



Platform Overview.

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Introduction.

Glue is a modern collaboration platform that fully utilizes the recent advancements in immersive 3D graphics, virtual reality, and cloud computing. It is intended for business professionals who need global remote access to a shared team space for efficient collaboration.

Essentially Glue is a virtual extension of your workplace, so the core concepts are familiar from everyday working life: *Teams, Team Members, Team Spaces and Team Files*.

Glue is not just an application you install on your computer or mobile device. Glue is Software as a Service which means that we develop and maintain a single globally shared software system which manages all the teams, spaces and files. This ensures that all improvements, updates and bug fixes apply immediately to all our customers, and that we always strive for 100% uptime equally for all our users.



Glue overview.

Glue Teams

When your organization starts using Glue, at least one team is created for you, and a person from your organization is assigned as the team admin. The team admin may then add more members with varying privileges and remove them from the team when they are no longer part of your organization.

As Glue stores business critical and sensitive information, all Glue users must be reliably authenticated, and only users identified as team members are able to access the team's virtual spaces and files. This also applies to Glue's own system administrators, so nobody can access your content without an invite!

Your organization may span several teams, and we will later introduce additional features which will allow for streamlined cross-team sharing of files and spaces, but for now, a Glue team is the definite scope of visibility and access. We will also be introducing guest privileges for occasions where you may want to invite someone to your virtual space, but with restricted access to your private content.

Authentication

Glue performs authentication using Auth0, a popular "identity as a service" solution provider. Auth0 provides a variety of integrations which makes it easy for users to log in with their Google accounts or, with a bit of help from us, to allow single sign on using your organization's Active Directory credentials.

If none of the readily available login shortcuts are applicable, you may always register an arbitrary e-mail address using the Auth0 sign up option. Auth0 will send a verification link to that address and once confirmed, the e-mail address can be used for signing into Glue.

Regardless of the method used, an authenticated user still needs to be a member of a team in order to access that particular team's content. Team admins need not worry about the specifics of authentication methods as team members are managed simply by e-mail addresses; we leave it to Auth0 to ensure users are who they claim to be and, in that regard, we are in good company, as global corporations such as AMD, VMware and Mazda trust Auth0 for authentication.

Glue Team Spaces

In Glue, all collaboration takes place within a virtual space. This is the key differentiating factor when compared to traditional communications software. In audio or video calling systems, meetings are dimensionless and transient. Glue provides virtual spaces in which teams collaborate. These spaces are immersive 3D environments which can either be selected from a library provided by our in-house art team, or which can be custom built specifically to your needs.

When we place people together in a virtual room, what they see and hear as well as what they can touch and manipulate combine to elicit the feeling that they are there with others even when there is great physical distance between them. This promotes high-quality interactions through which people can effectively co-create, learn, or plan.

Spatial audio

Having the concept of a virtual environment built into every Glue session allows the use of fully 3D spatial audio. This efficiently recreates the sensation that you are having a discussion with other people in a real space, with attenuation (audio volume falling off with distance) and proper directionality to the sounds and voices. This avoids the pitfall of regular conference calls which provide just a flat wall of sound coming over the speakers, and where the only effective way to discuss is to carefully take turns while everyone keeps trying to guess when it is appropriate to speak up.

3D avatars

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 VR users are tracked and perceived by other users as the gestures of the remote user's avatar, enabling a level of non-verbal communication completely missing from audio calls, at a fraction of the network bandwidth requirements to achieve the same in a live video call.

Objects

Different objects such as post-it notes, whiteboards, freehand 3D drawings and imported images may be laid out in the virtual space and 3D models may be imported into the space, making the space effectively not just an arbitrary location for a meeting, but a full team project room.

Persistence

Team spaces hosted in Glue, along with any content within, do not disappear when the meeting is over. They are a true extension of your workplace, accessible from anywhere in the world, any time of the day.

All spaces in Glue allow real-time multi-user collaboration, but it does not mean collaboration always has to take place live. You may enter a team space, observe any notes made or new 3D models imported by your colleagues, and make your own annotations for others to find and process as they return to the space later at their convenience.

