



A GLOBAL RESOURCE GUIDE TO
XRCOLLABORATION
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SPRING 2020



A GLOBAL RESOURCE GUIDE TO **XRCOLLABORATION**

“A Global Resource Guide to XR Collaboration”

is an interactive and comprehensive guide to using Augmented Reality (AR), Virtual Reality (VR) and Mixed Reality (MR) – collectively described here as “eXtended Reality” (XR) Collaboration platforms for business and education.

As we all find ourselves adapting to the new rules of social distancing brought on by a global pandemic of unprecedented scale, technology offers a way in which we can work, learn, and interact with one another in a viscerally personal way, while remaining physically distant in our respective homes.

We are watching the enormous impact this crisis is having on educational institutions forced to immediately transition from in-classroom learning to home-schooling or remote learning. We see ourselves and our business colleagues spending the bulk of the work day connecting through chat, video, and collaboration platforms with no user manual on how this all works best.

As most of us struggle with the challenge of adapting to this “new normal” where much of the world’s population finds itself unable to safely hold face-to-face meetings, XR Collaboration tools are emerging as viable alternatives — not to replace current video conferencing, but to augment them through spatial understanding. By sharing fully-immersive spaces with others, we begin to bridge the physical gap between us — opening up a whole new world of communication possibilities.

Think about your last “remote meeting.” First, ignore the kids who come in and ask where the peanut butter is, that is just part of your new background. If you are like many of us, you were disengaged, video camera turned off, checking Instagram on your phone while searching Covid-19 news in your browser, vaguely listening to what was being said on the conference call.

The same meeting in XR is a new experience; nobody can see your kids enter the room, you cannot be on your phone, you are transported to a new world or your colleagues are transported to yours and immediately you are 100% present. With XR conferencing, people may not be able to see your face, but they can certainly see your body language, and that is really powerful.

Our goal in creating this publication is to provide an unbiased resource that outlines how immersive XR technologies can not only support human interaction, but also empower us to collectively adapt to our new reality, while bringing us closer together.

You are about to learn how to deploy one of the most powerful communication tools mankind has ever created. You will have everyone’s undivided attention on the task at hand, but that also means that — as a facilitator of this new medium — you must use the technology responsibly. From platform selection to security to hygiene to device selection and management, this guide will walk you through everything you might need to know to leverage the transformative power of XR Collaboration in your organization.

We are all in this together, and we will continue to thrive, no matter what the future holds. Stay safe and productive, and remember: it is the personal connections we make each day that make us human. So let's put this technology to use to bring us together like never before.

Should you have any questions or suggestions, we welcome them, so that we can share this information in future releases of this document. Please email feedback@xrcollaboration.com with your input.

Thanks,

The XR Collaboration Team and Sponsors
April 9, 2020

Sponsors

Creation of this publication, the XRCollaboration.com website, and the interactive selection tool were done in a collaborative partnership aimed to provide the world with resources needed now more than ever. A special thank you to these organizations and their hard-working, dedicated, and passionate employees, without whom, none of this would have been possible.



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Qualcomm



MetaVRse



Cleanbox



AREA



XR Bootcamp



AWE



VRARA

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This free resource guide was created by a volunteer team of XR experts. The people listed here have been working around the clock, while managing homeschooling their children, juggling their regular jobs, and attending tons of virtual meetings on all sorts of platforms, to understand every aspect of these XR Collaboration tools, so that you, the reader, can make the most informed and beneficial decisions that will hopefully lead to educating, improving work, and saving lives. We thank each person on this list for their dedication to XR and its proliferation to unlock a new world of communication. Content has been drawn from countless sources; a special thank you to everyone who contributed to this project.



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Online Resource Guide

There are nearly 100 XR Collaboration tools currently on the market – so how do you know which one to use, and when? This comprehensive guide was designed to provide the information you need to decide when, how, and with whom to collaborate in XR. This guide is a snapshot of known, available products, their features, and the devices best suited for the solution. This is a rapidly evolving landscape so be sure to check for updates periodically at:

www.XRCollaboration.com

The website will serve as the central repository of detailed information about every XR collaboration product and an easy-to-use interactive tool for matching these to your needs. **All of this will be free to use, and free to share.** Our aim is to help everyone make the best of an extraordinarily difficult situation, and we believe that by coming together (virtually) we have the best chance of overcoming the great challenges that lie ahead.

The website hosts this publication in both HTML and downloadable PDF formats. **“A Global Resource Guide to XR Collaboration”** will be updated periodically so please make sure you sign up with your email address for updates!

Let's Start With a Glossary

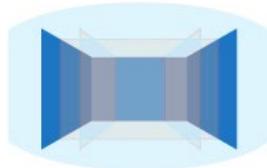
Many of you reading this document are going to be new to some of the technologies and concepts referenced. Therefore let's start with a short explanation of some of these.



VR + AR + MR = XR (One Acronym to Rule Them All)

The catch-all term 'eXtended Reality' or 'XR' encapsulates Augmented Reality (AR), Virtual Reality (VR), Mixed Reality (MR), and all the associated immersive technologies that power these. We define some of these terms below.

VIRTUAL REALITY (VR)



Fully artificial environment

AUGMENTED REALITY (AR)



Virtual objects overlaid on real world environment

MIXED REALITY (MR)



Virtual environment combined with real world



Full immersion virtual environment



The real world enhanced with digital objects



Interact with both the real world and the virtual environment

VR (Virtual Reality)

Virtual Reality is an artificial digital environment that completely replaces the real world. When you put on a VR headset, everything you see has been generated by a computer. However, the concept is becoming increasingly complex and nuanced as the boundaries between Virtual and Augmented Reality blur and the two modes merge at various points of the “immersive spectrum.” Some VR headsets such as the Oculus Quest now have external cameras that display a user’s real-world surroundings (to stop them from colliding with walls or furniture, for instance) and this “pass-through” functionality lets you combine physical and digital elements into blended environments sometimes referred to as “Mixed Reality” (more on this later). For the purpose of providing a definition, however, we will refer to VR devices as those that **primarily** display artificial digital environments.

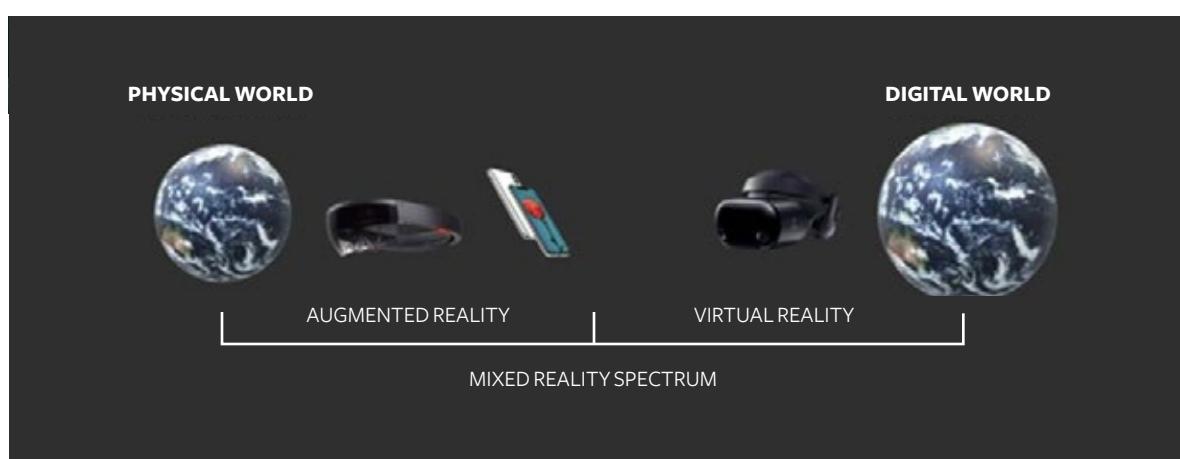


Image Credit - Microsoft

360-degree Video

360-degree videos are a common type of immersive media - widely available on platforms such as YouTube - made by “stitching together” captures of the real world. These captures are generated by special camera rigs with multiple lenses that simultaneously record everything around the camera position. For the purposes of this publication, we will consider 360-degree videos to be different from VR environments.



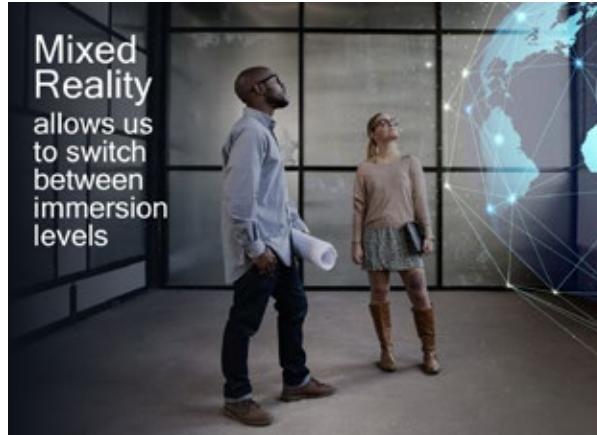
Augmented Reality (AR)

Augmented Reality (AR) is the overlay of digital content on top of your current view of the real-world environment surrounding you. This can either be experienced through wearable “smart glasses,” or mobile devices such as smartphones and tablets. There are currently many companies actively developing AR wearables – including, by all accounts, Apple – but the challenges of housing the necessary display resolution and processing power in a device that is comfortable, affordable, and something that users wouldn’t be embarrassed to wear in public are significant. The most pervasive AR applications, therefore, tend to be, designed for handheld devices, as they bridge the gap while smart glasses technology catches up to where it needs to be in order to trigger widespread consumer adoption.

That being said, when you are alone at home using headworn AR devices, no one is going to care what the device looks like – or even that you are in your pajamas! There are new devices arriving – [Nreal Light](#) for example – which are affordable, functional, and stylish. We would have seen a significant quantity of these devices coming to market in Q1/Q2 2020, but due to supply chain disruptions from factory shutdowns caused by the Covid-19 pandemic, we expect these products to be available in Q3/Q4 2020 instead.

