



APPLE VISION PRO AND SPATIAL COMPUTING - WHAT IT MEANS FOR ENTERPRISES

Abstract

Apple Vision Pro's launch on Feb'24 once again has brought excitement to the future of **immersive experiences**. At WWDC 2023, rather than pitching a futuristic, sci-fi, "Ready Player One" Metaverse type of experience, Tim Cook introduced it as Apple's first **spatial computer** which instead looks at virtualizing the many screens we already encounter on a day-to-day basis (websites, movies, notes, messages, FaceTime), in an innovative and immersive way.

In this article, we present our views on the recently launched Apple Vision Pro and what it means for enterprise applications, based on our prior experience and the knowledge that we have gathered by trying out the goggles first-hand.

Table of Contents

1. Spatial Computing – The New Frontier.....	3
2. Apple Vision Pro as a Spatial Computing Device.....	4
3. What is Exciting – Key Features of Apple Vision Pro.....	4
4. Technologist Perspective.....	5
a. App Development Experience.....	5
b. Migration of Current Apps to Vision Pro Experience.....	6
c. Comparison with Similar Products.....	7
5. What it Means for Enterprises?.....	8
a. Apple Current Focus and Eventual Adoption at Enterprises.....	8
b. Features Supporting Enterprise Adoption.....	8
c. Potential Enterprise Use Cases.....	9
6. What Infosys is Doing in this Space.....	10
7. Conclusion.....	10
8. About the Authors.....	11



