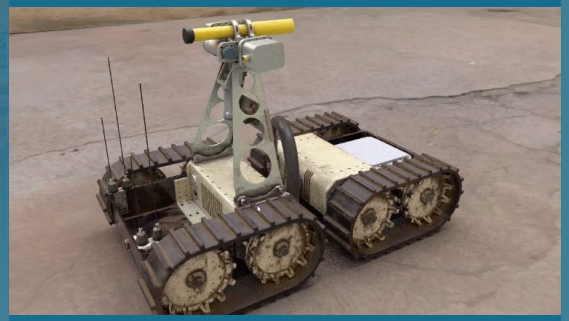
SAND2022-8003C

Sandia National Laboratories

Collaborative Augmented and Virtual Reality



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Collaborators: John Krukar, Zach Harris, Nick Ross, Emily Ahr, Jeff Glover, and Lauren Speer

U.S. DEPARTMENT OF ENERGY | NNSA National Nuclear Security Administration

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SAND2022-8003 C

Agenda

COLLABORATIVE AUGMENTED AND VIRTUAL REALITY (CARVR)

- Overview of CARVR
- Value Proposition and Strategy

TECHNICAL DEVELOPMENT

- Methodology and architecture
- Network data transmission

AR/VR SOFTWARE USING CARVR

- SEIS AR/VR | Virtual Reality Teleconference – April Suknot
- CAD2VR | Collaborative VR | Atomic Weapons Establishment – Matt Gallegos
- Collaborative Virtual Ecosystem – Kelsey Wilson

Collaborative Augmented and Virtual Reality (CARVR)

Overview of CARVR and it's impact on Sandia, our external partners, and several collaborative AR/VR projects

Collaborative AR/ VR (CARVR)

OBJECTIVE

- Provide cross-site networking for Augmented, Virtual, and Mixed Reality applications
- Real-time interaction with internal and external partners

TEAM FOR SUCCESS

- Collaborative development effort between orgs 9350, 2490 and 6530
- Importable plugin usable by any Sandia AR/VR Unity application

Enabling Collaborative VR Across Projects

WHY USE PLUGINS?

- Avoid duplicating effort within Sandia
- Individual projects with shared needs
- Minimize approvals and reviews

SUPPORT THE LABS & OUR PARTNERS

- Secure data transmission for both internal use or across sites
- Real-time communication for AR/VR Unity applications