There is no limit to the number of virtual spaces you may create for your team. You may create multiple dedicated project or team spaces or keep everything down to a single or a small number of multipurpose spaces.

Glue Team Files

We understand the need for other systems to communicate with Glue and the need to extract data from Glue to other systems. Each Glue Team is set up with a file storage that can be used to share arbitrary files with other team members. In addition to file sharing, various types of image, video, and 3D model files can be imported into the Glue virtual spaces.

As we persist all team spaces, this allows you to import your presentations and 3D models well in advance before a meeting. You may prepare your presentation on a desktop computer, upload the files into Glue, and then use a mobile device to join the meeting for presenting your material.

You can export artifacts created in Glue such as annotations, whiteboards, screenshots, or audio recordings. All of these can be accessed as regular images, PDFs, video or audio files, using the Glue web user interface in a regular browser such as Chrome or Safari.



Customizability.

Custom content

While Glue comes built in with a set of 3D environments, custom 3D environment models can be used as templates for new virtual spaces. These templates are visible and available only to your team.

We have a world-class in-house art team who can build any kind of custom environment according to your specifications. Should you want to provide us with a readymade 3D model, our team can convert it into a Glue environment, and we are developing a fully automated import pipeline for environmental 3D models.

We use the Unity Game Engine for our real-time 3D so you may provide us with a Unity Package, but we can also convert a 3D modeling software file such as FBX or OBJ into an environment. Please contact sales@glue.work or support@glue.work for details. Also, on our website we list partner companies who are more than happy to build environments according to your specifications.

Unity content provided to us cannot contain any custom code, and this applies both to any Unity Asset Store plug-ins, as well as to any proprietary business logic scripts developed by your organization.

Firstly, we are not allowed to load code dynamically as this is forbidden by many digital marketplaces and hardware vendor ecosystems.

Secondly, we cannot simply package your custom Unity scenes and thus include your custom scripts into our Glue application distributable. We load all environment models on demand from our cloud storage for privacy and download size reasons.

Thirdly, including all the custom code of all our customers in our single Glue distributable would mean that we would have to do a worldwide release of a new version of the application every time any of that code changed.

Fourthly and finally, there are potential IPR considerations which could quickly become complicated and expensive to manage.

Therefore, the Glue distributable only includes code developed or reviewed by us; any 3rd party components or libraries that we may use are from reputable companies and have been validated by our team.

We go through all this trouble to keep the Glue distributable to a reasonable download size, to protect your proprietary application logic getting into wrong hands, and to protect you from 3rd party code being executed on your computer.

Our team can review and approve inclusion of 3rd party libraries or plug-ins by request, but it is important to understand that these components will then become part of our application that gets deployed to all our customers.

We do have a superior alternative method to enable custom application logic for your organization without any of the aforementioned downsides. The solution is outlined in the following section.

Custom application logic

Between the cloud hosted service layer and the user facing client application (these components are described in some detail in a technical overview section later in this document), we have a highly configurable middleware layer which can be used for associating individual virtual spaces or even all spaces of a team with custom server-side components.

These components may be developed by our development team, by one of our technical partner companies, or by your organization. We provide a network communications protocol definition which can be used to listen and post network messages within a session that is taking place in a virtual space.

The custom server-side components are small standalone C# applications (with support for other programming languages planned) and do not require a full game engine such as Unity or Unreal for development. They can, however, control Unity GameObjects via our protocol definition, so a server-side component can be developed to have very specific knowledge of a particular Unity scene and to control objects and events in such a scene.

When a user enters a virtual space, any custom server-side components associated with that environment are automatically launched on the middleware layer. The environment where this component is executed can reside in our content delivery network, or it can be hosted within your IT infrastructure.



Hardware considerations.

Glue Team Spaces can be accessed with various devices. Features available on each hardware platform may differ but we make sure to provide the essential features as widely as possible across all supported platforms. At the same time, we play to the strengths and mitigate the weaknesses of each particular platform.

Virtual reality is exceptional for experiencing the scale and dimensions of 3D objects, but rather cumbersome for typing. Conversely, desktop provides well established patterns and best practices for managing text, files, multiple applications running in parallel, but the sense of scale of 3D objects is nowhere near what can be achieved with VR.

