

Landscape - Enterprise collaboration in Metaverse

Team 4 - Subra Manuguri, Manu Jose, Raman Peketi, Mike Germanis, Aditi Rane, Bhaumik Sherdiwala, Gaurav Batra

Introduction	3
Enterprise collaboration	3
The Metaverse	5
How does it work	6
Enterprise Collaboration meets Metaverse	7
Metaverse Collaboration harbingers	7
Meta Horizon meeting rooms	7
Microsoft Teams	8
HTC Vive sync	9
Cisco Webex Hologram	9
Google glass	10
Market readiness	10
Market size predictions	10
The Hidden “Data” Market	11
Are enterprises ready	11
Four pillars to success	12
Adoption	13
Age	13
Vision Issues	13
Physiological aspects	13
Access	14
Applications	14
Eco system	15
Hardware	15
CPU	15
GPU	16
RAM	16
Storage	16
Optics and display screens	16
Battery	16
Controllers	17
Networking	17

	2
Environmental Impact	17
Security	17
Market prediction	18
Incumbent Players	18
Niche players	18
Technical challenges	19
Interoperability	19
Cyber attacks	19
Real resources	20
Market challenges	20
Lower Remote work appetite	20
Compliance requirements	20
Conclusions	20
References	21

Introduction

Enterprise collaboration is all about efficient ways of sharing documents, information, data, knowledge among the individuals in an Enterprise. Most of the collaboration is traditionally done through in-person / video conference meetings, emails, chat, documents / content sharing. In these programs one can share video, audio and files to collaborate on a topic. Prior to the invention of the phone, collaboration took place during in person meetings. With the advent of voice communication, collaboration evolved into conference calls and meetings took place by audio in a conference room. There was a transition to video / audio that required expensive setups and dedicated conference rooms. This technology enabled people in one room to see the other while discussing topics, however items such as documents and slides could not be shared easily.

As technology progressed through the years and the internet matured, so did the offerings of enterprise collaboration software. The software is often free and easily accessible to the masses and now documents, pictures, videos and screen sharing have all been added to the previous audio / video offering. Premium versions with more features are used by Enterprises. It is even available in the palm of our hand with the invention of the smartphone. With the current offerings, teams from multiple regions can easily collaborate on a shared word document or presentation without having to leave their couch.

Now this is all wonderful, however some things are left out such as physical interaction and maybe this is fine for now. What we do know though is technology has not stopped progressing and enterprise products and services are becoming more complex. So will the next wave of technology be satisfied by the current enterprise offerings? We think not.

In this paper, we will be reviewing the enterprise collaboration landscape in the world of the Metaverse. We will go through basic definitions of the services that are considered as part of the enterprise collaboration, talk about the Metaverse, the hardware involved and the key areas for success of the incumbent players.

Enterprise collaboration

In this section, we will introduce what enterprise collaboration means [8].

Meeting solutions are real-time collaboration applications and associated end points that support interaction over a network between participants for teamwork, presentations, training and webinars. Some vendors segment their product lines to target and scale to one or several of those use cases, while others offer broad solutions that work for many purposes.

Enterprise offerings in this market perform equally well for workers in meeting spaces, at their desks or when mobile, with integrated voice, video, messaging and content sharing. Organizations with complex needs typically have meeting solutions for internal use — for collaboration, learning and internal communication — that are separate from those for external use in sales or marketing. Such complex needs can result in running meeting solutions from more than one vendor. Complete meeting solutions enable richness of information and interaction by combining messaging, content and screen sharing, video and audio.

Growing demand for real-time and remote collaboration tools, adoption of cloud-based services to accelerate collaboration, demand for a workplace connectivity platform, need for project and task management solutions, and need to increase competitive advantage are expected to be the major factors driving the growth of the Enterprise Collaboration Market.

Enterprise collaboration market can be sliced and diced in a variety of ways.

By Component:

- Solution
 - Enterprise Video
 - Unified Messaging
 - Enterprise Social Network
 - File Sharing and Synchronization
 - Portals and Intranet Platforms
 - Project Management and Analytics
 - Business Process Management
- Services
 - Managed Services
 - Professional Services

By Organization Size:

- SMEs
- Large Enterprises

By Deployment Mode:

- On-premises
- Cloud

By Industry / Sector:

- IT and Telecommunication
- Banking, Financial Services and Insurance (BFSI) sector
- Public Sector
- Healthcare and Life Sciences
- Education
- Energy and Utilities
- Retail and Consumer Goods
- Manufacturing
- Travel and Hospitality
- Others

The enterprise collaboration market is a huge \$36.24B opportunity and is expected to grow at the CAGR of 10.7%.