Hitting The Mark

Environment

Deploy to a variety of environments

Run on a variety of different networks, and support all sensitivities

Security

Control the flow of network traffic

Ensure accessibility, authentication, and encryption is consistent

Extendibility

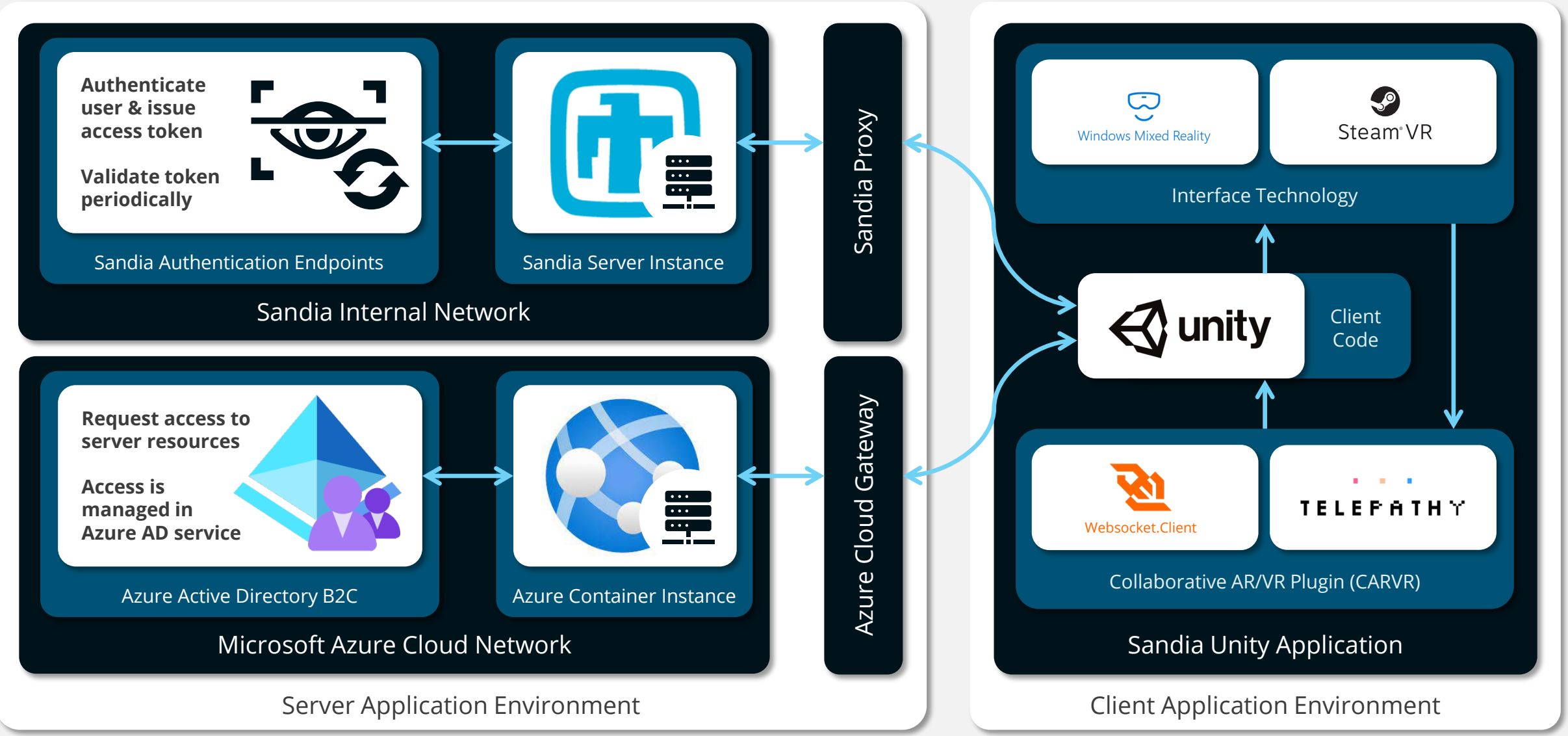
Develop an easily extended plugin

Develop reliable methods for extending or adding functionality

Technical Development

Discussion on our networking strategies, data transmission, and plugin mechanisms

Software and Network Flow Diagram



Data Transmission

EXAMPLE SCENARIO

- Player 1 connects to Player 2
- Clients confirm identities with a handshake

DATA SENT

- Identity information
- Spawned objects
- Player and object updates

Player 1 updates state by moving their left hand

Indiscriminate bytes are sent

01100001101101110101l0...010101101010

< 250ms

Player 2 parses the message and moves the object into position

Sample Packet Capture

SECURITY THROUGH OBSCURITY

We abstract data as much as possible in order to achieve security through obscurity – no matter the sensitivity of data displayed on the client, the data sent between clients is innocuous

Type	Unencrypted transmission
CONFIRM	**connectionId**: a6a2f88b-f919-4688-92d0-d3c51d1f64de, **roomId**: 9098
ID	**connectionId**: a6a2f88b-f919-4688-92d0-d3c51d1f64de, **roomId**: 9098
PING	**connectionId**: a6a2f88b-f919-4688-92d0-d3c51d1f64de, **roomId**: 9098, **startTime**: 2.553303, **serverTime**: 14.7926
PLAYER or OBJECT	**connectionId**: a6a2f88b-f919-4688-92d0-d3c51d1f64de, **roomId**: 9098, **timestamp**: 5.643406, **worldScale**: (1.0, 1.0, 1.0), **hmdPosition**: (0.0, 0.0, 0.0), **hmdRotation**: (0.0, 0.0, 0.0, 1.0), **leftHandPosition**: (0.0, 0.0, 0.0), **leftHandRotation**: (0.0, 0.0, 0.0, 1.0), **leftHandState**: 0, **rightHandPosition**: (0.0, 0.0, 0.0), **rightHandRotation**: (0.0, 0.0, 0.0, 1.0), **rightHandState**: 0
…	…