The big benefit we provide is that all the various features and hardware capabilities contribute to the shared virtual space hosted on the back end. The virtual space is therefore not tightly coupled to any specific platform or device. The users may use a desktop PC to efficiently type notes and import files into the scene, while on another occasion they may enter the same virtual space on a mobile phone to access those notes and files, while on the move and with no access to desktop devices.

Desktop and laptop workstations

Downloading and installing Glue for desktop (non-VR) use does not require 3rd party components or accounts. We have download links for the Windows and macOS versions of our native client application within our web app. These applications are the same for VR users, but additional software is required for most virtual reality headsets, described in a separate section below.

We are in the process of improving audio signal processing, but to prevent audio feedback issues and for the most immersive 3D spatial audio experience, the use of headphones is strongly recommended for desktop and laptop users.

VR workstations

For now, it is safe to assume that besides standalone VR devices such as Oculus Quest, SteamVR must be installed on the Windows PC running the Glue native client application. Virtual reality is not currently supported on macOS.

SteamVR compatible virtual reality headsets

Glue currently supports VR headsets and controllers such as HTC Vive and Vive Pro, Valve Index, Oculus Rift and Oculus Rift S. These devices are SteamVR compatible which is a freely distributed implementation of the OpenVR standard that we support. SteamVR allows us to support a wide range of devices from various hardware vendors without having to implement any device specific integrations.

SteamVR is distributed by Valve Corporation through its digital marketplace, Steam. A Steam account is required for downloading and installing SteamVR.

Windows Mixed Reality compatible virtual reality headsets

Another VR device standard exists for Windows Mixed Reality headsets, but we do not currently directly support WMR -- for the time being all WMR devices such as HP Reverb, Samsung Odyssey, and various others work fully in Glue via SteamVR. We are investigating direct support of WMR devices without the need for SteamVR.

In all instances, WMR devices require Windows Mixed Reality Home to be running for the headset to be operational. Glue will automatically start SteamVR when required.

Oculus Quest and Oculus Quest 2

Oculus Quest and the more recent Oculus Quest 2 are mobile standalone virtual reality headsets that come with controllers, inside out tracking (no external cameras or lighthouses required) and six degrees of freedom (positional and rotational). Oculus Quest requires no additional hardware to operate.

An Oculus account is required, and the devices are aimed for personal use like mobile phones, so the Oculus account associated with a Quest device can only be changed by doing a factory reset on the device. However, Glue for Oculus Quest has its own internal login and one device can be used for multiple sign-ins with different e-mail addresses.

Glue for Oculus Quest will soon be available for download in the Oculus Store and the installed app will be located in the device's Library.

Oculus for Business

The Oculus for Business is a business solution that allows enterprises to procure, implement and manage large fleets of Oculus Quest and Oculus Quest 2 devices.

Built on an enterprise-grade infrastructure that adheres to stringent data security standards, and it provides straight forward device management and advanced support so it's easy to adopt and scale throughout your organization. Oculus for Business Quest and Quest 2 devices are solely meant for enterprise usage and do not require any personal user accounts but instead can be managed from a browser based multi-device management platform.

Learn more about Oculus for Business: <https://business.oculus.com/>

System requirements

Required for desktop and virtual reality on Windows:

- Processor: Current generation i7 or i5
- GPU: NVIDIA 1070, 1070Ti or better
- Memory: 16GB+
- SSD hard drive
- 4G/LTE network connection or better
- Windows 10 version 1073 or later

Required for desktop on macOS:

- MacBook or MacBook Pro
- 4G/LTE network connection or better
- macOS version High Sierra 10.13 or later