The major players in the market are ***Adobe Systems, Cisco Systems, Facebook, IBM, Igloo Software, VMware, Microsoft, Atlassian, Google, and Slack Technologies.***

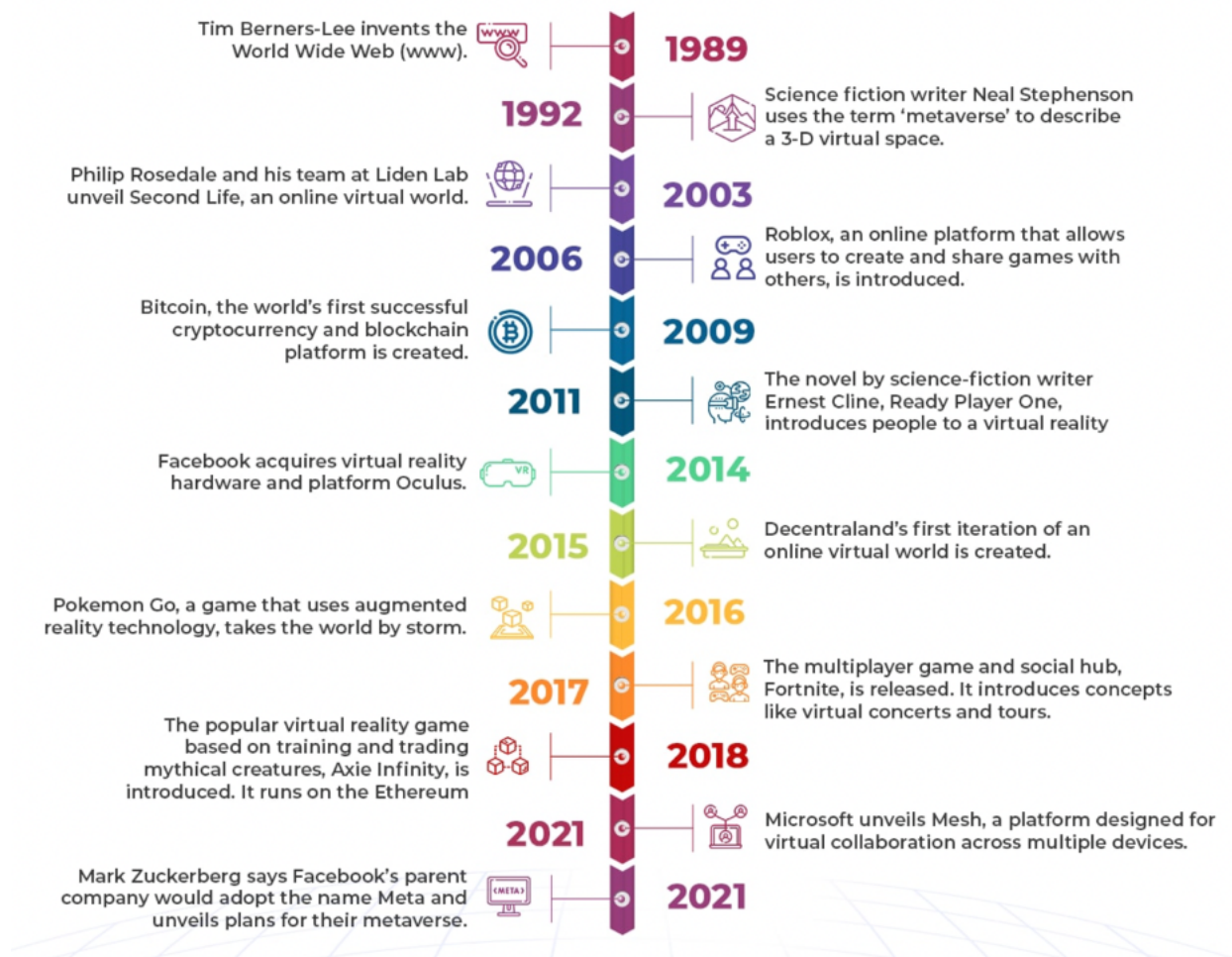
The Metaverse

Gartner defines a [metaverse](#) as a collective virtual shared space, created by the convergence of virtually enhanced physical and digital reality. It is persistent, providing enhanced immersive experiences, as well as device independent and accessible through any type of device, from tablets to head-mounted displays. [8].