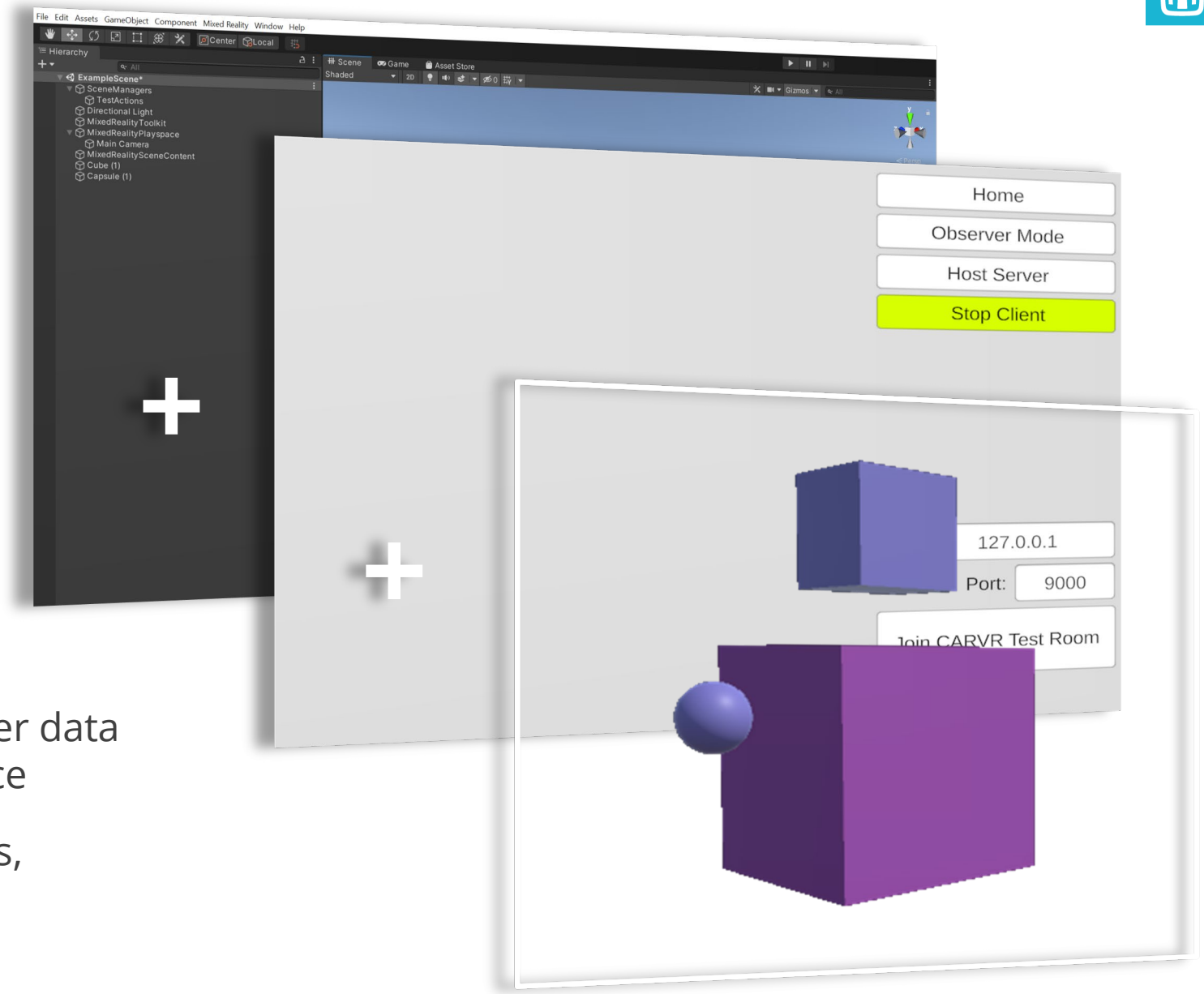
Plugin Mechanics

UNITY PLUGIN

- CARVR code and prefabs (e.g. models, animations, etc.) are imported dynamically in real-time
- Networking features may be imported to multiple projects