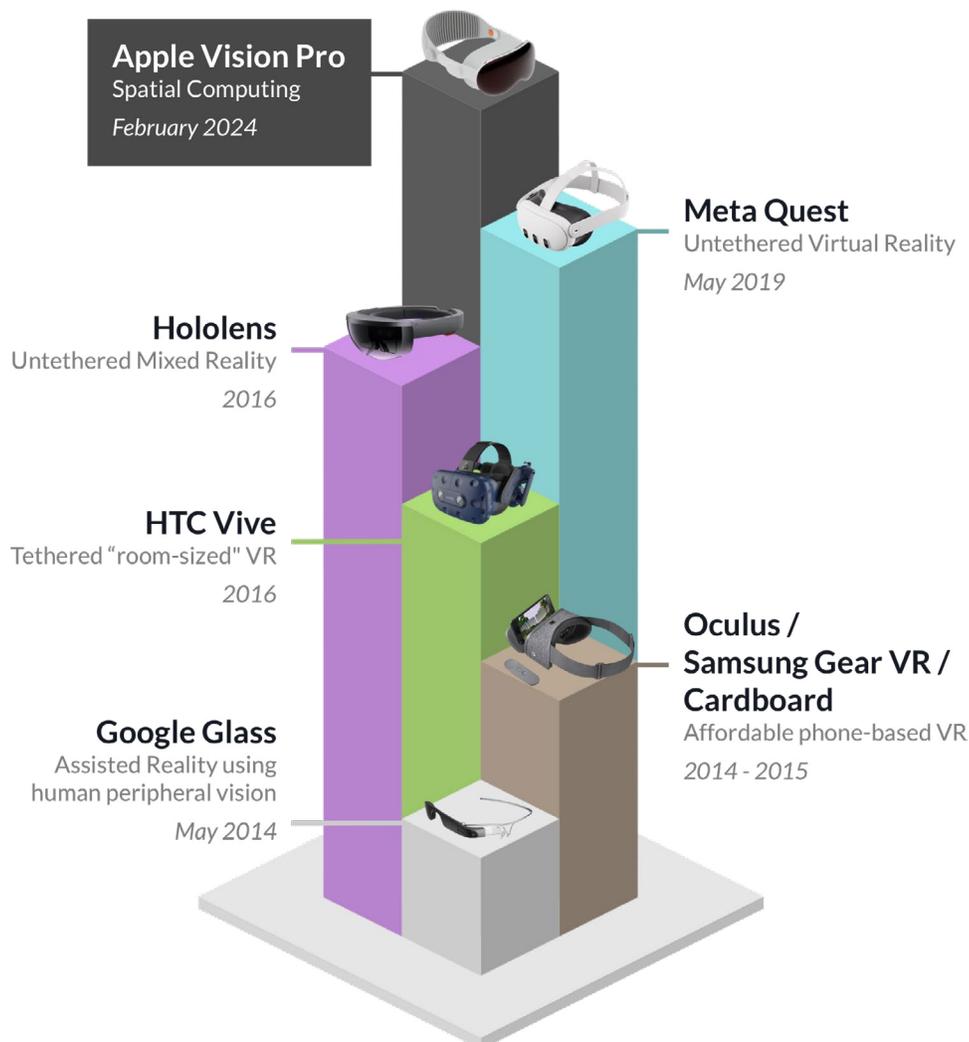
Spatial Computing – The New Frontier

Spatial computing can be thought of as a blanket term that covers the combined capabilities of disruptive tech innovations that are making their way into the world. It is a series of technologies that can “see” and map the real world, understand it, and predict the next moves of objects within it. Spatial computing is key in the ongoing convergence of the physical and digital worlds. Holographic computing refers to a similar concept, and so 3D Immersive Holograms could be thought of as a subset of broader spatial computing. In both cases, environmental scanning/mapping is done to get a detailed representation of real-world surfaces and create anchor points so

that digital objects can be placed on real surfaces. Devices like Vision Pro, HoloLens, and Magic Leap use this with the perceived 3D physical space as the output canvas for placing objects, video, audio, etc., and for haptics. Also, they both use physical actions (head/body/hand movements, gestures, eye movements/gaze, and voice) as inputs for interaction. All these features allow for a smooth merging of the real world with the virtual world to create seamless and immersive experiences by anchoring virtual objects within the user’s physical world and taking advantage of real-world depth cues. Occluding holograms based on other holograms and real-world objects

helps elevate the immersive quality of the experience.

The diagram below shows the major advances in the evolution of spatial computing and Extended Reality (XR) devices since 2013 with the launch of Google Glass, an assisted reality device that uses human peripheral vision without blocking the eye, Oculus Devkit, that rekindled interest in virtual reality as the wave of the future of immersive experiences, to HoloLens that introduced the concept of mixed reality, up until the recent launch of Apple Vision Pro, a spatial computing device that is capable of both augmented and virtual reality experiences.



VISION



Apple Vision Pro as a Spatial Computing Device

For its spatial computing and Augmented Reality (AR) features, Vision Pro handles the blending of the digital and physical by streaming the user's environment in full color in real-time and overlaying digital content on top. There are 12 cameras and a special R1 chip to process the data coming from all the sensors which helps reconstruct the environment around the user in 3D and hence address some of the immersion issues that other devices have been plagued with.

Although, at times during the announcement, Apple Vision Pro felt like an

advanced version of HoloLens, Magic Leap, and Meta Quest, Apple has intentionally chosen to differentiate and distance itself from the competition by carefully avoiding using the same terminology. With its usual focus on design, Apple has tried its best to solve many problems with the current Extended Reality (XR) devices. Often during the announcement, things looked and sounded familiar, but they also felt much improved and better.

Apple has patiently watched and waited, all the while learning from other companies that have paved the way and addressed

the major concerns with other wearable products with a polished, self-contained solution (~5000 patents) and is releasing their goggles only after making significant progress.

Given Apple's credentials for driving product success by creating polished and seamless experiences, and by creating an entire ecosystem around their products, it seems like that's how Apple is hoping to win again. It is obvious that Apple's ambition is to create a new foundation on which the future hardware and software for immersive experiences can be built.

What is Exciting – Key Features of Apple Vision Pro

Apple has packed many new features into its Vision Pro device. Some hardware features such as retina display, biometric authentication, eye-tracking, foveated rendering (to avoid eye fatigue), spatial audio, and immersion control are more based on technological evolution on the cards. Other device manufacturers chose not to push for these features to keep their device prices low, while Apple did not spare any expense to include them to bring in the best user experience possible. Apple's strength again seems to be in creating seamless experiences that leverage the combined technical prowess emerging from these components.