- A platform for people to come together, connect and collaborate.
- A virtual world beyond physical space
- The World is only as Rich as what Users Decide to Bring in

Although the term has been made popular in the commons by the recent rechristening of Facebook to Meta, the fundamental concept has been around for a while ever since sci-fi writer Neal Stephenson coined the term “metaverse” to describe a 3D virtual space. A lot has happened in the last three decades, with notable contributions to the idea from Phillip Rosedale’s Second Life, an online virtual world, and to Facebook’s announcement in 2021. [9]

HISTORY OF METAVERSE



How does it work

The metaverse is a virtual environment where users can interact with others on a software platform. So what does this mean? Well to answer that we will use computer games as an example. Today's most common games are played on a two dimensional screen with the user inputting commands through a device, a keyboard or controller. The real life person will send the commands to the character in the program to do whatever it is that they might find entertaining. This can be done on platforms where their friends can join and the avatars can interact with one another. So essentially you are "playing" with your friends through an avatar on a two dimensional screen.

Now the metaverse has different hardware to begin with. There is a two dimensional screen involved however it is brought very close to your eyes much like goggles, filling your complete vision. As you move with these goggles on, the picture on the screen will also move showing the virtual world around you. Instead of a two dimensional screen and the user having to send a

command to turn the character around to see what is around them in the virtual world they can just turn their actual head. This also works for stepping forward, backward, up and down.

Instead of the old controls the metaverse can use a device in each hand that tracks the movement and translates it into the virtual space. Now since the technology is still early on the devices and offerings vary a little but this is generally the case. The metaverse is this virtual space and physical interaction with it and it is currently hosted on multiple platforms.

Enterprise Collaboration meets Metaverse

From an enterprise's perspective we are living in version 0.1 of the Metaverse [13], with Zooms and Teams, sort of merging physical and digital worlds and collaborative tools like Slack and Miro enabling digital collaboration. They don't provide an immersive experience and they are kind of flat.

As organizations are required to embrace the Metaverse as it becomes more and more prevalent, the augmented employee could become a norm. Immersive technologies such as AR/VR along with AI, Digital twins will change the collaboration landscape of the enterprises.

In the Metaverse, employees and teams can be anywhere in the world and yet they can be very close to each other collaborating on solving that complex problem at work.

There are early attempts by several companies in this space and the adoption is in its very adoption stage.

Metaverse Collaboration harbingers

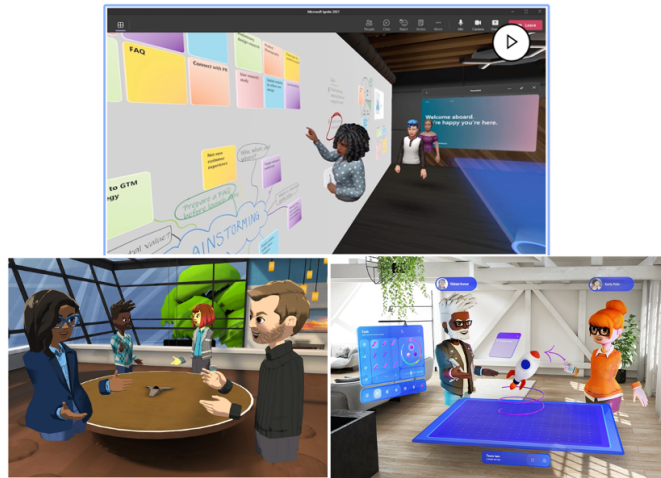
Meta Horizon meeting rooms

Facebook has announced [Horizon Workrooms](#), a VR meeting tool that may one day replace Zoom and other remote collaboration tools. Available as an open beta on Oculus 2 headsets, Horizon Workrooms aims to closely mimic the in-person meeting experience by leveraging all of Oculus' fancy features.



Microsoft Teams

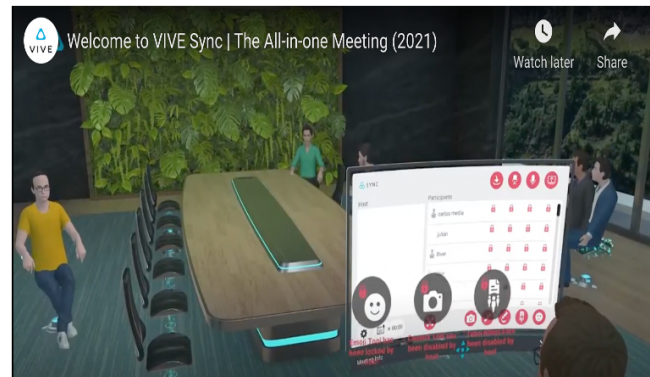
Microsoft Mesh enables presence and shared experiences from anywhere – on any device – through mixed reality applications. They offer multiple apps that handle different use cases in this area.