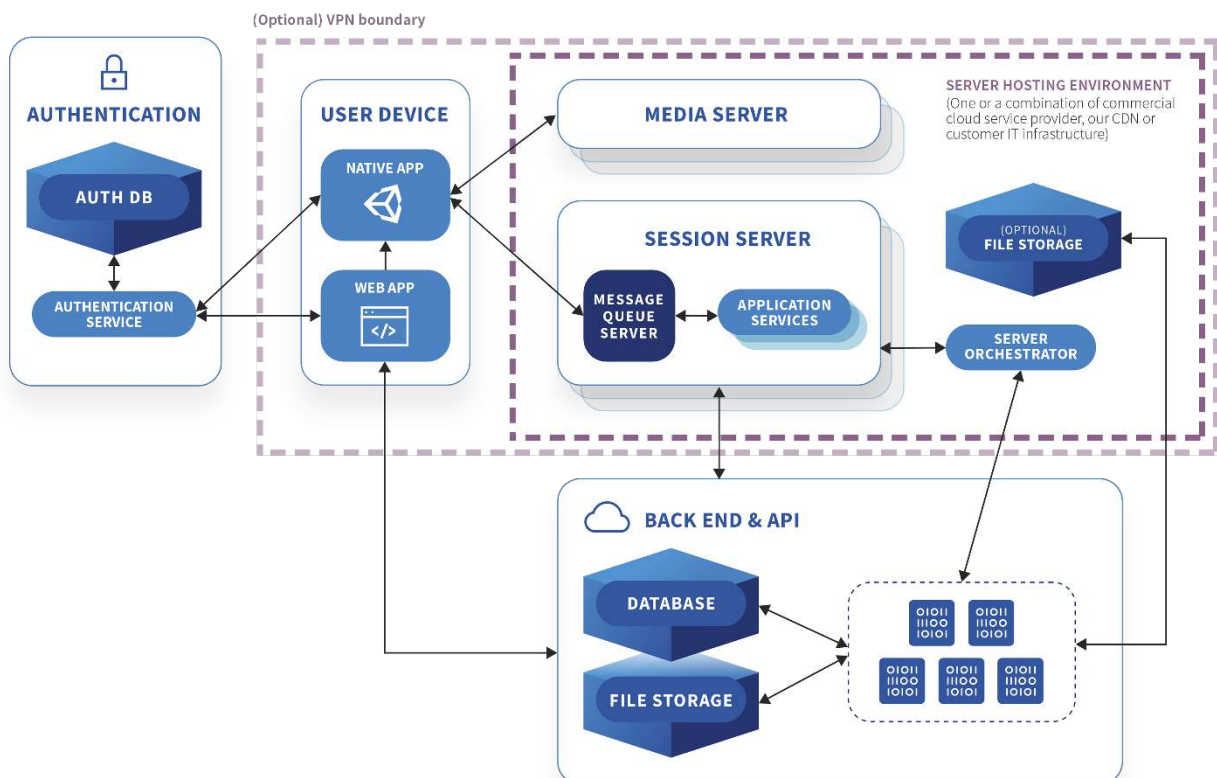
The following virtual reality headsets are supported:

- HTC Vive and Vive Pro
- Oculus Rift and Rift S
- Valve Index
- Windows Mixed Reality headsets (e.g. Samsung Odyssey, HP Reverb)
- Oculus Quest and Quest 2



Architecture.

Glue consists of a large number of software components and while it is by no means required to be familiar with the technical underpinnings of our service, the following section provides a brief overview of the operating environment and main subsystems of Glue.



Cloud back-end

We employ modern serverless technologies in our implementation of the Glue service. This means that we do not have to worry about any back-end servers that we would have to monitor and maintain.

Our service back end logic is executed as tiny individual functions in a cloud service provider's data centre. These functions are stateless and short-lived, which contributes to the overall health of the system, as the complexity of modern software tends to make long-lived, stateful server applications much more prone to subtle (and sometimes not so subtle!) errors that may get noticed long after the error has already occurred, and are therefore difficult to fix.

We cannot define in detail on which exact servers our back-end code is executed, no more than we can define which exact servers our everyday e-mails pass through. Rest assured, though, that the cloud service provider's business model completely relies on a strong privacy guarantee, and all data is transmitted over the network with the same level of encryption as used in secure mail and banking applications.

All persistent data such as user accounts, team files and spaces are stored in data centres within EU boundaries and according to GDPR regulations. Our service providers are ISO 27001 certified.

Web application

We provide a web application for performing most out-of-session activities such as managing team members, spaces and files. The web app runs client-side in a regular web browser, and it communicates with our cloud back end. We can also on request provide access to APIs that can do largely what the web app can, to enable integrations between Glue and your own business critical systems.