Some of the enhanced and/or new use cases and immersive experiences enabled by the above include:

Fluid New Experiences

- Enables a completely new way to interact with the input system that feels intuitive - by looking, tapping, and speaking.
- Start in a window, bring in 3D content, transition to a fully immersive scene, and come right back.
- The app lives in the space: 3D interface, with infinite canvas to arrange the apps and fill the space

making the top-of-the-line workspace a reality. It is even reactive to particular lighting and helps cast shadows.

- The device has a close integration with the MacBook – one can extend the MacBook screen by just looking at it.

Dynamic Reality

A unique feature called EyeSight – when a person approaches someone wearing Vision Pro, the device feels transparent. And when the user is fully immersed in an environment, EyeSight gives visual cues to others about what the user is focused on.

Collaboration & Connect

FaceTime video tiles are life-size, and as new people join, the call simply expands in your room and can bring documents to meeting with your colleagues. Users wearing Vision Pro during a FaceTime call are reflected as a Persona – a digital representation of themselves created using machine learning techniques, which reflects face and hand movements in real-time.

Photos & Videos

Vision Pro is Apple's first 3D camera. You can capture magical spatial photos and spatial videos in 3D, then relive those moments with immersive Spatial Audio.

Entertainment

An immersive way to experience

entertainment – transforming any room into your own personal theater.

However, there are some shortcomings as well

There are some notable omissions in the Vision Pro specifications, such as the horizontal and vertical field of view. We have not noticed any content clipping in any direction, so it is definitely comparable to other leading devices. There is no guardian boundary to handle objects and safety hazards in the physical environment. To our surprise, we did not feel a compelling need also as Vision Pro uses external cameras to capture the scene on which computer graphics elements are overlaid. There is no connectivity with iPad and Apple Pencil which could make some collaboration features, such

as whiteboarding, easier. Also, we were hoping to see full-body avatars, especially with downward-facing cameras on the device. Apple's popular fitness app and connectivity with the Apple watch are also lacking.

In some aspects, the device falls short of our enterprise customers' expectations as well. The feedback that we have from our enterprise clients on current similarly priced devices in the market is that a price point of \$3500 is steep for many of our customers. The device feels heavy even with an external battery pack, and a battery life of 2-2.5 hours with an external battery is honestly quite low. While it is good to altogether get rid of any cumbersome controllers, some haptics are essential for providing feedback while interacting with any virtual elements.

Technologist Perspective

App Development Experience – What Does it Mean for App Development Ecosystem?

Apple is known to be a very closed ecosystem company, however with the support for Microsoft Office tools on Apple devices (they still must be installed from the App Store), and partnerships with companies like Unity and PTC to help evolve the development ecosystem,

it is showing signs of positive changes.

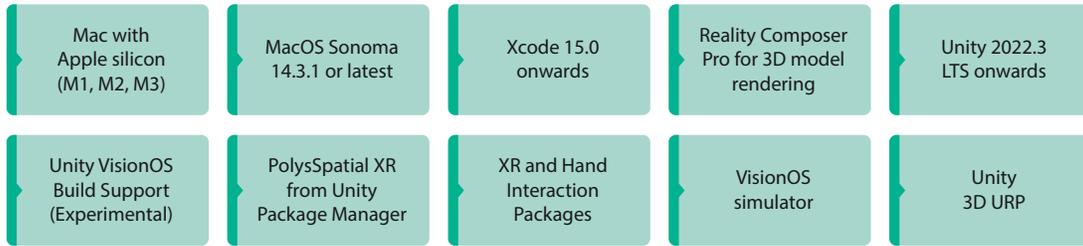
VisionOS, the spatial operating system, is built on the foundation of macOS, iOS, and iPadOS. It creates an all-new platform for developers to build experiences using familiar Apple developer tools like Xcode, SwiftUI, RealityKit, and ARKit, as well as support for Unity3D and the new 3D-content preparation app Reality Composer Pro. Moreover, Apple has a

developer pipeline for making iOS/iPadOS apps easily transferable to VisionOS, in the same way it did for the iPad when it launched. At this point, it is hard to imagine Apple allowing any 3rd party app stores for Vision Pro and how it may impact Apple's XR aspirations.