App	Overview	Device support
Mesh app	Gather a few peers and download the Mesh app on HoloLens 2 for room-scale collaboration scenarios. The Mesh app is powered by Mesh.	HoloLens 2
AltspaceVR	Request access to the AltspaceVR Preview to bring your work events to Mesh-enabled AltspaceVR.	HTC Vive, Oculus (Rift, Rift S, Quest, Quest 2), Windows Mixed Reality, PC

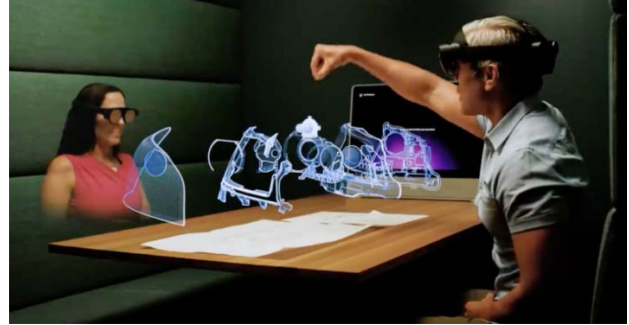
HTC Vive sync

Vive sync is an all-in-one meeting and collaboration solution for VR [10]. The solution integrates with the existing enterprise workflows thus enabling to schedule meetings with outlook plugins, join meetings with single click, and supports uploading a wide variety of formats. Allows non-VR participants to join the meetings. The meetings provide tools like sticky notes, file/video/desktop sharing, collaborate on 3D content etc.



Cisco Webex Hologram

Cisco's famous webex is transitioning into the Metaverse by offering a Webex Hologram [11] solution that provides a real time, photorealistic holographic interaction that goes beyond the video conferencing for a true immersive experience.



Google glass

Google has attempted to take collaboration to the next level by offering a wearable solution.



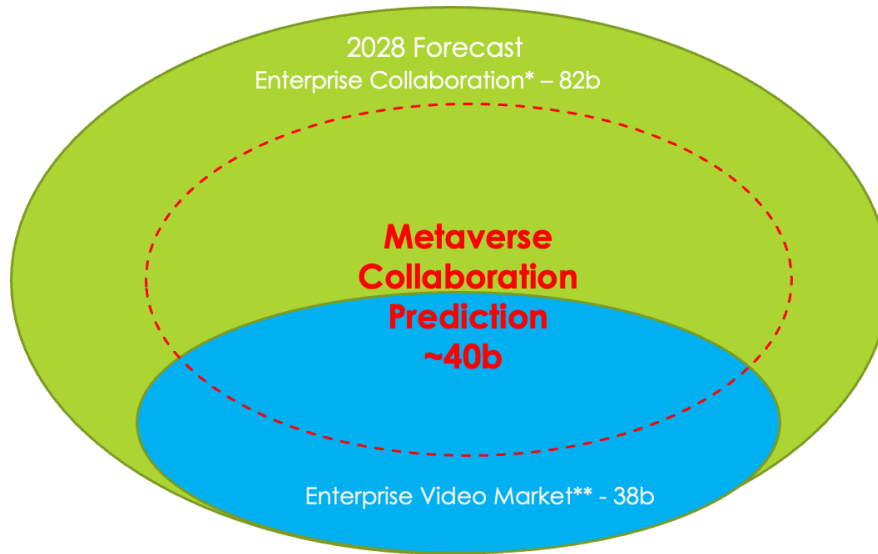
The solution was built to fit into the enterprise work flows by improving the focus on high value work and removing the distractions through voice command integration. The solution also provided a way to collaborate in real time by integrating with Google Meet and improving the accuracy of the training videos by annotations and augmented reality.

Market readiness

The size of the market, out there for the enterprise collaboration solutions in Metaverse, depends on the enterprise adoption and the employee readiness to spend time in the virtual world for collaboration. Covid changes the office landscape and now hybrid work looks like the future for employers. This means that a lot of emphasis is going to be on how to effectively work in a hybrid environment. The hybrid work could be the trigger that would accelerate the adoption of metaverse collaboration tools.

Market size predictions

Enterprise video collaboration is expected to be a \$38B dollar market and Metaverse a \$1Trillion market. As a result we feel the Metaverse enterprise collaboration solutions become more mature in the coming days and years, the market space is expected to be at least \$40B in size by year 2028. A lot of the collaboration in hybrid work will happen as a result of metaverse meetings which are much more immersive in nature.