Mixed Reality (MR)

Mixed Reality (MR) enables you to interact with and manipulate both physical and virtual items and environments, using next-generation sensing and imaging technologies. Mixed Reality allows you to see and immerse yourself in the world around you even as you interact with a virtual environment using your own hands—all without ever removing your headset. It provides the ability to have one foot (or hand) in the real world, and the other in an imaginary place, breaking down basic concepts between real and imaginary, offering an experience that can change the way you communicate.



For the purposes of this publication, the term Augmented Reality (AR) will also encompass Mixed Reality (MR).

Avatars



Avatars are representations of a user's body in XR (Most systems do not render full body avatars – you will usually see characters from the waist up). User avatars represent each user's position in the shared virtual space. Each user's voice realistically emanates from their avatar's position. The head and hand movements of users are tracked and perceived by other users as the gestures of the remote user's avatar, enabling a level of non-verbal communication that is completely absent from audio calls, while requiring only a fraction of the network bandwidth of a live video call.

Avatar Realism



Avatar realism is one of the main factors that affects interpersonal interactions and co-presence in XR. This can be considered by both the faithfulness of the avatar's representation of the actual person, and behavioral realism (realistic and natural physical behavior, e.g. blinks). Note that in most systems, the user's facial expression and eye gaze are typically not faithfully replicated, but this will change as eye-tracking and face-tracking functionality becomes more common in VR HMDs.

Generally, users react positively to being able to see their virtual bodies, but many platforms do not offer highly-realistic avatars. The current limits of scanning technology and rendering capacity requirements mean that there is often a trade-off between lag and detail/resolution levels. Some XR Collaboration tools offer cartoonish avatars, which might not appeal to business users. Some start by offering a cartoonish user avatar, but allow for some customization. It's become more common in many tools to allow the user to create avatars which are highly personal and realistic - some even convert 2D face photos and wrap them onto avatars. In a few tools, avatars are extremely sophisticated. In fact, there is a vibrant marketplace for avatar designs. Getting the best results requires some learning to build expertise in designing your avatar.

[Full body realism](#) is still nascent, but as that technology quickly develops, it presents an opportunity, as emotional expression conveyed through body language and facial expressions is actually a more important factor than photorealism in producing fully immersive interactions.

“As the technology gets more sophisticated, VR business calls will usher in more nuanced nonverbal communication that is lost in today’s video conferences. Research shows that approximately 65%-75% of all communication is nonverbal in nature.”

-Jeremy Bailenson, Director of Stanford University’s Virtual Human Interaction Lab

To learn more about the importance of this and what advances are occurring to create higher avatar realism please [read this report](#).

Head Mounted Display (HMD)

A head-mounted display (HMD) is a display device, worn on the head or as part of a helmet, that has a small display optic in front of one (monocular HMD) or each eye (binocular HMD). A binocular HMD has the potential to display a different image to each eye. This can be used to show stereoscopic images – two offset images displayed separately to the left and right eye. These two-dimensional images are then combined in the brain to give the perception of 3D depth. Monocular HMDs are not recommended for XR Collaboration purposes.

HMDs may be used to view a see-through image imposed upon the real world view, creating what is called Augmented Reality. Most HMDs are mounted in a helmet (VR HMD) or a set of goggles (AR HMD). Please see the “**XR Device Hardware**” section for more details.

XR Collaboration

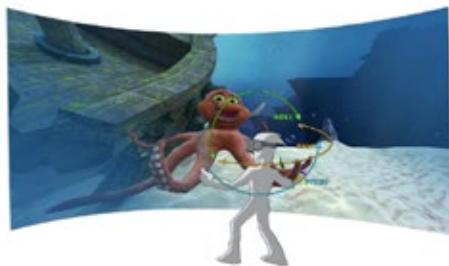
XR Collaboration refers to the use of XR technologies to bring groups of people together for remote activities such as meetings, conferences, design reviews, classroom sessions, and more. Using XR technologies, individuals and organizations now have the ability to communicate in a much more visceral, connected way, engendering a greater sense of physical presence through the use of head-worn devices. Note: Handheld device and computer users also have the ability to join these events, but with far less immersion.



Note on “Degrees of Freedom”

Previously in XR, users have only been able to look up-down-left-right in the X/Y/Z axes yielding three degrees of freedom (3DoF). This was adequate for stationary 360-degree video experiences, but underwhelming when it came to providing full immersion. Unlocking movement on the X/Y/Z axes, in addition to looking in these directions, you can also move in them, giving you six degrees of freedom (6DoF). This enables a much more immersive user experience, since there is real-time connection between physical movement and visual perception, it also minimizes issues with cognitive dissonance and “[simulator sickness](#),” which can arise from it.

3 Degrees of freedom (3-DoF)

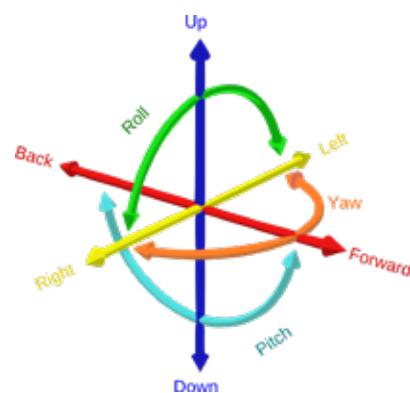


6 Degrees of freedom (6-DoF)



- Can only watch

- Full immersion
- Can become part of the story
- Can now interact and change the story



A Brief History of XR Collaboration

XR collaboration tools date back to the “virtual tradeshow”, first described and presented as “ConventionView” by Visual Data Corporation – now known as Onstream Media – in April 1993 ([complete history of video conferencing](#)).

2003, Second Life, an online virtual world was born growing to over one million regular users by 2013. The platform features 3D-based user-generated content giving the users a sense of virtual property, space and appearance. Second Life also has its own virtual currency, the Linden Dollar, which is exchangeable with real world currency. ([Wiki-Second Life](#))

2013, AltspaceVR, a platform that provides meeting spaces in Virtual Reality, where users can [host events](#), have conversations, watch videos, play games, and browse the Internet. Avatars in AltspaceVR can automatically mimic a user’s body language by tracking the VR controllers and using predictive algorithms. In October 2017, AltspaceVR was acquired by Microsoft. ([Wiki-AltSpace VR](#))

2020, There are nearly 100 XR Collaboration products available to customers, many of these focused on social, education and enterprise applications. Please review the “[XRCollaboration.com Product Directory](#)” section for a listing of software products you can use.



Video Conferencing Tools

Overview

Video conferencing software enables two or more people to communicate via video and audio using an Internet connection. It enables them to conduct live remote meetings by transmitting audio, video, and text. Best-in-class video conferencing services let users share their screens, remotely access one another's desktops, chat via text, exchange files, communicate via digital whiteboards, and even broadcast conferences to large groups of passive viewers.

Popular Video Conferencing Tools

There are quite a number of well established video conferencing tools that are used around the world. Here is a list of the most popular ones and links to where you can get more information or download the software.



Cisco WebEx



Google Hangouts Meet



Slack



Crowdcast.io



GoToMeeting



Skype



Discord



Microsoft Teams



zoom
Zoom

What They Are Good For

Video conferencing tools provide adequate functionality for various meeting use cases. Many corporations have already purchased licenses for such solutions and use them regularly. They can be scaled to large audiences and operate well in a moderated environment or a one-to-many format.

When They Are Not Enough

These video conferencing tools, however, are geared toward voice-heavy, video-heavy, or PowerPoint-driven communications rather than collaboration. They lack the kind of interactive functionality and content flow that XR can offer. Users can, for example, interact with the speaker(s) by asking questions via voice or chat, yet they cannot directly interact with any of the content. For example, users cannot draw on a slide being shared by a presenter or add new images that everyone can see. Screen sharing is possible but is usually limited to one user at a time sharing content in a non-interactive way. Furthermore, running video content streams via screen sharing is very bandwidth-intensive and tends to result in very low quality video viewing experiences for all users.

Advantages of Using Video Conferencing Tools

- **Existing familiarity:** you might already be using the tools at work or school.
- **Corporate IT support:** the tools may play nice with your corporate IT systems and security requirements.
- **Wide availability:** the tools may support your native language, when needed.

Disadvantages of Using Video Conferencing Tools

- One “speaker” at a time.
- No (or limited) collaboration tools.
- Content is not interactive.
- Network requirements for video and screen sharing can result in poor quality communications.

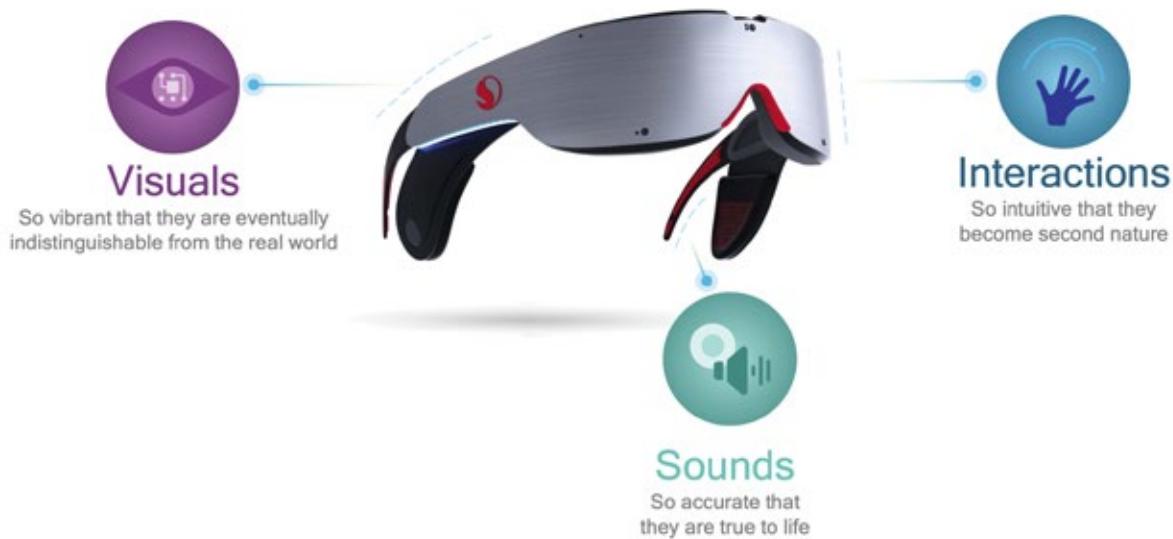
Using Video Conferencing Tools in XR

There are very new solutions such as [Moot](#) and [SPACES](#) which enable VR integration of video conferencing platforms. These bridge the gap between video conferencing (e.g. Zoom, Slack, Webex, Skype, Google Hangouts, etc.) and XR providing users with customization options to place objects to change the environment.