At a high level, the steps involved in building immersive applications for Vision Pro are as follows:



1. First things first – setting up the environment with the following prerequisite tools:

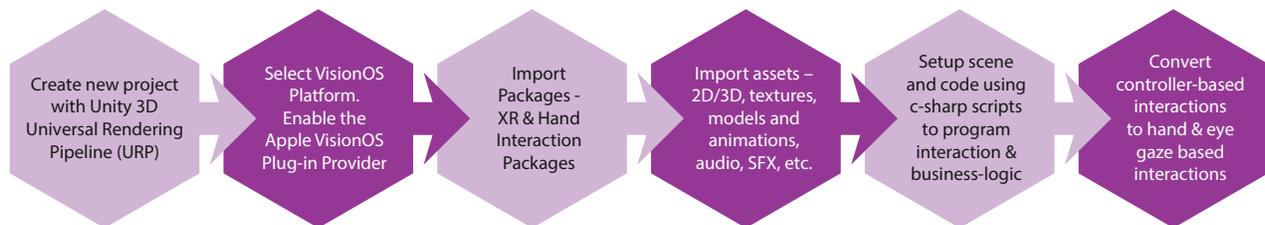


2. Development pipeline:

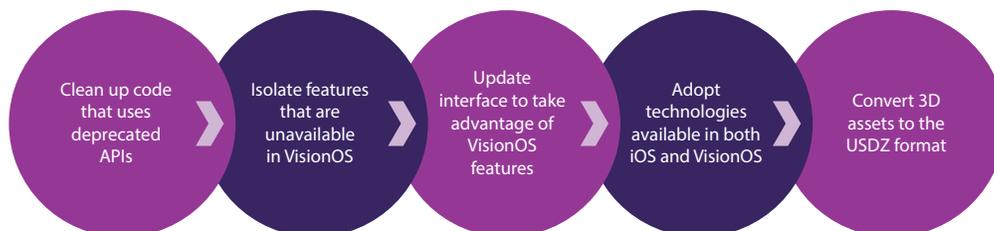
Development (Native/Unity3D Game Engine)	Test	Distribute
<p>Develop Experiences & Interactions:</p> <ul style="list-style-type: none"> • Windows with traditional views and controls • Spaces - side-by-side or fully immersive spaces • Volumes that could be viewed from any angle <p>Reality Composer Pro: Compose, edit, and preview assets, such as 3D models, materials, and sounds</p> <p>Swift UI, ARKit & RealityKit:</p> <ul style="list-style-type: none"> • Build and render 3D Models and scenes, blend 2D and 3D content • Program animation, physics, lighting, sounds, and custom behaviors for app content • Render Augmented Reality apps • Plane detection, Image tracking, Scene reconstruction, Hand tracking, World tracking, and device-pose prediction <p>Apple SharePlay and Group Activities Framework: Enables to development of next-generation collaborative experiences</p> <p>Input:</p> <ul style="list-style-type: none"> • Program direct and indirect gestures • Create custom gestures 	<p>Xcode Debugger & Instruments: Measure, investigate, and optimize the use of system resources, and memory to improve performance</p> <p>VisionOS Simulator: Switch between simulated scenes which are provided by Apple from the Simulator for testing in different background</p> <p>Vision Pro Device:</p> <ul style="list-style-type: none"> • Connect and pair the device with Xcode • Provision Vision Pro device for testing through the Apple Developer Program • Running app on Vision Pro device 	<p>Distribute using iTunes Connect:</p> <ul style="list-style-type: none"> • Create Vision OS App • Create a Product page to help people understand about application • Take screenshots of application and app previews by maintaining high-quality images • Create App icon and App Store icon – on VisionOS, the app icon appears as a circular 3D object that comprises a background layer • Describing App – App name, subtitle, description • Set the app category (Business, Entertainment, Education, etc.)