* [Grant View Research report on Ent Video market, 2020](#)

** [Mordor Intelligence Ent. Collaboration market report, 2022](#)

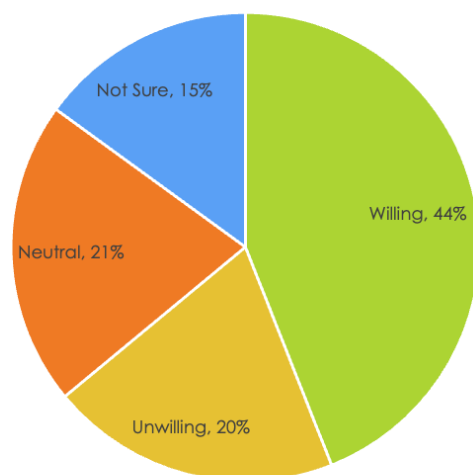
The Hidden “Data” Market

Like the saying “you can mine for gold or you can sell pickaxes.” There is a hidden opportunity in this whole metaverse meeting space which is the humongous amount of data that these meetings generate. With the renewed advert to AI/ML to predict consumer behavior this three dimensional meeting data is going to play a key role in determining the engagement score, consumer behavioral analysis, and a lot of other interesting outcomes. It’s a big opportunity for data companies to harness this data as well as store this data efficiently for querying.

Are enterprises ready

“Build the technology and they will adopt” - Is that going to be true in this new paradigm? Are employees and enterprises ready to jump into this new collaboration bandwagon. It depends on a lot of factors and here is one such survey that was conducted by Lenovo as shown below.

Employee Survey conducted by Lenovo on adopting Metaverse workplace



Only 44% of the employees surveyed expressed willingness to adopt these solutions. This is only one example but offers an insight into the current state of the collaboration solutions in Metaverse. How do solutions need to evolve to increase the adoption in enterprises? What are the factors that should be considered to make these solutions a success? Lets look in to the pillars that will define the success of metaverse in enterprise collaboration below.

Four pillars to success

Following are the four pillars to successfully transform current Enterprise Collaboration Metaverse based collaboration solutions and wider adoption by enterprise customers.



Four pillars can be abstracted out as follows

- Adoption - Make the solution acceptable by mature enterprise audience
- Apps - Integrate the solution with other critical business processes and applications
- Eco System - Solutions need a strong backbone to sustain the scale of the applications
- Security - Solutions need to be built with inherent security and privacy

Adoption

Adoption is an important pillar to make a Metaverse enterprise collaboration solution be widely used by the enterprises.

Age

Enterprise customers are more mature and are different from the typical virtual gaming population. Attracting the mature audience requires non-intrusive, lightweight and easy to use headsets and other controlling devices. A radical new way of device and controller designs is necessary than the existing approaches that were captured above.

Vision Issues

Although this is a common issue for both enterprise and non enterprise audience, enterprise audience could potentially be more impacted due to the age. Customers with corrective lenses and other vision issues like astigmatism are likely to cause an impediment to the adoption of these solutions.

Prescription vision correcting adapters could possibly be the first step towards making the existing headset based solutions better and be friendly to enterprise customers. Providing a better IPD (Inter Pupillary Distance) control in the existing headsets would help in delivering a non-blurry and eye strain free solution.

Physiological aspects

Wearing the headsets for prolonged duration could potentially cause following issues in certain population categories

- Skin irritation
- Motion sickness
- Dizziness
- Mental health related issues

Metaverse collaboration solutions that address these issues have a higher chance of being adopted by enterprise customers.

Access

Availability of the solutions to a wider variety of enterprises at affordable cost ranges is an important criteria for the successful adoption of the metaverse collaboration solutions. Solutions should be made available across all geographies that an enterprise spans. The lower cost options are essential to really penetrate into the SMB market space. The value creation around the cost of the peripherals needed for an immersive collaboration is needed for successful adoption.