They are very user-friendly alternatives for those who might be anxious about jumping into XR but are not a replacement for those, as they do not provide all of the same collaboration features that dedicated XR Collaboration tools offer.



Introduction to XR Collaboration Tools

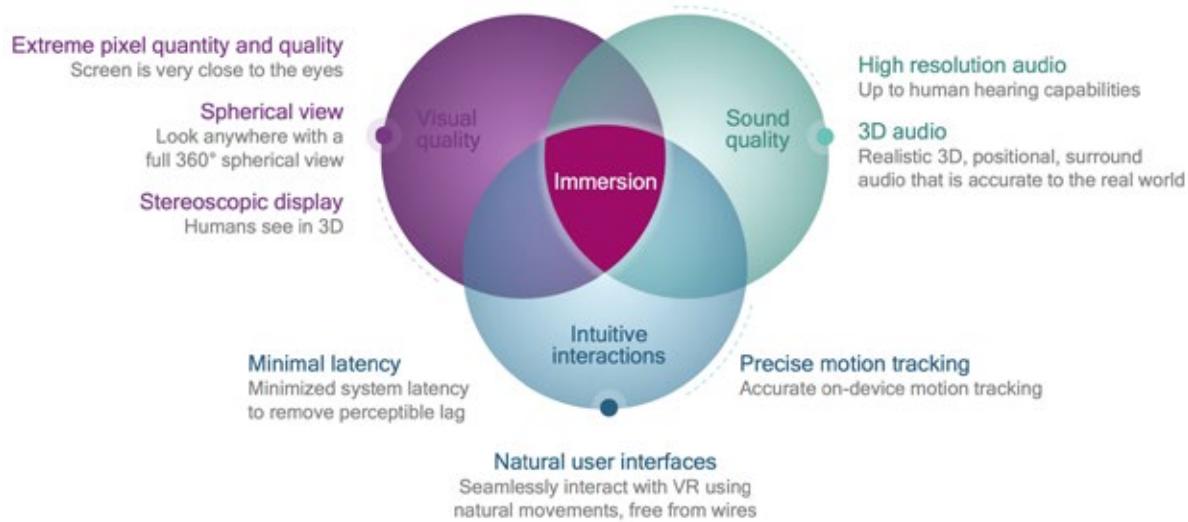


Key Benefits Over Video Conferencing Tools

XR Collaboration offers several advantages when compared to alternatives such as video conferencing, phone meetings or even face-to-face interactions. These include an enhanced sense of presence, eliminating extraneous distractions, enabling enhanced and more dynamic visualization of information and objects, as well as interaction with these objects in 3-D. Furthermore, those dynamic interactions can happen in real-time with other collaborators, regardless of where they are physically located at that point in time. Additionally, even before this global crisis triggered by the

coronavirus pandemic, the cost, stress, environmental impact, and time-waste caused by global business travel was becoming a pressing issue which led many companies to consider adoption of XR collaboration tools - either to partially or entirely replace such face-to-face interactions. In the post COVID-19 world, however, what was previously desirable will become in many cases the only viable alternative for co-workers to continue meeting and collaborating meaningfully with one another.

Increased Presence/Immersion



Virtual Reality's goal is to fully immerse a person in a digital landscape, triggering the same kinds of physical and psychological reactions they would experience in the real world. This is called "presence"—a mental state in which people recall VR experiences as if they had actually occurred. Interactions mediated by XR collaborative tools have the advantage of instilling that sense of presence. This arises from being immersed in an environment as opposed to viewing it through a screen, as well as a sense of "embodied cognition" which comes from your own actions, movements, and expressions being replicated by your avatar and having a visible – even tangible – effect within the virtual environment.

Less Distractions During Meetings

During an average one-hour video conference, participants report approximately 15 minutes of distraction from phone and other peripheral actions. XR platforms, on the other hand, fully immerse participants, focusing attention more fully on the interaction at hand.

Highly Customized Meeting Environments

XR meeting locations can be designed to replicate real-world locations, such as board rooms (with custom furnishings and equipment as well as branding and reference information), or allow for more creative settings. This can be particularly useful in educational use-cases, where it would be possible, for example, to hold a class on the surface of the moon or examine a jet engine inside a realistic virtual hangar.

Interaction with 3D Objects

XR tools allow for interactions that would be too difficult, expensive, or dangerous in real-life. Architects can visualize different layouts, identifying potential issues and avoiding costly mistakes before construction even begins. Designers and engineers can test prototypes and view how minute changes affect aerodynamics and performance. Clinicians can optimize the layout of operating rooms and manufacturers can easily move several tons of heavy machinery and equipment until they find the most efficient arrangement which can be agreed collectively and implemented with confidence.

Potential Disadvantages of XR Collaboration

Even though XR Collaboration tools have many strong advantages compared to other digital solutions – such as video conferencing – there can be some disadvantages, depending on how the tools are deployed and used. There are some potential issues to be aware of.

Text Input Can Be Challenging

A current issue with most XR experiences is that traditional methods of text input can be awkward, slow, inefficient, and downright frustrating, as anyone who has attempted to type on a virtual keyboard can attest to.

Advances in voice technology are likely to make voice-to-text input the norm for XR as it offers an intuitive, quick, and hands-free alternative.

An ongoing area of research and development is focused on addressing this challenge using Brain Computer Interfaces (BCI) devices. These devices are being designed to effectively read the mind of the user and translate thoughts into actions. A specific example of this is decoding imagined speech into text input.

Accessibility Challenges

XR can empower those with disabilities to communicate and engage more effectively with others in a remote immersive environment. These technologies can potentially meet the needs of people with permanent, temporary, situational, or changing disabilities. However, issues such as hardware access, network connectivity, weight of the device vs strength of the user and systems user experience all need to be assessed in order to deliver on an optimally accessible experience.

While features such as enhancing spatial sound volume from one side of the body over the other, foveated rendering that highlights sharp contrasts for visually-impaired users, to enabling those confined to a wheelchair to walk around a virtual boardroom table, all potentially enhance accessibility. On the other hand, the heavy emphasis on motion controls, use of your body to control the experience and even sometimes requiring the user to be in a certain position (e.g. standing) all pose potential accessibility challenges which should be acknowledged and addressed where appropriate. Research is being done in both software and hardware (for example, [SeeingVR](#), [Microsoft](#), [Canetroller](#) and [Project Tokyo](#)) to find ways to address accessibility in XR and more advances in this area are to be expected in the near future. Products like [UltraLeap](#) promise to provide mid-air haptic interactions that could morph into a new language tool.

Introducing XR Collaboration into the process of remote communication accepts and welcomes everyone into the space and through supportive XR Collaboration tools, everyone is empowered, bridging remote collaboration regardless of accessibility limitations.

Further information on this topic can be found here: "["Accessibility, Disabilities, and Virtual Reality Solutions"](#)".



SeeingVR, Microsoft's

Common User Requirements for XR Collaboration Tools

Each of you will be looking to address different needs when it comes to considering the use of an XR collaboration tool. However, we have identified a set of common requirements that should be considered when selecting the best tools and platforms to suit those needs. On our XRCollaboration.com website, we provide an interactive tool that can be used to tailor recommendations to those specific needs and requirements.

High Level

- Support participation via a wide range of devices to allow more convenient access to potential participants: PC-based VR, standalone VR, smartphone tethered AR, standalone AR, tablets, smartphones, and Windows/Macintosh computers.
- Stable and reliable software. Check the vendor's blog or release history to see if they are regularly posting software updates.
- Offer accessibility equal to or better than IRL (in real-life) events.
- Intuitive enough so that first-time users aren't discouraged from participating. We've spent time gathering information on each tool's first time onboarding experience so you can plan ahead how much time it will take to get started.
- Support at least 5 participants in real time without glitches or lag. We've evaluated each tool's ability to support concurrent users in a single collaboration session.
- Allow both free access and paid access, public access as well as private access.

User Interface

- Allows users to quickly and easily visualize the way their avatar appears to others
- Should offer users a consistent set of features on every supported platform
- Interaction controls should be available without having to switch in and out of XR
- Should not have distracting, "always-on" UI elements that crowd the user's view
- Simple toggle-able menu with most common commands accessible via minimal steps
- Display time of day (in the user's timezone) and details of current session
- Allow users to easily see the schedule and navigate to other sessions
- Support both teleporting and joystick locomotion/turning
- Use standardized controls for locomotion and interacting so users can easily switch between platforms
- Ideally allow users to change settings without affecting their avatar movements
- Contain pause function so that users can temporarily leave the XR environment easily (we all need "bio breaks"!)
- Functionality to save sessions, slides, information on fellow attendees
- Allows participants to easily exchange contact details

Who Benefits Most From XR Collaboration Tools

There are particular groups of people which we can identify as having the most value and interest in using XR collaboration tools.

Business Users

Even before the paradigm change toward remote working that we have experienced due to the global Coronavirus pandemic, the ability to reduce work travel expenses and foster real-time knowledge and expertise sharing offered tangible ROI to enterprise users. As the medium-to-long-term consequences of this crisis and the likely continued need to enforce various levels of social distancing continue to make themselves felt in the coming weeks and months, XR tools will prove increasingly valuable for business users across all sectors of the economy.