Migration of Current Apps to Vision Pro Experience

Some of the important activities involved in porting existing Unity3D application to VisionOS is as follows:



Likewise, porting existing iOS app to VisionOS would involve some of the key steps given below:



Best practices while developing apps for Apple Vision Pro:

Encompass the distinctive features of Apple Vision Pro (AVP)

- Leverage Immersion, Spatial Audio, Space, etc., and make user experiences lively. Incorporate native capabilities like passthrough and eyes and hands-driven spatial input in ways that feel natural/intuitive on the device.
- Provide Accessibility by using VoiceOver, Switch Control, Dwell Control, Guided Access, Head Pointer, etc., so that users can utilize the most friendly interactions.
- Use widgets and windows for 2D UI-driven experiences. That way, one can resize and place them appropriately based on available space.

Prioritize comfort

- Content should be positioned relative to users heads, well within their FOV (field of view).
- Optimize motion to avoid becoming overwhelming, too fast, or missing a stationary frame of reference.
- Invoke actions with indirect gestures that let people interact with apps while their hands rest on a lap, on a table, or at the sides.
- If you need to include direct gestures, then ensure that content is displayed at optimal distance and their interaction time is limited.
- Encourage people to share activities with others using Shareplay to provide a feeling of togetherness and collaboration.

- Like any other HMD, restrict people's movement while they are in a fully immersive experience.

Prioritize Privacy

- Minimize the use of sensitive information and provide a clear statement of what information the app uses and how it uses it.
- Adopt the system-provided input mechanisms, which have built-in access control features.

The success of any device like Vision Pro largely depends on the app ecosystem. It is a well-known fact that what XR needs for a breakthrough is a killer app. Since its launch announcement at WWDC, Apple seems to be targeting developers to create that killer app for Vision Pro. It will be interesting to see what developers and Apple partners are able to create while leveraging the strengths of the device.

Comparison with Similar Products

Characteristics	Meta Quest	Microsoft HoloLens	Apple Vision Pro (AVP)	Remarks
Resolution				AVP has best in class resolution, superior device for Video, 3D Rendering & overall immersive experiences
Interaction				Eye tracking & other gesture input makes AVP truly hands-free
Collaboration				AVP has built-in 3D persona-based FaceTime collaboration
Ergonomics & Comfort				Slight weight imbalance problem in AVP
Security & Privacy				Optic ID based biometric authentication is key differentiator in AVP
Cost v/s ROI				Can be an adoption barrier for AVP & HoloLens
Types of experiences	 Primarily VR	 Primarily MR	 AR/VR/MR/Spatial	Passthrough feature and flexibility to control level of immersion is unique in AVP

While at this point in time, the ROI for Apple Vision Pro is low, but given the fact it is technologically advanced and provides a seamless experience, over a

period of time, the Vision Pro user base might increase just as the iPhone user base increased gradually when it launched. This will level the playing field, and we foresee a

rise in enterprise adoption.

Also, currently, the Apple Vision Pro's focus is the consumer, but it's gearing up for enterprise scenarios.

What Does it Mean for Enterprises?

Apple Current Focus and Eventual Adoption at Enterprises

Apple is bringing spatial computing to the consideration of the masses in a way that makes complex technology feel approachable, simple to use, and familiar. Apple has initially positioned it for consumers, with mostly personal use cases being shown during the launch. However, Vision Pro is equally useful for designers, developers, enterprise and industry professionals. Promotional videos were also largely centered around people wearing the Vision Pro in their homes, promising something akin to playing on a big screen TV rather than a bespoke XR solution. Although the price point of \$3500 is still way out of reach for most, it brings consumer adoption one step closer through better immersive experiences. Expectations are that it will break down the adoption barrier in the future by replacing multiple devices, just as the iPhone did for mobile computing almost two decades back.

Although the launch event did not focus on enterprise use cases, based on our experience working with our clients across industry verticals, we have identified some key innovations that Apple has incorporated into this versatile device to make enterprise and industry adoption easier than its predecessors.

Features Supporting Enterprise Adoption

Security: In recognition of the current challenge surrounding enterprise adoption of such devices within existing IT infrastructure, Vision Pro prioritizes robust privacy and security features. This empowers users to maintain control over their data, facilitating seamless integration into corporate IT ecosystems. Building onto the privacy and security features within Apple's iOS environment, VisionPro introduces the following novel

functionalities specifically designed for the realm of spatial computing:

- New authentication via Optic ID
- Users' privacy is safeguarded through Optic ID data getting fully encrypted, is not accessible to apps, and never leaves their device.
- The data of the eyes is not shared with Apple, third-party apps, or websites.
- The information from the cameras and sensors is processed by the system. So, individual applications do not get further details to enable spatial experiences.