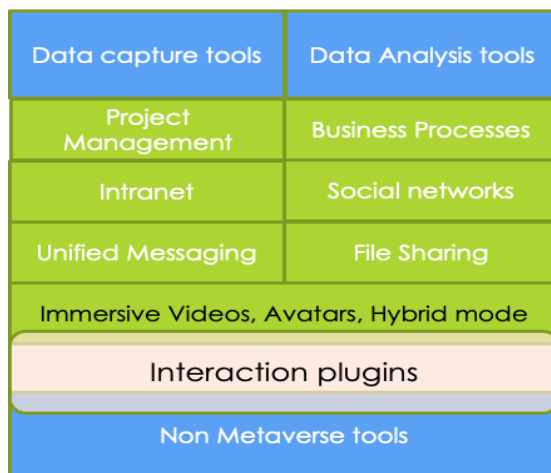
During COVID, one simple collaboration solution, called Zoom, has skyrocketed in enterprise and consumer adoption due to the simplicity that it offered. Metaverse collaboration solutions are no exception in this category of simplicity. Solutions need to be simple and should have a smaller ramp up time for any new consumer.

Applications

Enterprise collaboration requires a deep integration of various solutions that are essential for the business processes in an enterprise. Metaverse solutions should consider the enterprise application integration as one of the important pillars to stand up on for its success.

All the existing modes in which the enterprise video meetings are being consumed by the customers should form an absolute MVP for the Metaverse applications.

Applications



To provide seamless and immersive collaboration experience across all enterprise workflows during these meetings, following enterprise applications need to be integrated well into a Metaverse collaboration solution.

1. Unified messaging - Launching a collaboration session from an enterprise messaging system is important to make the solutions handy to the user. For example, today Slack

can launch Zoom or Microsoft teams meeting right from the direct message chats as well as the channels.

2. Enterprise social network - Modern day companies and the evolving Web 3.0 companies use internal social networks. Enabling social network angle in the enterprise collaboration solutions is crucial to appeal to the social network savvy customers.
3. File sharing applications - Integration with file sharing applications like Microsoft SharePoint, Google Docs etc is an essential business workflow feature for the Metaverse collaboration applications.
4. Intranet platform access - Metaverse applications should offer a seamless access to the enterprise's own intranet platform, so that the virtual meetings become more productive when collaborators need access to the intranet.
5. Project Management applications - Integration with project management applications like Jira, confluence, bugzilla etc is a crucial aspect of the success and will resonate well with enterprise customers.
6. Business process integration - A deep integration into the business process software and portals like Microsoft Visio, OpenText tools, IBM tools, SAP tools etc is important for providing a seamless collaboration experience for the enterprise customers.

In addition to all the above traditional enterprise applications, a Metaverse collaboration tool should consider an integration with the non-Metaverse Enterprise video collaboration tools to accommodate enterprise customers that haven't adopted Metaverse solutions yet.

A hybrid approach of allowing the switch over to traditional video meetings between the participants at will, would be a great tool for Metaverse applications in reducing the adoption impedance in enterprises.

A solution that manages its Northstar goal of "There is an App for everything...", will see significant success in this space.

Integration with all other enterprise applications will also provide a treasure trove of data for the Metaverse collaboration applications and the solutions that leverage this data to it's and its customer's advantage will drive the market adoption and will emerge as a leader.

Eco system

In this section, we will talk about all the real components that are necessary to build a virtual Metaverse collaboration application.

Hardware

CPU

Today, the most powerful virtual reality headset on the market, Oculus Quest 2 ships with Qualcomm Snapdragon XR2 chipset [1], and it is significantly underpowered compared to the

desktop variants of the Intel and AMD that are used for high performance computing. Enterprise applications will be power hungry and they need faster and faster CPUs to be able to accomplish superior and immersive collaboration experience.

Chip making companies like Intel, AMD, Qualcomm, nVidia, Apple etc are uniquely positioned to build next generation System-On-Chip architectures to accommodate the Metaverse applications.

GPU

Today's VR headsets are reaching 1 Tera FLOP speed [1], which is almost the same as an Xbox graphics capability. Both are in no way closer to the 2016 desktop GPU capabilities. For an immersive experience and to provide fairly detailed viewing experience, the Metaverse applications need to render at very high resolutions. For comparison, nVidia RTX 3090 can produce 36 Tera FLOPS, which was needed for high end graphics.

High end enterprise collaboration applications with realistic avatars would require lot of GPU power and the solution that strikes a nice value with respect to cost and functionality will lead the pack in the Metaverse applications.

RAM

Larger RAM is required in Metaverse applications for faster loading and for larger environments during enterprise collaboration. Imagine an enterprise collaboration space like spatial.io [2], where virtual industrial product exhibitions could take place. Providing an immersive experience in these massive environments require a decent amount of RAM in the headsets. For reference, Oculus Quest 2 has a RAM of 6 GB [1] and it is highly unlikely to cater to huge environments.

Storage

Metaverse is persistent, which means all objects and activities need to be stored and retrieved when needed. This is no different in enterprise collaboration applications that run in Metaverse. Massive high speed and secure storage are necessary to provide the great experience to the collaborators that are sitting across the globe and experiencing a Metaverse meeting.

