping production

• Ensures employee safety, eliminating risks and training accidents, especially for inexperienced employees
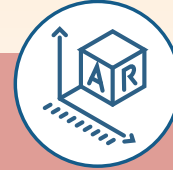
ACCELERATORS

Increasing ROI Confidence

- An increased number of case studies across more varied applications, verticals, use cases, and customer types lend confidence to claimed value.

- Higher return leverages some objective truths with direct return trace (e.g., remote expertise is a direct travel cost saving).

Universal Digitization Growth

- Industry 4.0 and IoT can grow with or without AR/VR, but AR/VR fits naturally into these efforts and will be strengthened.

- The strengths of AR/VR usage directly align with the most valuable areas of digitization, producing a quick ROI with well-understood use cases. Enterprise activity with competitors well-versed in the market, rather than forcing a technology.

Growing Software and Hardware Capabilities

- Straightforward growth in display resolution and brightness, processing power, tracking accuracy, battery life, etc. expand capabilities into more areas and to more users.

- Machine vision leveraging machine learning for constantly improving Simultaneous Location and Mapping (SLAM), object recognition, and geo-registration. Lower latency and higher accuracy mean better user experience and more accuracy-sensitive opportunities.

BARRIERS

System Integration

- A major initial barrier for enterprise AR

- Numerous existing implementations with little shared foundation: IoT and connectivity, content storage/distribution, Enterprise Resource Planning (ERP), and device management.

- Novel device types in HMDs with unique usage patterns and requirements.

- Integrating not only with infrastructure but with existing use cases and workers; worker uptake and usage is an unpredictable variable.

Content Optimization

- Existing content is mostly unsuited for proper AR/VR consumption. Physical manuals are prominent, and even digital content is mostly Two-Dimensional (2D)/traditional file types. Three-Dimensional (3D) content sometimes exists and can be ported, or otherwise needs to be created.

- Without properly optimized/created content, devices go unused. Use case value decreases for every subpar content interaction, and integrations without content ready for AR/VR can be a non-starter.

- In-situ capture with data collection can be leveraged to create content in real time for training, but needs a strong supporting platform to avoid messy data lake issues.
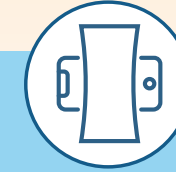
Security and Privacy

- Cameras on nearly every AR/VR HMD and all mobile devices, and required for most device usage: SLAM, object recognition, content georegistration, camera pass-through.

- Can be highly dependent on use case, company type, workflow, and location. Classified content and locations have more stringent device and content management requirements for security.