Integrated user authentication has been one of the biggest challenges with XR devices in use cases for our large banking and retail customers. For instance, dealing with payments and fund transfers has always been a challenge. Typically, a secondary device is required for user authentication. With biometric authentication (Optic ID iris scanner), Apple Vision Pro aims to solve this problem, which will enable us to build some impactful and immersive digital and Web3 experiences for banking and finance, insurance, and retail verticals. These new privacy and security features will ensure that only the user can see the information that they are entitled to, like their bank account details or crypto wallet information.

Collaboration: One of the problems that companies exploring immersive experiences for work are focusing on is to create the best possible digital persona of a user to make collaboration more natural. Apple Vision Pro solves this problem with its 3D camera, which can scan the user's face to create their digital 3D persona. Eye tracking and external sensors/cameras help animate their eyes, mimic hand gestures, and recreate their true expressions. AI techniques help remove

the headset that the user is wearing from their digital representation. On current devices, the experience still deals with the problem of uncanny valley Vision Pro seems like a step in the right direction. Realistic avatars and spatial audio for virtual presence, eye-tracking based menu selection and navigation, and 3D layered UI for immersive whiteboarding and design thinking sessions could have come in handy when we were developing a global cross-site collaboration platform for one of our engineering design and construction client that manages large infrastructure projects, and for a top tax consulting firm.

Hands-free Controls: While creating hands-on training applications for our customers from the insurance, energy and utilities, and airline sectors, we often received complaints regarding controllers, ergonomics, and the need to be hands-free for training to be effective. With no controllers, Apple Vision Pro aims to make AR/VR applications truly hands-free. With IR illuminators and multiple cameras, users can invoke actions with gestures while their hands rest on their lap, on a table, or at the sides, even in different lighting conditions. They don't need to be pointing at anything. Combining this with passthrough AR, voice notes, and improved typing, several impactful solutions around training, information, and assistance for various industries can be built, especially for manufacturing, and heavy asset engineering. Some of the relevant use cases here include quality assurance and inspection in manufacturing, and assembly, installation, and repair for field services.

Retina-quality Display: One of the clear standouts for Apple Vision Pro is its picture and audio quality. Combining retina quality micro-OLED display, lag-free foveated rendering that minimizes eye fatigue, and spatial audio, creative and

immersive experiences for hospitality, travel and entertainment, events and marketing, education and sports, and retail verticals can be brought to life. For example, our experiences, such as the Australian Open live 360 broadcast, VR retail store, fully immersive tennis game, and ad platform, would benefit immensely from these features for extended viewing and mass adoption.

Partnership Ecosystem: While Vision Pro comes with Apple's own apps that businesses might already be using (FaceTime, Safari, etc.) that one can try right out of the box, recent announcements have also highlighted