Optics and display screens

Current virtual headset offerings contain an optical grade polycarbonate plastic lens and need an accurate positioning of the pupils to get the best immersion experience that is free of blur. There is a significant opportunity for the enterprise applications to influence the optics evolution and display resolutions of the screen to ensure a high fidelity experience to the enterprise collaboration users.

Battery

Enterprise collaboration applications with innumerable features needed to make the experience seamless, will consume significant amount of power. Any application that optimizes on the

battery by using the deep integration in to the Operating Systems power APIs and custom SoC designs will benefit a lot.

Controllers

Interacting with the different elements of the collaboration meetings require more than a headset. It starts with integrated hand controllers, blackboard pens etc to complicated motion simulators that provide the immersive experience to the participants. A collaboration solution that leverages the controllers to make the experience more productive will lead the pack.

Networking

The last decade's mantra of "Network is the new OS" will continue to remain in the forefront of the Metaverse applications. High speed network availability is absolutely essential for seamless experience in the Metaverse collaboration applications. The applications that leverage compression technologies and other WAN optimizations are crucial to the success of the enterprise collaboration.

Environmental Impact

A socially conscious company or an investor is paying attention to their ESG (Environment, Social and Governance) goals these days. Metaverse applications, including collaboration applications, should consider the ESG goals while delivering the immersive experience. End of the day, the resources are real and limited and it is important to be socially responsible while consuming those resources.

Security

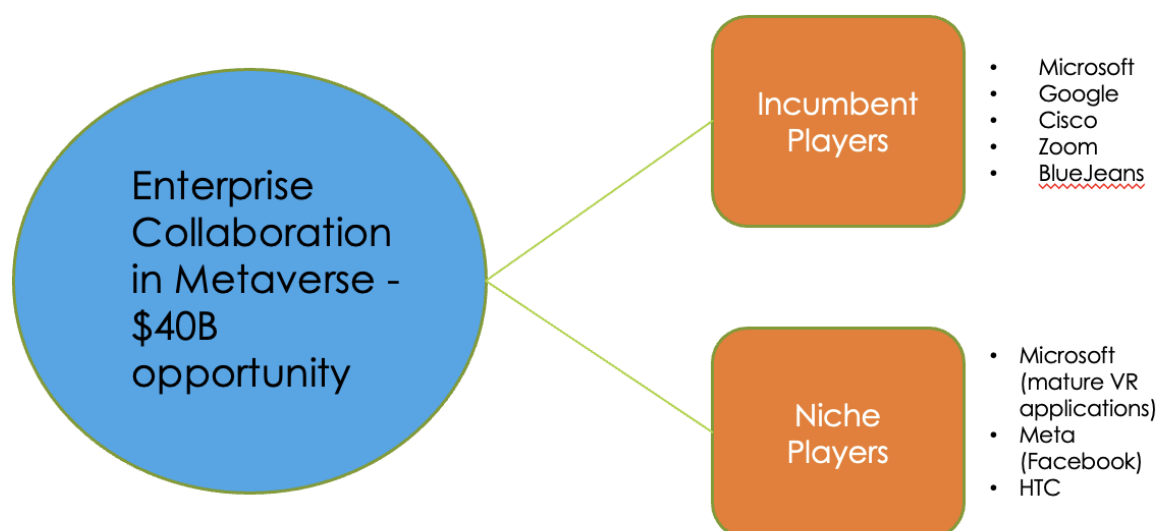
This is one of the most important pillars that helps a Metaverse collaboration application to succeed. Security and Privacy should be built into the application.

Following aspects should be considered while designing the collaboration applications

1. User security
2. Data security
3. Network security
4. Privacy concerns on data and identity
5. Data leak protection
6. Abuse
7. Harassment
8. Racism
9. Cybersecurity governance criteria
10. Web 3.0 and Blockchain security

Market prediction

Metaverse is a Trillion-dollar opportunity



Enterprise collaboration is a \$40B opportunity in an anticipated \$1T Metaverse market. We hypothesize that there will be two different types of the players that will fight for this collaboration space.

Incumbent Players

These are the existing enterprise collaboration software providers that will try to provide VR/AR extensions to their solutions so that they can expand into the Metaverse space. These could be clunky to begin with but as the customers mature, the solutions will also mature.

Niche players

These are the native Metaverse players that will leverage their expertise in the Metaverse technologies and eco system to build more integrated collaboration solutions. These players have an opportunity to reinvent the enterprise collaboration from what we know now. The collaboration in its mature form may not really look like what we expect it now.