- Government regulations can showcase large differences in policies region-to-region, state-to-state, and city-to-city, creating complexity and confusion. Being a novel device type also exacerbates potential negative impact from regulation (less understood, more stringent).
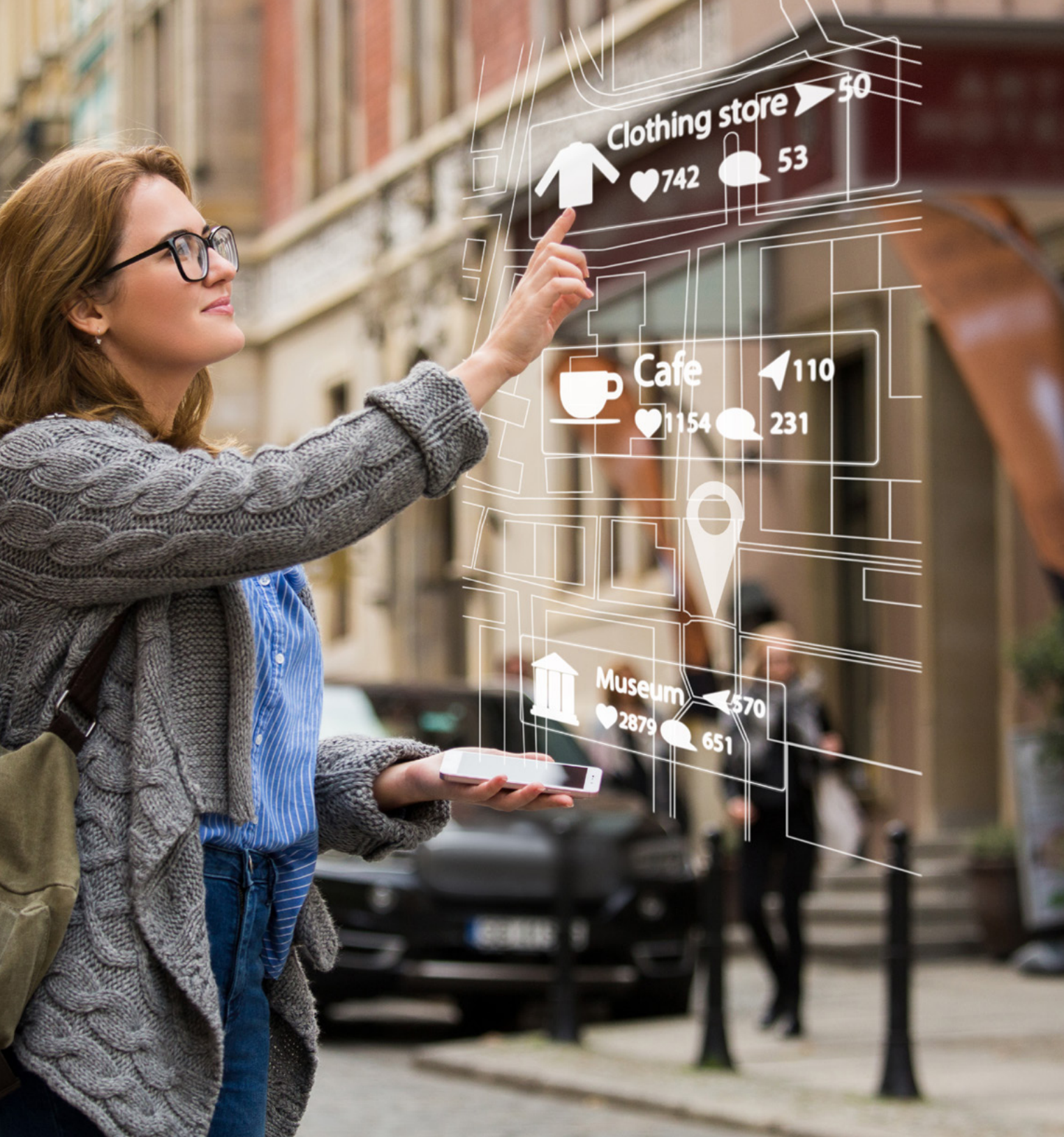
PERVASIVE SCREEN

AR/VR plays a pivotal role in the growth of the pervasive screen ideology. Currently, there are two approaches to displaying content wherever users want it: many physical screens in as many places as possible, and a single user device that can virtualize screens anywhere. AR/VR serves the latter and will be a pivotal device type going forward as digital content consumption and interaction continues to grow. The idea of the pervasive screen naturally touches most markets, with value for any use case that benefits from greater content access: media & entertainment, tourism, education, retail, automotive, smart industry, and more.
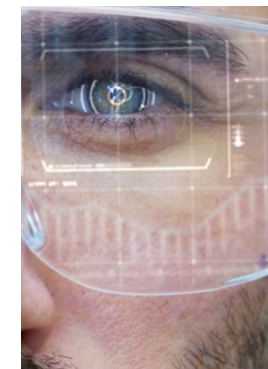
AUGMENTED AND VIRTUAL REALITY RESEARCH COVERAGE

These findings are part of ABI Research's **Augmented & Virtual Reality Research Service**. As a leading source of AR and VR intelligence, ABI Research focuses on technologies and use cases that provide value through data visualization and immersive experiences, quantifying market opportunities across the value chain for both AR and VR, head-worn and handheld form factors, while identifying enabling technologies within and across markets, such as smart industry, edge compute, machine learning, and 5G.

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