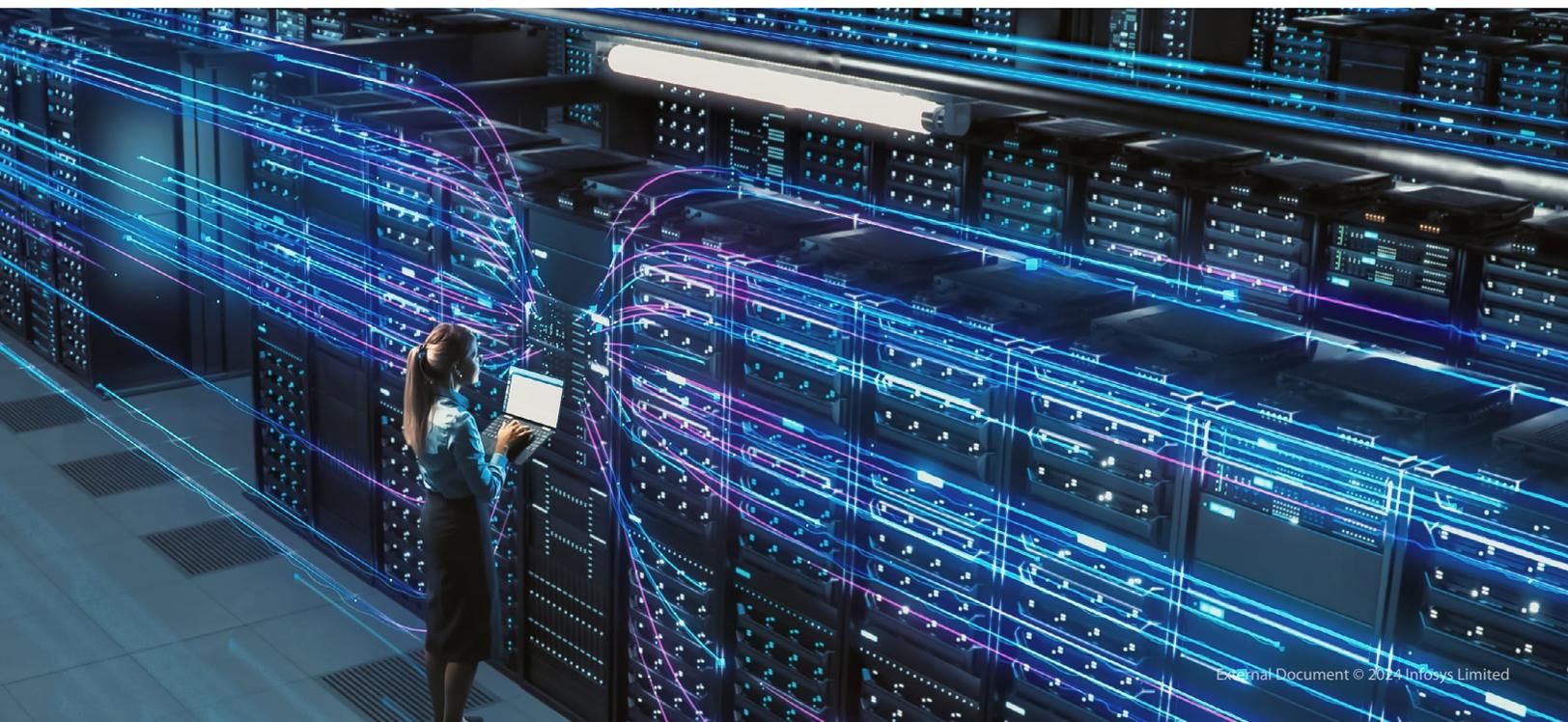
a few productivity tool partners, such as Adobe (Lightroom, Photoshop, Premiere Pro), Microsoft (with Excel, Word, and Teams integration), Unity, and Disney. Working with 3D models was framed almost (strategically) as an afterthought to make the device relatable to most users who do not deal with 3D models in their day-to-day lives "yet". However, their partnership with Unity indicates their focus on the developer community and enterprises. We can already envision content curated by Apple and Unity to help people develop VR apps for Vision Pro or to create new immersive 3D apps using passthrough AR.

Potential Enterprise Use Cases

Overall, looking at Apple Vision Pro's feature set, it seems like it will be mostly useful for productivity, collaboration, onboarding, education, training, and content-sharing scenarios for enterprise usage. Also, professions like health, security, warehousing, field service engineering, sales, emergency, military, etc., in which this kind of ambient and spatial computing experience makes great sense, will benefit the most.