Educational Users

The educational sector has also experienced a shift toward the more widespread use of [immersive technology in the education sector](#), capitalizing on benefits such as greater engagement and higher knowledge retention rates triggered by experiential learning. Yet with millions of students – from primary to university level – now finding themselves effectively unable to attend traditional lessons and benefit from face-to-face interaction with teachers and classmates, there is an urgent need for XR technologies to help fill the gap and enable educators to make meaningful connections with learners in ways that replicate those personal and persistent interactions. Following the initial impact of these containment measures, we can already point to examples of individuals [repurposing XR platforms such as games](#) for this purpose, yet in the longer term educators should also be confident of having access to consistent spatial computing tools to enable the delivery of educational content. Grove Learning is an example of such a platform which uses XR management software to allow classrooms to share the same experience on Oculus Quest and Go devices. These so-called “Arcade Management software” solutions are centralized experience distribution systems, and also include platforms such as [SpringboardVR](#) and [Synthesis VR](#), which facilitate collaboration through enabling users to conduct classroom training and group experiences through sharing software, as well as providing license management functionality and metrics.

Great recent case study of running a large Education conference in VR:

www.educatorsinvr.com/2020/03/08/behind-the-scenes-of-the-educators-in-vr-international-summit/

Conference Speakers/Attendees

The impact of the Covid-19 pandemic was most immediately felt in the live events industry – perhaps most notably beginning with the cancellation of Mobile World Congress in Barcelona. A rapid series of trade shows and conferences followed suit as it became clear that it would be dangerously irresponsible to proceed with any manner of large in-person gathering. There have been rapid efforts to transition to virtual conferences, yet industry experts such as [Liv Erickson](#) point out that there are still many significant technological and logistics challenges that need to be addressed before large scale XR conferences become viable. This complex and fast-evolving area will be further addressed in the next update to this publication.

Social Users

The sense of presence afforded by XR also fosters social interactions outside of work and educational settings. However, the tipping point for social use of XR collaboration is further along than for enterprise and education, as consumers will only engage with it once a meaningful number of their social circle is likewise able to join them in these virtual environments. It is likely that this will only be pervasive once devices become significantly more affordable and user-friendly. This is another area which will be further addressed in updated versions of this resource.

Military Personnel

XR collaboration can prove extremely useful in a military setting, both in training and in battlefield deployment where critical information can be accessed in real-time. In 2019, Microsoft announced a \$480 million deal to supply thousands of HoloLens units to the U.S. army, and army chiefs testing the device have since praised the depth of perception in the Integrated Visual Augmentation System (IVAS), leading to a request for [40,000 XR headsets](#) in the 2021 budget.

Medical Personnel and Patients

Virtual collaboration has been extensively used by physicians and nurses in [training scenarios](#), and increasingly expanded to include real-time collaboration enabling clinicians to [share valuable information remotely](#).

Types of XR Collaboration

There are specific types of collaboration which are best suited to XR environments. Here is a summary of the most important ones:

3D Model Collaboration

The ability to visualize and collectively alter prototypes before they are executed is a key advantage of using XR for collaboration. Many of the XR Collaboration tools are focused on taking highly complex 3D models and enabling detailed rendering and interaction. Some of the tools enabling viewing and interacting with very, very complex models (>50 million polygons) through network based rendering techniques.

Design reviews now frequently take place in XR, with the lead designer in the XR headset and the rest of the team watching what they are viewing using 2D displays or spectator mode.

Business Reviews

A number of the XR Collaboration products offer various project management, sharing and presentation tools which make it very powerful for holding business meetings. Not having to pack everything into a single slide and allowing participants to have persistent content displayed during a lengthy meeting is very powerful! Some tools offer room and content persistence so you can come back to a meeting after taking a meal break and everything.

Breakout Rooms

Sometimes when you are participating in a large XR conference event, participants will want to have the ability to quickly self organize into a smaller group by entering a “breakout room.” Look for this feature in the tools you select if you are planning to run large scale events.

Casual Co-Working

Maintaining work relationships and social interaction in the in the age of a distributed workforce. Will likely be an enduring challenge for most societies around the world in the coming months. In this context, XR is likely to become an increasingly useful tool in the arsenal of employees and contractors alike.

Educational Classes

One of the most important reasons we created this publication was to address the global move to online learning. Many of the tools which are useful for running Business Reviews or large group lectures and lessons provide the features needed for learning from home. Many tools focus on providing teachers with the administrative, content management and scheduling features that will be needed to comprehensively offer an educational experience for their students.

Integrated support for recognized Learning Management Systems (LMS) and broad platform support (2D desktop and lower end cost XR HMDs) is very important.

Entertainment

A large number of VR Collaboration platforms have been successful mainly through user demand to have a place to engage with others in a social or casual gaming context.

Networking

Getting socially connected with others is important - especially in XR! As a result, some tools offer special features designed to enable people to connect socially. Sometimes this is realized by connecting users using third party platform APIs such as LinkedIn or Twitter.

Lectures/Lessons (Large Groups)

XR is a powerful tool in [democratizing access to education](#), enabling students to access content and interact with teachers in ways that would often be limited by geography, finances, or venue capacity in the real world.

Roundtable/Group Work

Tools which allow people to collaborate both simultaneously (by meeting at the same time in a shared XR environment) and at different times (by offering a persistent environment which “remembers” individual contributions and serves as a core hub of activity) enable a very broad range of potential use cases where individuals from different teams and countries can converge around a project.

Pay per User

If you are trying to monetize content, you might want to hold a “pay per view” type event. Look for tools that have integrated ticketing features, connections to monetization and payment systems and event management tools.

Trade Show

XR is redefining the concept of showrooms and product demonstrations and transforming the customer experience. Customers can see virtually how products will look or function in a real setting before buying them, have more-accurate expectations, more confidence about their purchase decisions, and greater product satisfaction.

Sales Presentations

XR offers clear advantages when selling the advantages of products and services to prospective customers. These include not only the ability to present information in much more dynamic and interesting ways, but also to help potential customers visualize and even manipulate prototypes and have real input in the design process at an early stage.

Sprint/Standup/Scrum Meetings

Remote agile teams doing daily scrums utilize visualization tools to present their progress on project assignments. It is often difficult to convey abstract concepts in a stand-up presentation, but XR offers interactive tools which combine the presence of physically sharing an environment with the ability to leverage visual assets to illustrate concepts more effectively.

Workshops

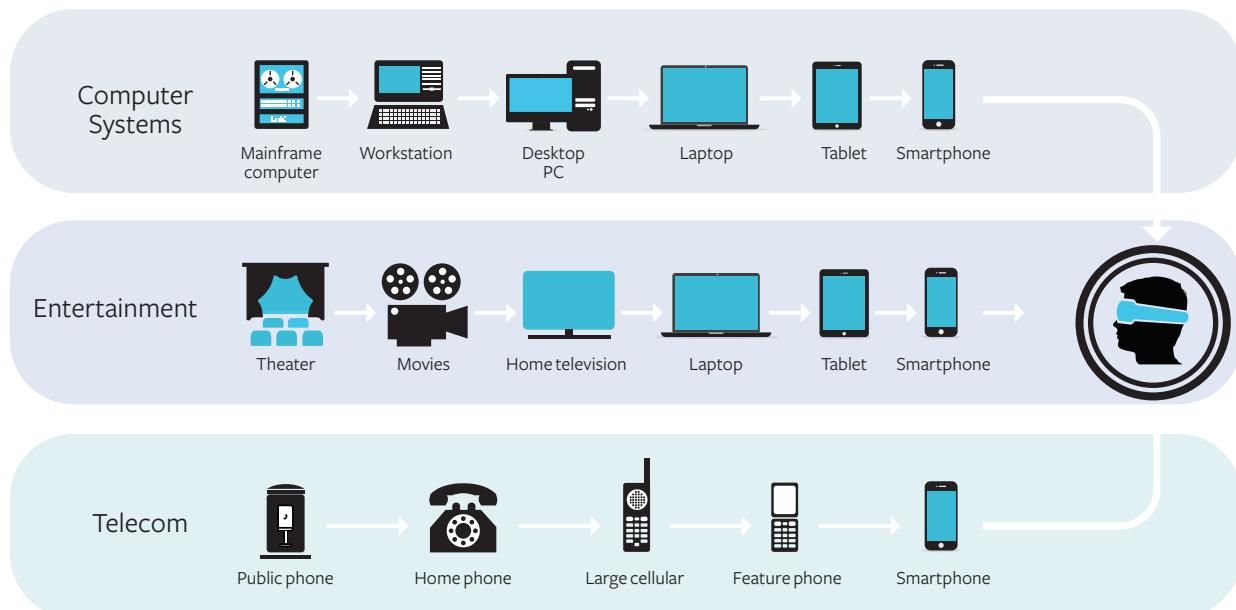
XR can enable high levels of interaction between participants (who can convene virtually from wherever they are in the world), lending itself quite well to workshops, which can be further enhanced with 3D assets.

XR Device Hardware

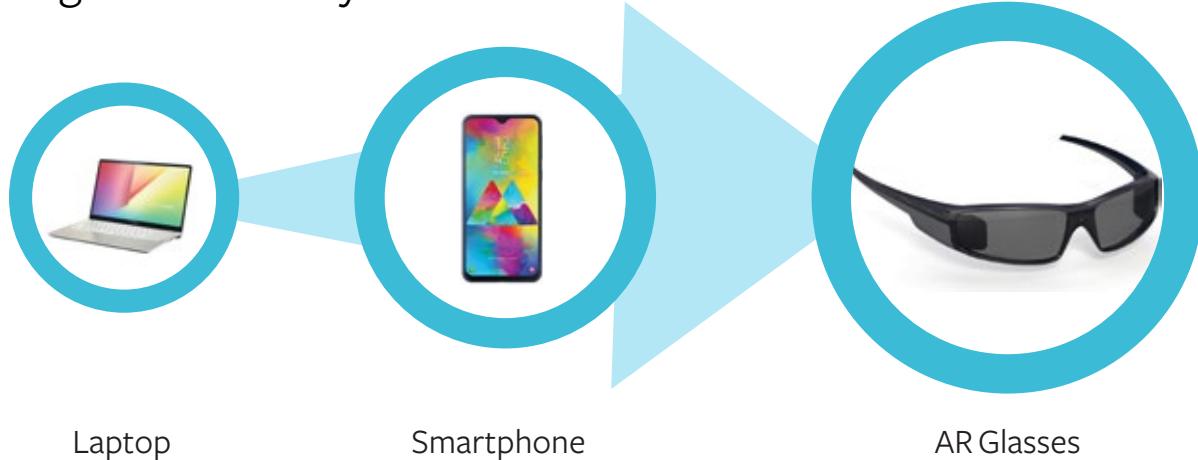
When you plan to use XR Collaboration software, you will need physical equipment. While you can use more traditional computing equipment -- desktop/laptop computers, tablets and smartphones -- the real power of XR Collaboration comes from using more immersive XR headsets or HMDs (Head Mounted Displays).