Native applications

For performance and standardization reasons, we still need to distribute a native application for end users. **Native** in this context means that there is an executable software that is specifically built and optimized for each supported platform or operating system. Currently we develop such applications for Windows and macOS desktop/VR workstations and laptops, and the Oculus Quest.

In the future this native application may become consumed entirely by our web app, but for the time being we still require a small software component to reside on the user device as it is the only way to ensure a smooth user experience.

We make sure that the native application is never a single point of failure: The application contains no data that is not also persisted on the back end. This way, all your team's files and spaces, even custom spaces built specifically for you, are always accessible.

On the other hand, all team specific data is loaded on-demand from the back end using secure transmission methods, so no sensitive information is packaged into the application distributable.

Because the native application is in constant communication with the back end and most of the data is dynamically fetched on demand, there is no offline mode. However, the bandwidth requirements are very low when video streaming features such as screen sharing are not used. A mobile 4G/LTE connection is completely sufficient for a smooth user experience.

For now, the native application should be considered just a virtual space browser, until web standards for immersive multi-user 3D and AR/VR stabilize and regular browsers catch up with what we are doing today.

Middleware

Between the cloud and the native application running on the end user's device, we have our proprietary middleware layer. When the user's application signals the service back end that the user is requesting access to a virtual space, the system spawns a session server dedicated for hosting all activity in that particular space and synchronizing the user interactions within that space between users.

While the service back end is responsible for persistent data associated with teams, spaces and files, the session servers manage the real-time data: The continuously updating positions and gestures of the users, their voice data, and the use of any in-session features such as drawing or manipulating of 3D objects.

The session server acts as a post office, accepting messages from individual end user applications, and broadcasting those messages to all other end user applications connected to the same virtual space. On the other hand, the session server is responsible for all the bookkeeping, recording the changes made within a space and storing them in the service back end.

We consider peer-to-peer networking too unreliable for hosting the sessions, as that would completely rely on the performance of the user devices and their network connections. By providing a dedicated server, we can guarantee that the virtual space itself is always available and never impaired by any user's low-performance device and/or poor network connection.

It is also a security consideration; we prefer to only allow for the server component to hold certain privileges and to communicate with the service back end. Client applications could always be hacked for malicious purposes but in Glue, the client applications are only allowed to communicate with a middleman. Also, as each session server manages exactly one virtual space, there is no chance for a hacked client being able to eavesdrop on the network messages of other virtual spaces.

The session servers are small and lightweight and are spawned strictly on-demand, so no extra costs are incurred by having a large amount of virtual spaces. Only when a virtual space is actually in use (when there is a user or users interacting in the space), is there a server process active. Once all participants have left the space and any changes have been persisted to the service back end, the session server process is terminated.

As these session servers are independent and manage exactly one virtual space at a time, we are able to allow for a wide variety of configuration options for them: You may leave the hosting of session

servers completely to us; alternatively, we may host static servers specifically dedicated for your team; or, we may install within your IT infrastructure the dedicated session servers which will only be used for hosting your team's virtual spaces and sessions.