Besides media and entertainment companies, industries poised to benefit significantly from Apple Vision Pro include:

-  Healthcare, with applications in medical training and remote patient care
-  Manufacturing, by enhancing processes and training through augmented reality
-  Retail, through virtual try-on experiences and interactive displays
-  Marketing, with immersive campaigns and product visualizations
-  Education, by transforming learning experiences with virtual content
-  Travel, offering virtual exploration and augmented reality guides to enhance the tourism sector



What Infosys is Doing in this Space

Infosys set up an extended reality (XR) practice almost a decade back, which helps its clients discover meaningful use cases, create prototypes, and scale successful experiments through enterprise-grade deployments. Our clients belong to all different industry verticals and have a wide spectrum of use cases. Our

hands-on experience in building custom solutions for our clients spans a variety of technologies (augmented/mixed/virtual reality, blockchain, IoT, spatial computing, AI/ML, cloud, etc.), tools, and game engines (such as Adobe CS, Autodesk Maya, Unity, Unreal and Nvidia Omniverse), hand-held devices (smartphones, tablets), all leading

wearables across the reality spectrum, and software stacks (iOS ARKit, Android ARCore, webXR, device SDKs). As such, we have a very good idea about the capabilities and limitations of various devices in the market today and use cases where they make sense. For more details, visit our Infosys Metaverse Foundry [page](#).



Infosys Virtual Living Labs



Immersive Retail Store



Visual Merchandising

Conclusion

After firsthand experience with the Apple Vision Pro, while the revelations may not have been groundbreaking, the device undeniably sets a new standard for immersive experiences, offering a tantalizing glimpse into the future of wearables. Given Apple's established success record, the likelihood of the Vision Pro gaining widespread use over time seems almost certain. Even though the hefty price tag may pose a barrier for both individuals and enterprises, creative financing and a dedicated consumer base are expected to drive adoption. The limited release could serve as a strategic move to refine features for a more affordable consumer version in the future. Despite potential price hesitations, this could ignite healthy competition among tech giants, fostering innovation in the spatial computing and AR-VR space reminiscent of the competitive dynamics between iOS and Android in the mobile industry. Exciting times lie ahead as Apple paves the way for a new era in spatial computing device innovation.



About the Authors



Dr. Vishwa Ranjan

AVP, Sr Principal Technology Architect,
Infosys Center for Emerging Technology
Solutions (ICETS)

Vishwa heads Enterprise Extended Reality (XR) CoE and Infosys Innovation Network. Entertainment Industry veteran with years of hands-on experience on several blockbuster special effects movies (e.g., Star Wars), AAA video games, and animated feature films. Innovation-focused thought leader with an impeccable record in planning and execution of strategic initiatives. Well-respected team leader with a creative, technical, and entrepreneurial mindset. Co-creator of Infosys Innovation Network (IIN), a platform for Infosys and startups to engage with each other in a mutually beneficial partnership model.



Sameer Choudhary

Principal Product Architect,
Infosys Center for Emerging Technology
Solutions (ICETS)

Sameer leads Infosys Extended Reality (XR) and Metaverse CoE, with the vision to enable Infosys to become a leader in the fourth wave of the Digital technology era. He focuses on incubating emerging technology-led solutions in XR and Spatial Computing spaces in the form of IPs, Platforms, Framework, and Accelerators, and adoption of the technology in an Enterprise context, 'FOIK' projects execution, and so on. With 26+ years of industry experience, Sameer has been instrumental in conceptualizing/ building many products, platforms, and solutions in the area of Advanced Mobility, Location Services, Wearables, Artificial Intelligence, ChatBot, Computer Vision, Augmented Reality, Virtual Reality, and Mixed Reality.

Contributors

Abhishek Tank

Harshal Kolambe

Maurice Go

Prasad Joshi

Prashant Mishra

Renuka Bhramanna

Surender Nalla

Venugopal Subbarao

Reference

- <https://www.apple.com/apple-vision-pro/>
- <https://www.apple.com/in/newsroom/2023/06/developer-tools-to-create-spatial-experiences-for-apple-vision-pro-now-available/>

For more information, contact askus@infosys.com



© 2024 Infosys Limited, Bengaluru, India. All Rights Reserved. Infosys believes the information in this document is accurate as of its publication date; such information is subject to change without notice. Infosys acknowledges the proprietary rights of other companies to the trademarks, product names and such other intellectual property rights mentioned in this document. Except as expressly permitted, neither this documentation nor any part of it may be reproduced, stored in a retrieval system, or transmitted in any form or by any means, electronic, mechanical, printing, photocopying, recording or otherwise, without the prior permission of Infosys Limited and/ or any named intellectual property rights holders under this document.