Desktop, Tablet and Smartphone Devices

Although there has been great progress in making HMDs lighter, more affordable, and pervasive, a large proportion of users still engage with XR Collaboration tools via more traditionally available desktop, tablet, and smartphone devices. Additionally, a small percentage of the general population will encounter mild discomfort with Virtual Reality and should plan to use either traditional devices or AR HMDs. A 2D display can be a viable option for accessing XR Collaboration tools, but it will often come with limited interaction and a less convenient display experience.



Augmented Reality HMDs



There are a lot of different Augmented Reality or “smart glass” devices, but few are currently powerful enough to provide a good user experience for XR Collaboration. We have identified the most available devices for this type of use and provide information about them below.

Standalone HMDs

A standalone Augmented Reality device is one which does not need separate compute equipment but has everyone you need all in a single head-worn device.

HoloLens 2

[HoloLens 2](#) is the successor to the pioneering Microsoft HoloLens. This new model has a diagonal field of view of 52° and a resolution of 47 pixels per degree. Although it is relatively expensive and currently hard to obtain, it promises to offer high end hand tracking and integrated collaboration tools. Many of the high end XR Collaboration tools currently or plan to support the HoloLens 2.



Tethered HMDs

A tethered HMD is one which needs to be connected to external computing resources - typically via a wire although some of the newer devices support high-speed local wireless connections to the computing equipment. In many ways, you can consider a tethered HMD one which primarily functions as a display and sensor device, while all of the content they show will actually be rendered elsewhere.

Windows Mixed Reality

Recommended Minimum System Requirements
for [Windows Mixed Reality](#)

- Intel® Core™ i5 7200U (7th generation mobile), dual core with Intel® Hyper-Threading enabled or better
- AMD Ryzen 5 1400 3.4Ghz (desktop), quad core or better
- 8GB+ RAM
- Compatible HDMI 1.4 video output
- Windows 10 Fall Creators Update or later



NReal Light

The [Nreal Light](#) device can be tethered to either a dedicated compute “puck” or a select USB-C connected smartphone running Android OS. It provides an effective balance between price, form factor, display quality and functionality.



Magic Leap 1

The [Magic Leap 1](#) combines a headworn device with a tethered compute pack and a wireless controller. New software releases have greatly extended the ability of the Magic Leap 1 to spatially map a room and enable use of voice and hand tracking for interaction.



Varjo XR-1

The [Varjo XR-1](#) is a hybrid AR/VR device that has an extra high-resolution camera to capture footage of a users' surroundings and uses smart software to fuse the camera and synthetic imagery, blending the two to create a much more immersive XR experience.



Recommended Minimum System Requirements

(Windows 10 Only)

- NVIDIA GeForce RTX 2080 Ti, NVIDIA Quadro RTX 6000
- Intel Core i7-7820X
- 32 GB or more RAM

Virtual Reality HMDs

Standalone HMDs

There are many relatively newer Virtual Reality HMDs that do not need to be connected to a computer to work, and provide a very good user experience. It is anticipated that standalone HMDs will continue to be in high demand for the next few years.

Standalone devices have come down dramatically in price, especially over the past year, to the point where they have become relatively inexpensive (e.g., the Oculus Quest retails at US \$399). The impact of the Covid-19 pandemic (especially in China) has meant a shortage of devices. Popular HMDs such as the Oculus Quest and Valve Index have been consistently sold out since Christmas 2019. It is likely this situation will continue for much of 2020.

It is also important to note that there are key differences between these devices. In particular, some provide only 3 degrees of freedom movement tracking whereas others support a full 6 degrees of freedom. (See the **“A Note on Degrees of Freedom”** section above for more details.)

Oculus GO

The Oculus Go is an ‘All-In-One’ self-contained VR HMD that is very portable and easy to use. The device has a 5.5-inch display panel with a 2560x1440 (538 ppi) resolution as well as a 60 – 72 Hz refresh rate. It requires no tethering (except for set-up) to function. It comes with one untethered hand-held controller. It has spatial audio drivers built into the headset strap directly providing sound without the need for headphones.
www.oculus.com/go/



Oculus Quest

The Oculus Quest is the first 6-DoF Go ‘All-In-One’ self-contained VR HMD with inside-out tracking allowing for a fully immersive experience. It requires no tethering (except for set-up) to function. It comes with two untethered 6-DoF hand-held controllers. It has spatial audio drivers built into the headset strap directly providing sound without the need for headphones.

www.oculus.com/quest/



Vive Focus Plus

The Vive Focus Plus is a self-contained, untethered VR HMD featuring 6DoF controls and ‘world scale’ inside-out tracking. It comes with two untethered hand-held controllers and boasts a 2880 x 1600 combined resolution for a high PPI of 615 plus a 72 Hz refresh rate.

<https://enterprise.vive.com/us/product/focus-plus/>



Pico Neo 2

The Pico Neo 2 is a self-contained, untethered VR HMD featuring 6DoF controls and 4K resolution, comfort, enterprise functionality, precision eye tracking and spatial stereo speakers.

www.pico-interactive.com/us/neo2.html



PC-Dependent HMD

More powerful – and generally higher resolution – Virtual Reality HMDs will need to be connected to a relatively powerful PC - make sure your computer has the required features. Here are some of the more popular devices in this category:

Oculus Rift / Rift S

The Oculus Rift S is a tethered VR HMD with 1280 x 1440 pixels per eye (2560 x 1440 total) and a refresh rate of 80Hz. It comes with two untethered hand-held controllers and Oculus Insight 6DoF inside-out tracking, gyroscope, accelerometer, and magnetometer.

www.oculus.com/rift-s/

Recommended Minimum System Requirements (Windows Only)

- NVIDIA GTX 1050 Ti/AMD Radeon RX 470 or greater or a NVIDIA GTX 960 or greater
- Intel i3-6100/AMD Ryzen 3 1200, FX4350 or greater
- 8GB+ RAM
- 1x USB 3.0 port
- Windows 10



HTC Vive and Vive Pro

The HTC VIVE Pro features dual-OLED displays with Foveated Rendering and a resolution of 2880 x 1600 pixels, 1440 x 1600 pixels per eye at 615 PPI and a 90Hz refresh rate. It features SteamVR Tracking, G-sensor, gyroscope, proximity, IPD sensor and a 110 degree field of view.

<https://enterprise.vive.com/us/product/vive-pro/>

Recommended Minimum System Requirements (Windows Only)

- NVIDIA GeForce® GTX 970, AMD Radeon™ R9 290 equivalent or better
- Intel® i5-4590, AMD FX 8350 equivalent or better
- 4 GB or more RAM
- HDMI 1.4, DisplayPort 1.2 or newer
- 1x USB 3.0 or newer port
- Windows 7 SP1, Windows 8.1 or Windows 10



Valve Index

The Valve Index features dual 1440x1600 RGB LCDs running at 120Hz with full back-compatibility to 90Hz, plus an experimental 144Hz mode plus and global-shutter RGB cameras for high quality stereo pass through. It comes with built in earphones and two untethered hand controllers. It can be used with any Base Stations featuring support for SteamVR Tracking including Valve Index Base Stations, HTC Vive Base Stations, and HTC Vive Pro Base Stations.

<https://store.steampowered.com/valveindex>

Recommended Minimum System Requirements

- NVIDIA GeForce GTX 970+ or AMD RX480+ Available DisplayPort required, HDMI not supported
- Dual Core with hyperthreading, or better
- 8 GB or more RAM
- DisplayPort 1.2 or newer
- USB 3.0 or newer
- Windows 10, SteamOS, Linux



Varjo VR-1

The Varjo VR-1 features a 'Bionic Display' with a resolution of over 60 PPD / 3000 PPI and a screen refresh rate of 60/90 Hz. It also features integrated 100hz stereo eye tracking and compatibility with Steam VR Base Stations for room scale interaction. It does not come with its own controllers but it is compatible with Steam VR controllers.

<https://varjo.com/products/vr-1/>

Recommended Minimum System Requirements (Windows Only)

- NVIDIA GeForce® GTX 1080 / NVIDIA Quadro P6000 or better
- Intel Core i7-6700 or AMD FX™ 9590 or better
- 16 GB or more RAM
- HDMI 1.4, DisplayPort 1.2 or newer
- 2x DisplayPort 1.2
- Windows 10 (64bit)



Maintaining Proper Device Hygiene

Because of the high cost of XR devices, these are often still shared, especially in the workplace. However, the proximity of the hardware to our eyes, nose, and mouth - not to mention the constant handling of controls and need to adjust the headset with our hands -- heightens the risk of transmitting bacteria and viruses between users.

While this has always been an issue, the current global health crisis has put the need for maintaining high levels of device hygiene top of mind. While XR is potentially a great way to maintain human connections even while practicing social distancing, it is important to be mindful of physical hygiene best practices to ensure your device is sanitary to ensure user adoption and long-term business success.

Clean Controllers as well as Headsets

Controllers are often overlooked in hygiene procedures, yet on average, viruses can live on surfaces between four and five days. Users should ensure controllers and any other peripheral accessories that come in contact with the user are cleaned between rotations.

Remember, Foam Inserts Don't Enable Effective Cleaning of Headsets



Concentrated UVC Light Cleaning

Consider making use of one of the [medical grade UV light cleaning solutions](#) on the market. These can not only help to cut down on the overall time spent cleaning devices, but also increase the effectiveness of your device hygiene routine. They are also proven to **kill 99.99% of all fungi, bacteria and viruses, such as COVID-19**, that are on your devices.



The porous foam that usually sits on the inside of HMDs allows for bodily fluids to easily seep into the material, preventing wipes from effectively cleaning headsets. We recommend all devices should be either covered with a waterproof headset cover or coated in a waterproofing chemical before making use of alcohol-based wipes (60% isopropyl alcohol). You might also consider using a neoprene cover for your VR devices to provide additional protection. At an absolute minimum you should use sanitary disposable liners.