There are few players that could potentially fall into both the categories, for example Microsoft. Microsoft can leverage its current Holo lens experience in providing the digital twins experience along with its Microsoft Teams collaboration application, and lead the pack in offering the solutions in this space.

Why Microsoft could be a winner in the metaverse enterprise collaboration

- Microsoft has an established collaboration platform with the necessary security features that large companies are adopting
- They already have a meeting share platform that incorporates meeting amenities such as file sharing, whiteboard and various backgrounds and chat.
- Microsoft is an established leader in the gaming world by Xbox
- Microsoft has experience with mobile devices and their MS Teams collaboration software is expertly adapted to the mobile platforms
- They already have a customer base and large business clients who use their MS Teams so a seamless transition to this new technology could be very viable
- They have capital to buy out any metaverse startup

Why they will not win

- They do not have the social reputation as Meta (this may not be a big deal for Enterprise collaboration).
- They may use a new technology to do old things with and not push the boundaries like a startup might.
- Their hardware may fall behind the competition and since the wearables is a big deal to adoption this may dismantle their efforts.

Technical challenges

There are significant technical challenges that Metaverse collaboration solutions need to overcome.

Interoperability

As more and more big companies start investing in Metaverse space, they tend to build their own Metaverse solutions. Enterprise collaboration applications that are built should be able to provide the interoperability between these Metaverse spaces to be able to succeed in this space.

Cyber attacks

Everyone in the IT industry should've already heard the Log4j attack [4] that happened recently. Cyberattacks cause significant damage to the enterprises and the average cost of the data breach has increased from \$3.86M to \$4.24M in the year 2021 [3].

Enterprises adopting the new Metaverse based applications, be it for collaboration or something else, will add an additional attack surface that they need to manage in their ever changing cybersecurity threat modeling.

Real resources

No matter how virtual the application is, the need for the resources is real and they are limited in nature. Metaverse collaboration applications require a lot of resources and would add to the cost of the overall application. Delivering the collaboration applications with a keen eye to the efficiency of the solution is the key here.

Market challenges

Collaboration applications in Metaverse could face an uphill battle in adoption by the Enterprises for the following reasons.

Lower Remote work appetite

Appetite for remote collaboration goes down as enterprises could find the in person meetings offer significantly more value than the virtual meetings. Some areas, especially sales meetings, need that personal touch and interpersonal relationships to make business prosper.

Compliance requirements

Legal, Judicial, Fiduciary and Governance requirements add more burden for enterprises adopting the solutions in the Metaverse, thus discouraging them to move fast. This will pose significant market headwinds for the Metaverse collaboration applications.

Conclusions

In the post COVID era, remote work is here to stay. Employees of the enterprises will continue to demand the options to work from home and Metaverse provides a significant potential for the enterprises to provide an immersive and more productive collaboration experience to engineer and design the next generation products.

Metaverse collaboration applications that focus on building on the overcoming adoption issues, seamless enterprise application integration, building an efficient eco system and with a keen eye to security and privacy of the enterprise customers will lead the pack and emerge as leaders in this space.

With billions of dollars being poured into this space by companies like **Microsoft, Meta platforms, Apple, Google, Sony, nvidia and Qualcomm**, we expect to see great potential for

collaboration applications to develop in the Metaverse space and adoption by enterprises will grow in this decade.

References

1. <https://uploadvr.com/oculus-quest-2-benchmarks/>
2. <https://spatial.io/>
3. <https://spanning.com/blog/cyberattacks-2021-phishing-ransomware-data-breach-statistics/>
4. <https://www.dynatrace.com/news/blog/what-is-log4shell/>
5. <https://www.mordorintelligence.com/industry-reports/enterprise-collaboration-market>
6. <https://www.grandviewresearch.com/industry-analysis/enterprise-video-market>
7. <https://www.gartner.com/reviews/market/meeting-solutions>
8. <https://www.businesswire.com/news/home/20220207005085/en/Gartner-Predicts-25-of-People-Will-Spend-At-Least-One-Hour-Per-Day-in-the-Metaverse-by-2026>
9. <https://www.cnbctv18.com/technology/expained-the-history-of-metaverse-12015212.htm>
10. <https://sync.vive.com/>
11. <https://projectworkplace.cisco.com/capabilities/hologram>
12. <https://www.google.com/glass/start/>
13. <https://www.thedigitalspeaker.com/enterprise-metaverse-change-collaboration/>