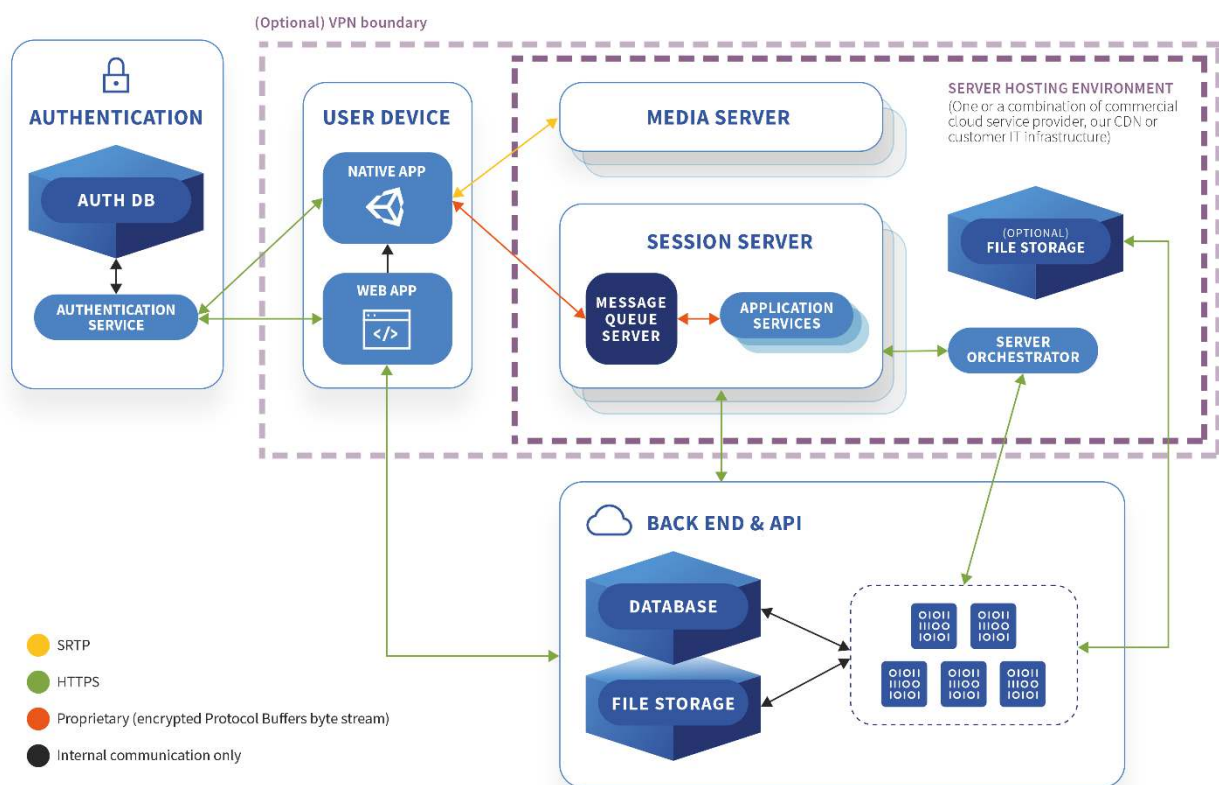
Physically the session server is not a single monolithic application but a collection of microservice-like components. In addition to the standard components, we can associate custom business logic components with specific virtual spaces, in which case such components will be automatically instantiated when a session server is spawned.



Security.

Since Glue is intended to host business critical information, we take security extremely seriously.

We do not store any critical information on our local servers, instead all files and databases are stored in secure cloud. All our APIs require authentication and sufficient user privileges. Users are authenticated for both the web application as well as the native applications. We do not store any password information in our databases, and all access tokens are temporary. Shared files and virtual spaces are only visible and accessible to Glue Team members. There are no plaintext URLs pointing to private assets that can be guessed or randomly accessed.



Communication protocols

All the out-of-session network traffic is handled with HTTPS messaging. For the real-time session network traffic, files are downloaded and uploaded with HTTPS but for VoIP, 3D transform and other similar small but frequent network event messages, we use our own Noise Protocol Framework cryptography implementation which we apply on a proprietary message format implemented on top of Google's Protocol Buffers.

IT policy considerations

We understand the inconvenience of introducing new applications in enterprise IT environments, but for the time being this is required to be able to enjoy the benefits Glue can provide. Your organization's IT department should make the necessary provisions to allow for the installation, execution, file and network access requested by the Glue application.

The native Glue application requires the following network locations to be whitelisted by the IT policy and allowed HTTPS communication through firewall:

- collab.glue.work
- auth.glue.work
- glue.eu.auth0.com
- *.s3-eu-west-1.amazonaws.com
- *.s3-eu-west-1-r-w.amazonaws.com
- *.eu-west-1-compute.amazonaws.com
- *.hel50.r.cloudfront.net

In addition to the above, for performance reasons we establish low-latency low-overhead TCP and UDP communication pipes between the native client application and the session server process.

The following domains must be whitelisted for TCP and UDP traffic:

- *.rt.collab.glue.work, ports 7780-7799






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