Follow Rigorous Hand Cleaning Procedures

People handling XR devices -- at conferences, location-based entertainment (LBE), or other shared environments (once it is safe to congregate in such places once again) – should always have a ready supply of alcohol-based (60% or higher) hand sanitiser which should be applied before the wearer handles the headset. If possible, the users should wash their hands with soap and water for a minimum of 20 seconds instead.

Hand-washing technique with soap and water



Create your own
<https://washyourlyrics.com>

Baby Shark
Pinkfong

Adapted from National Health Service, who adapted from the World Health Organization Guidelines on Hand Hygiene in Health Care.
Created under the Open Government Licence. See <http://www.nationalarchives.gov.uk/doc/open-government-licence/version/3/> for details.

Additional Information

For additional information regarding Covid-19 (also known as the Coronavirus) you are advised to follow up-to-date information from the [World Health Organization](#).

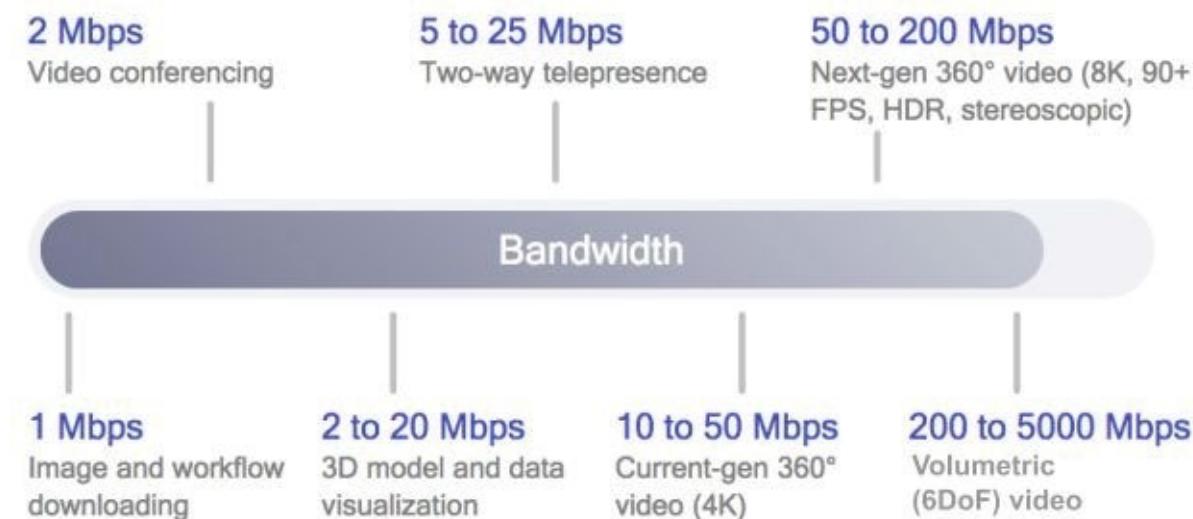
Collaborating For The First Time

Before you start collaborating in XR, some housekeeping tasks are required to ensure the experience runs smoothly for all those involved. This includes preparing your physical environment and setting up each of the XR collaboration tools that you plan on using. These steps will differ depending on the combination of devices and tool(s) you plan on using. In addition to helping you select the best XR tool to suit a variety of specific needs, the XRCollaboration.com website provides some product-specific information on how to go about this setup for different tools and devices, together with approximate estimates of how much time you should allow for those tasks.

Preparing Your Physical Environment

Upgrade Your Network Connectivity

Whether you are using a video conferencing tool or a XR collaboration tool, you will want to ensure you have a stable and reliable Internet connection. A poor internet connection is likely to interfere with the experience, or even render it entirely useless. Visit www.dslreports.com/speedtest to test your connection speed.



Video Conferencing Tool Requirements

Even though the focus of this publication is on XR Collaboration, we know that some of you will be thinking about the requirements for video conferencing tools so are provided that information too.

Minimum Bandwidth

If you are using a video conferencing tool, you will need an internet connection – broadband wired or wireless (3G or 4G/LTE). Minimum bandwidth is 600kbps (up/down) and recommended is 1.5 Mbps (up/down). We generally recommend an average of an additional 60 to 150 kbps for VoIP traffic.

Optimum bandwidth for video conferencing:

High Definition Video: 2.5 Mbps (Receive) and 3.0 Mbps (Send)

High Quality Video: 1.0 Mbps (Receive) and 1.5 Mbps (Send)

Standard Quality Video: 0.5 Mbps (Receive) and 0.5 Mbps (Send)

The actual bandwidth requirements and utilization will vary based on multiple factors, including:

- The make and model of the web camera used.
- The resolution setting of the camera.
- The frames per second (FPS) setting.
- How many cameras are activated in the meeting.
- How many active cameras are on the same network.
- The bandwidth utilization of other meeting activities, such as screen or desktop sharing, Voice over IP (VOIP), etc.
- Whether or not the PC in question is transmitting video, or only receiving.

Maximum Latency

Issues begin when there is interference within the network that could cause a delay in the transmission of data, which could come in the form of latency, jitter and packet loss:

Acceptable latency for video conferencing is less than 300 milliseconds round trip from one endpoint to another before a noticeable delay – between the speaker and the receipt of their words by the far end participants – is registered. The degree of acceptable latency is influenced by the type of the video conference. It is also desired to have **less than 40 ms jitter and 1% or less packet loss**.

XR Collaboration Tool Requirements

Minimum Bandwidth

If you are using a XR Collaboration tool, you will need a good internet connection – broadband wired or wireless (4G/5G). Optimum bandwidth is 1.5 Mbps (up/down). We generally recommend an average of an additional 60 to 150 kbps for VoIP traffic.

Recommended bandwidth and latency for XR Collaboration:

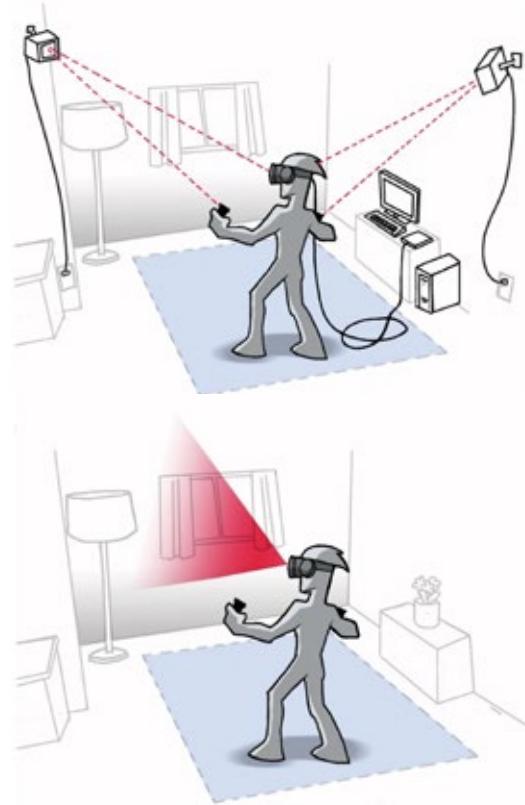
Surprisingly, the bandwidth requirements for XR Collaboration tools are generally much lower than video conferencing tools! This is because most of the content is preloaded before you enter a collaboration “room” or session. A higher bandwidth will result in a faster “startup” time getting into a session. Once a session is started, bandwidth is primarily consumed by voice, annotation, movement tracking for other user avatars and content (2D, 3D) insertion and sharing. Of course, if you start sharing your computer screen into your XR Collaboration tool session, you will need the extra bandwidth for the video streams (see the **“Video Conferencing Tool Requirements”** section for details). Overall if you have 10Mbps down you should be able to handle anything.

What is more important than bandwidth for XR is the **latency** of your connection.

Planning a Standing Space

If you are using a VR device and plan to be standing and moving, you will typically need a clear rectangular space in the real world to move around in. Depending on the VR device you are using, you may need to set up tracking sensors (often referred to as “lighthouses”) which are used to track your physical movements and reflect those in the virtual environment. Newer devices often have those sensors built into the device itself, which makes this initial setup a much more straightforward process.

Typically, we recommend a safe area in excess of 3 feet by 3 feet (1 meter by 1 meter). However, some tools will work best with a minimum safe area of 5 feet by 5 feet (1.5 meters by 1.5 meters). The useful “guardian” feature of the Oculus Quest headset streamlines this process by giving users the ability to establish a safe area within any room, which the device will remember and recognize for the duration of the session.



Planning a Sitting Space

If you are going to be engaged in lengthy XR collaboration sessions or are unable to stand, it might be preferable to set up your device while sitting down. In such cases, it is recommended to use a seat which can swivel to reduce the amount of strain when looking around at different areas of your XR environment.

Prescription Inserts

While some devices, such as the HoloLens, are designed to let users wear spectacles underneath the visor, some HMDs are not compatible with prescription glasses or at least don't allow for room to wear them comfortably. Should you not want to switch to wearing contact lenses when using XR, it is possible to order prescription inserts for various devices such as the Magic Leap 1. These usually cost in the range of US \$100-250.

Microphones

The quality of your voice and the reduction or removal of background noise is very important in your XR Collaboration experience. We recommend that you **select a good noise-cancelling, unidirectional microphone** and if you will wear it, it should be something that feels comfortable over long periods of time. Some people prefer boom or desktop stand microphones.

Preparing Your XR Environment

Picking a Username

Since you are likely to be using XR collaboration tools in a professional setting, it is a good idea to ensure you select a username for your XR tool that makes you readily identifiable (your first name + last name initial is usually a good approach).

Avatar Planning

Design an avatar that is easily identifiable as you by others. Look at using your own personal face image and/or customize your clothing style where such options are available. Some tools have more sophisticated avatar personalization options than others, so (as per above) you should allow for a learning curve and budget some time to familiarize yourself with the tools available. Plan at least 30-60 minutes for your first time experience to access tutorials, and learn how to navigate the menus and other features.

Don't Overdo It

As people get used to new XR devices, they may find it very natural and enjoy the experience, or they might not have a tolerance for more than 20–30 minutes at a time (this is especially true with VR, where some people even experience some form of motion sickness). Although “simulator sickness” is more common in content such as movement-intensive games, we do recommend keeping VR meetings to no more than 30 minutes until you get comfortable and then working up to longer sessions.

XR Collaboration Tool Features

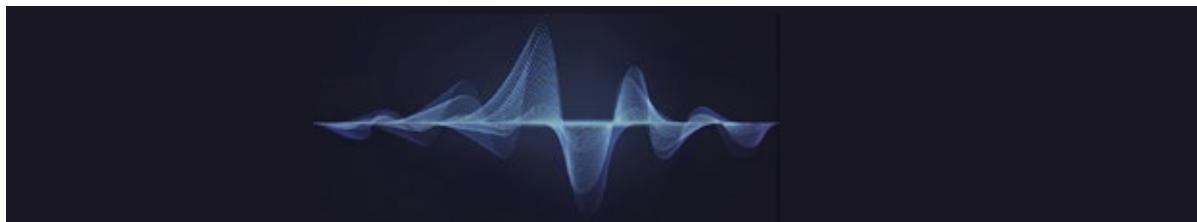
This section will identify key XR Collaboration tool features and provide a detailed description of what the feature and its benefits are. This will be important to guiding you to understand the potential of using XR collaboration tools for your communication needs.

Modes of Interaction



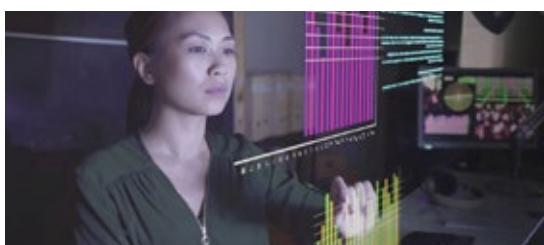
Voice

XR platforms are increasingly incorporating various [voice-based technologies](#) which improve the user experience and make interactions more intuitive, simultaneously bringing them closer to what we naturally expect in real-life and enhancing them with “super-powers” that are not available in the course of an average face-to-face or video conferencing meeting. These include voice commands which can bring up information in the form of digital displays or holographic objects, or AI assistants which can take, save, and subsequently share meeting notes and action points, and even translate what is being said into various languages, in displays visible only to relevant participants. These productivity-enhancing functionalities are increasingly becoming features of various platforms, and we expect the trend towards intuitive, voice-based interaction to continue as the demand for them also grows in the business community.



Visualization

The ability to share information visually in a three-dimensional space is a powerful advantage afforded by XR collaboration tools. In addition to contributing towards building a sense of presence and immersion as mentioned



above, this also [reduces the cognitive load](#) on the brain, which, from a neuroscience perspective allows more efficient comprehension and retention of information being presented. Most people find it difficult to visualize abstract concepts and two-dimensional data on a spreadsheet, yet in XR it is possible to present the same information in much more relatable and instantly recognizable ways that do not require the brain to constantly engage in a translation process which keeps us from being fully present in the moment. It follows that the quality of collaboration arising from such interactions is likely to be higher.

Controllers

In order to create the sense of embodied cognition crucial for immersion and presence, it is crucial that a user's physical actions are accurately mirrored in the virtual environment. Controllers have become increasingly sophisticated at tracking and translating hand movement with little or no lag, as well as allowing them to access menus and transport themselves around those environments with a few simple clicks. As XR technology evolves, however, we are likely to increasingly see such interfaces becoming more "transparent" meaning that movements can be tracked without the need for the user to be holding an actual controller, and that lightweight wearables will not only allow for more nuanced movements (think individual fingers flexing as opposed to blocky, static hands) but also [haptic feedback](#) that can convey the feeling of pressure, resistance, and temperature. In the not-too-distant future we might very well expect realistic (and entirely sanitary) XR handshakes to become the new social norm for business interactions.



Gaze Tracking

Just as voice and gesture recognition technologies have come along in leaps and bounds in recent years, gaze tracking has evolved to the point where devices use it to replace the need for controllers in many instances. Microsoft's [HoloLens 2](#), for example, allows you to trigger various actions simply by directing your gaze towards a holographic button or trigger, and automatically scrolls text in tandem with the rate at which a particular user reads. Although this is a relatively high-end feature at the moment, we can expect it to filter down to more affordable mass-consumer devices in future, and for such intuitive, frictionless interactions to increasingly become the norm.



Content

XR collaboration tools offer a wide range of functionalities that replicate and/or augment other digital collaborative tools (file sharing, messaging, calendars, clocks, timers and even traditional real-world ones such as [white boards](#) and [sticky notes](#)).

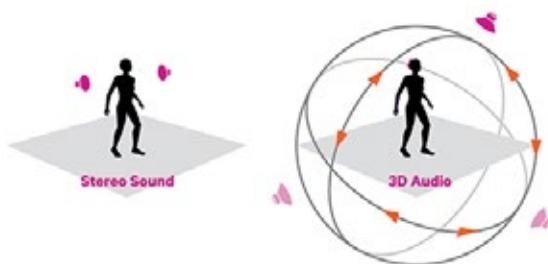




Spatial Audio

Humans are hardwired to pay attention to sound and instinctively use it to map their surroundings, find points of interest and assess potential danger, so spatial audio is a key part in making the experience of collaborating in XR more immersive and building the aforementioned sense of presence. Spatial audio essentially emulates how we perceive sound in the real world by mimicking the pitch, volume, reverberation level and other audio cues the brain would expect during such real-world experiences. Building a dynamic soundscape is essential for effective immersive experiences. It allows programmers to create content whose sounds can come from any

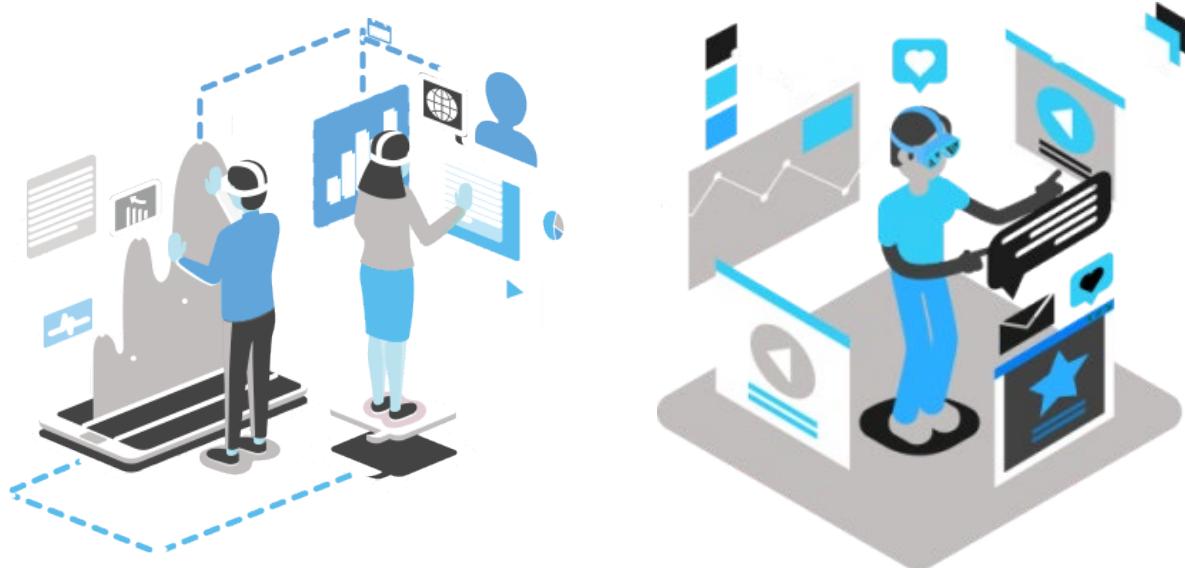
direction. To achieve this, XR uses software algorithms that manipulate a program's sound wave frequencies, creating audio levels that become louder or softer depending on the user's distance from a virtual object. The sound also shifts from one headphone speaker to the other as the person moves their head from side to side or as the virtual objects move on their own. Different size rooms give you different levels of comfort as a human, and if things don't match your expectations in terms of what they should sound like, you instinctively feel quite uncomfortable.



Room Configuration

A “room” in VR is a very broad term, which can range from a deserted beach to an industrial plant or even the surface of another planet. It also encompasses more traditional board rooms and basically anything else your imagination can conjure up. From Ian Dawson’s “Iron Man Jarvis” interface in Tony Stark’s lab to Dulce Baerga’s simulators in Second Life, the potential for branded and customized XR environments is tantalizing. There are already many ways in which users can build customized and branded rooms with relative ease, but it is also worth investing the time in optimizing the room to maximize your collaborative efforts, especially since you are likely to be spending a lot of time in those rooms as virtual meetings become more commonplace.

Customized Rooms



While standard rooms have a limited set of standard prefabricated environments, customized environments can be integrated with a variety of content such as streams from social media platforms such as Twitter, Facebook, and Instagram. Additionally, it is popular to upload customer banners and 3D models into the room where guests can interact with that as additional content.

Private & Public Rooms

XR platforms largely tend to mirror the way we approach shared spaces in the real world, namely dividing them into public and private, with established social norms dictating how we access these and interact within them. Public rooms in XR tend to be readily accessible and free to use, yet offer limited privacy and customization features. Private spaces, however, offer options for the user to decorate and personalize the layout with virtual objects, social media feeds, bot assistants and much

more, depending on the platform. Crucially, you then have the option to invite others to join you (or not) in that space. There is no set prescription about which type of room is best suited for each use case, but as a rule these would tend to fall under the same brackets as they would in the real world, where a casual meeting would likely be held in a public space which did require either party to engage in extensive preparation, whereas an important and potentially confidential presentation lasting over half an hour would perhaps justify the creation of a dedicated room.

Room Mirroring

Many XR collaboration tools provide users with the ability to effectively replicate real-world environments virtually, therefore “mirroring” their look and layout in XR and minimizing the need for creating and setting up environments from scratch (see streaming session above).

Content Control

Camera Lock in Scene

One of the most off-putting problems that new XR users encounter is a sense of disorientation when moving or trying to view content at different angles within a virtual room and have it shift from under their feet, triggering a sense of cognitive dissonance. Therefore, many XR collaboration tools offer the ability to “lock” the scene in place so that you may observe your surroundings, your own appearance, and that of others undisturbed.

Stream to Twitch

The Amazon subsidiary focuses on the gamer community, and is therefore more appropriate for a narrower segment of use cases.

Stream to YouTube

YouTube was one of the first platforms to actively embrace immersive 360-degree video live streaming, and continues to support this.

Stream to Facebook

Facebook is investing heavily in immersive technologies, not only in VR with the family of Oculus hardware, but also in developing future Augmented Reality wearables and virtual social tools that integrate with Facebook. Many XR platforms offer the ability to stream directly to Facebook, and this functionality is likely to become more widespread as further tools are developed to try and entice users to engage with various XR technologies and incorporate them into their daily lives.

Session Recording

This feature can be extremely handy, not only for note-taking at a later stage without having to assign a person to be in charge of taking minutes during a meeting, for example, but also to enable participants who might not have been able to attend a meeting for whatever reason the chance to catch up. This is particularly useful in distributed teams where different time-zones make it challenging for everyone to meet at the same time.

Session Transcripts

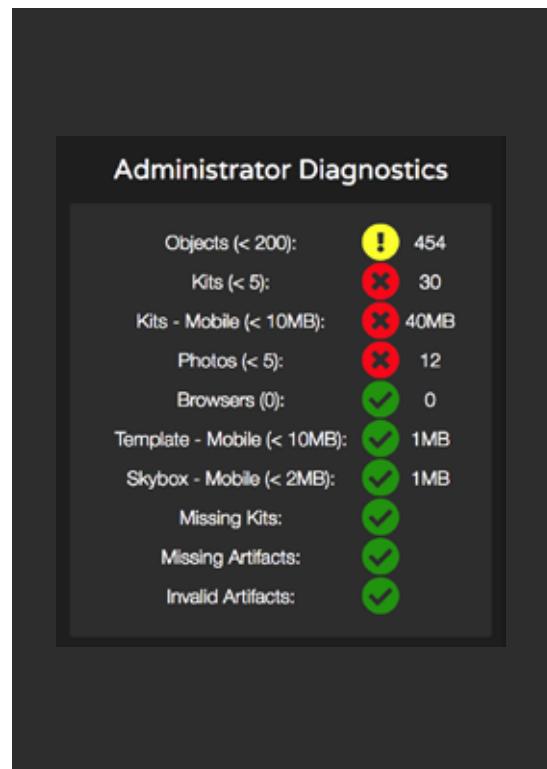
If a platform offers the facility of providing automatic session transcript, this evidently saves significant time in terms of note-taking during meetings and once again is a valuable tool for minimizing distraction and helping participants to become meaningfully engaged in their interactions.

Administrative

There are a number of features that XR Collaboration platforms provide to facilitate administrators and organizers of collaboration sessions. Here are some of the more important ones and information on how to make the best use of them.

Diagnostics

Some of the XR Collaboration tools provide diagnostics that you can use to evaluate your custom room design or additional content to make sure that your fellow collaborators will have a good experience.



Time Zone Management

Working with a virtual team can be complicated – especially if you are separated by different time zones. Some XR Collaboration tools provide features to overcome time zone challenges and make the most of your geographically distributed team by, for example, automatically calculating time zone differences and taking those into account when arranging meetings. However, if time-zone management isn't a built in feature of the XR Collaboration tool you are going to use here are two tools that can be used to coordinate schedules across the world.

Every Time Zone: Need to know what time it is, or will be, across the world when you schedule your next XR Collaboration? Every Time Zone lets you compare multiple time zones now or at a specified future date.

World Time Buddy: Planning a XR session across multiple time zones? World Time Buddy gives you a side by side view of scheduling in every time zone you need in order to help you choose the perfect time for your session.

Set a Default Time Zone

When multiple people are working from different time zones, communications can quickly get complicated, so it is a good idea to set a default time zone for your group—either where the majority of the participants are located, or where your clients are. Alternatively, GMT (Greenwich Mean Time) is often still used as a standard.

Max Simultaneous Collaborators and Sessions

It is important to review each tool's capabilities in terms of the maximum number of simultaneous collaborations you can have in one "room" or session and the total number of sessions. Most XR Collaboration tools have capacity limits and we have this information available in the XR Collaboration Product Directory hosted at XRCollaboration.com

Participant Roles

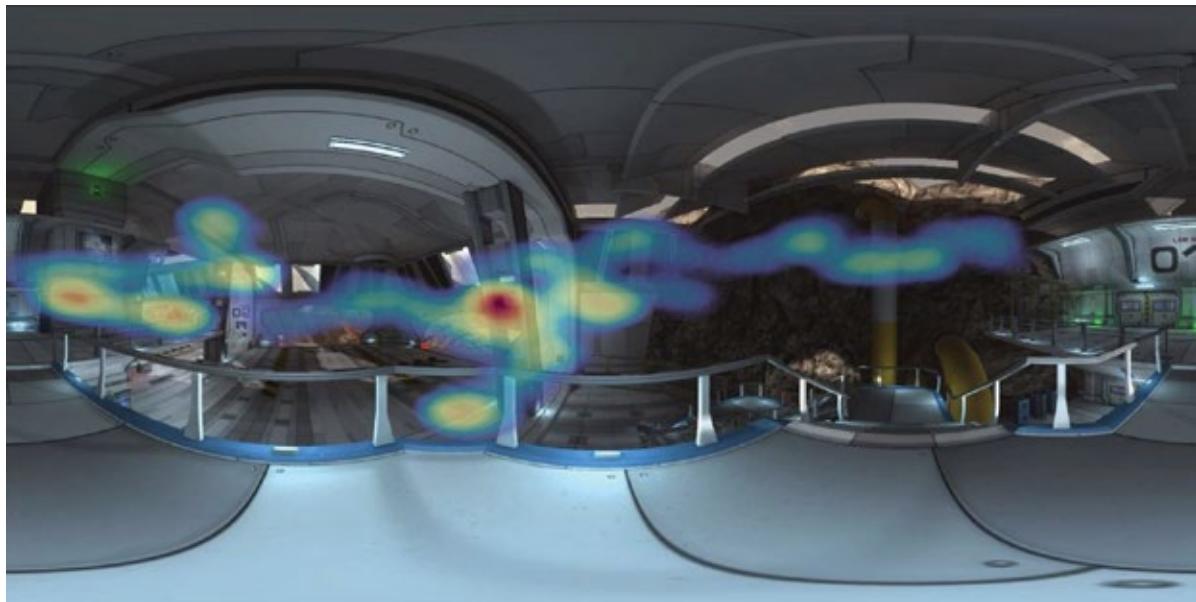
It is important to evaluate tools to determine if they support specific role types. As you engage in collaborations with more than 8-10 people you will find that having separate features for Admin, Moderators, Speakers, Collaborators, and Viewers will be valuable.

Training Tools

The amount of time that it will take to onboard yourself and other new users to a XR Collaboration platform is important to take into consideration. We have taken a look at the different onboarding methods (interactive first run experiences, video tutorials, written tutorials, etc) for each XR Collaboration tool and put this information in the XR Collaboration Product Directory hosted at XRCollaboration.com

Session Analytics

There are specific analytics that you will want to get from XR Collaboration tools – primarily the information about both events occurring within the artificial reality and of the device being used to create the artificial reality. It can be useful to review the session analytics to determine the effectiveness of your room design, XR tool feature access and content assets. XR analytic metrics can be divided into these groups:



XR Scene Metrics

Sometimes the design of a room or 3D space or content you are using for XR Collaboration isn't effective enough. Analysts commonly visualize this information as a heat map, coloring the different regions of a VR space according to the amount of attention they received from users. The more interest an area gets, the redder it appears. You can use these metrics to evaluate the results of your design and content layout and make changes as needed:

- Event Zones (where users are participating within a room or virtual space)
- Gaze Heatmaps (where users are focusing their eyes)
- User Paths (how users flow through the XR environment)
- Content Engagement (which content elements users are interacting with)
- Tool Engagement (which functions user are interacting with)

XR Device Metrics

We need to make sure that the devices being used by XR Collaboration participants are effective for the experience. Remember that technical issues will reduce the desire for people to use XR for collaboration so we want to know about them right away. For example, VR needs to run at least at 90 frames per second – drop in frame rate could produce lagging or choppiness that disorients your fellow collaborators. Here are some of the metrics that will be of interest:

- Performance (FPS)
- Teleportation Events (locomotion count)
- Hardware Data (user devices by class and model)
- HMD Collision with World
- Controller Collision with World
- Button Presses



Attendee/Session Metrics

Getting data about what people did during an XR Collaboration meeting is important - especially for teachers and business managers. Tracking session time is common practice for Web analysts across all digital platforms, but it is especially relevant for XR since it can be a meaningful measure of engagement. When users are immersed in a XR experience, they tend to spend a lot of focus and time on exploring their surroundings

(even when they are aware of interaction opportunities). Session time can offer valuable insight into the immersive and transportative effects of your VR experience. Here are some metrics to look for that will support this analysis:

- Number of Attendees
- Comparison between Attendee Counts, RSVP, and Kicks or Removals
- User Locations (geo mapping)
- Session Time

XR Collaboration Product Directory

There are many XR collaboration products with more entering the marketplace nearly every day. Rather than get into the details of each product in this publication, we highly recommend that you visit XRCollaboration.com and use our interactive tool and feature comparison information to make your own selection of the best product for your particular needs and requirements.

Tools are shown in randomly sorted order and not based on any specific recommendation. We have, however, grouped tools that are more general purpose separately from tools which are designed to address more specific needs and industries.

www.XRCollaboration.com

The website hosts this publication in both HTML and downloadable PDF formats. “**A Global Resource Guide to XR Collaboration**” will be updated periodically so please make sure you sign up with your email address for updates!

Should you have any questions or suggestions, we welcome them, so that we can share this information in future releases of this document. Please email feedback@xrcollaboration.com with your input.

Thanks,

The XR Collaboration Team and Sponsors
April 9, 2020

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