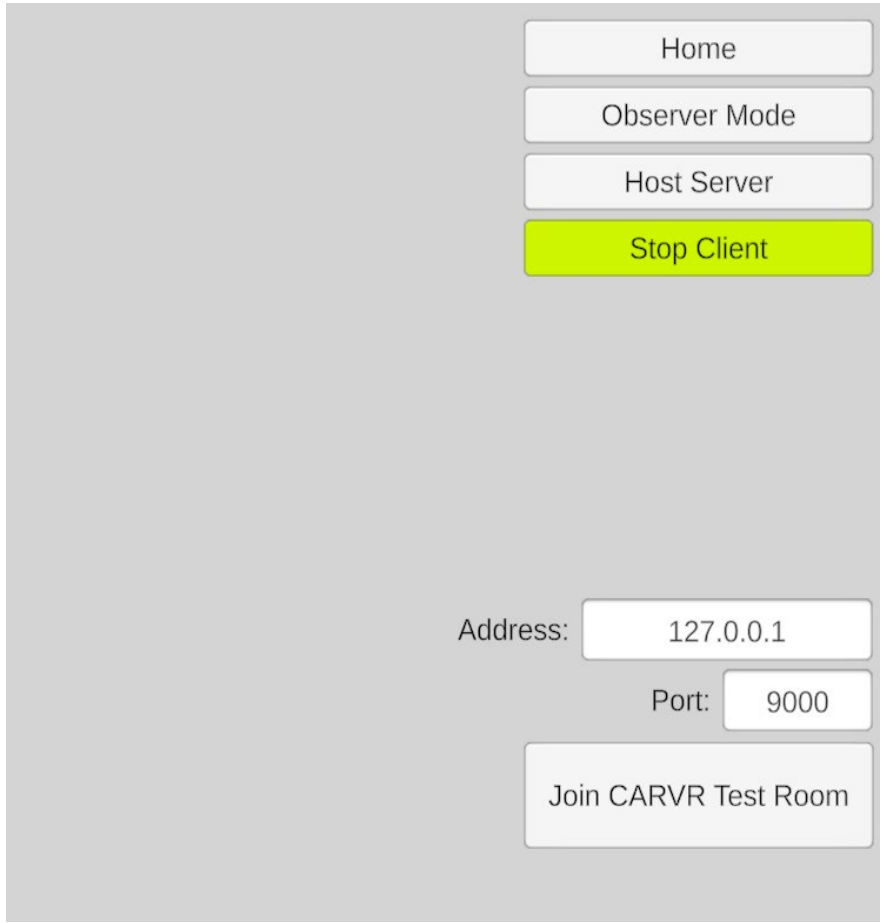
ASSURANCE

- Externally loading models and other data enhances security and performance
- Sensitive data, such as CAD models, cannot be stolen over the network

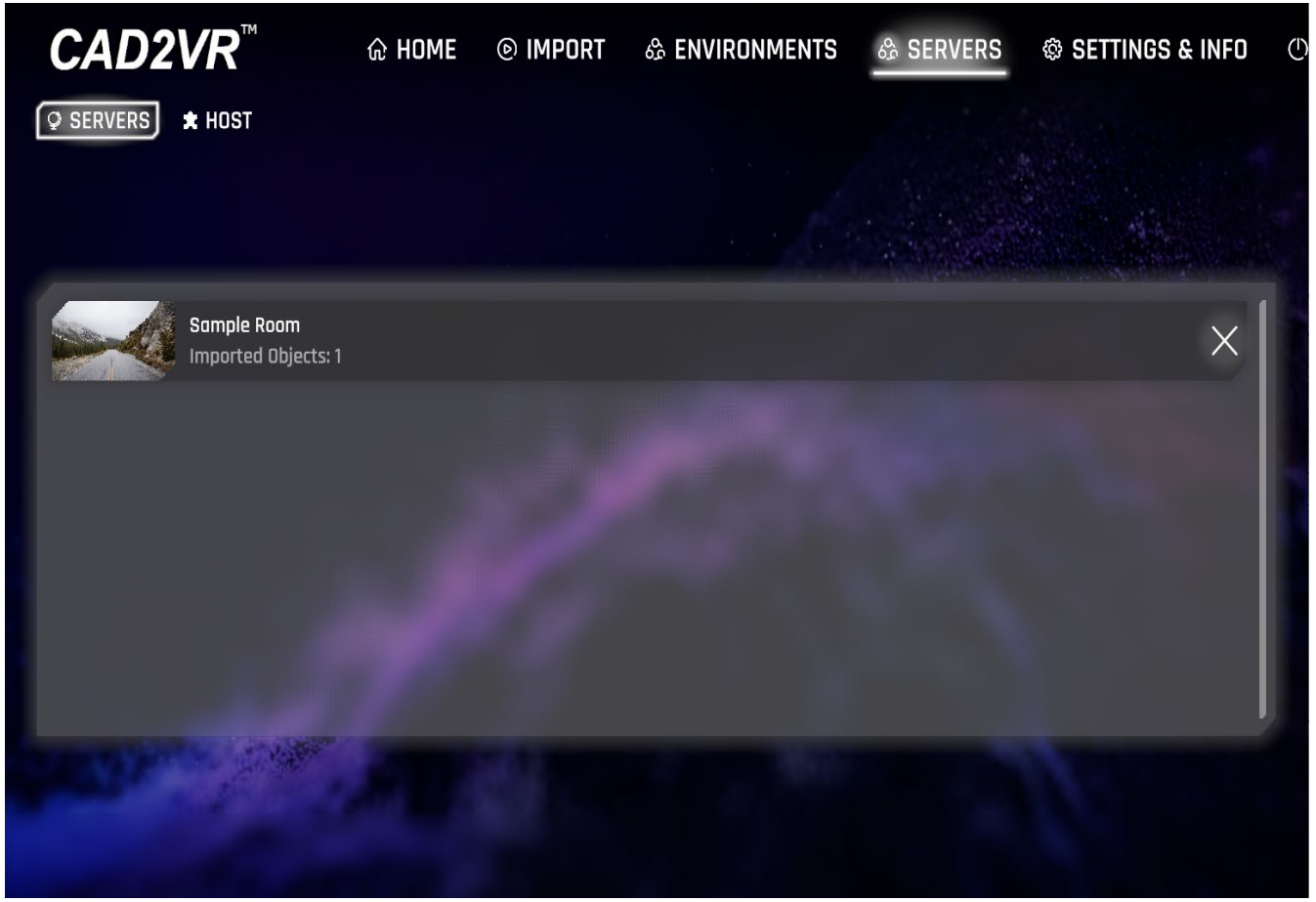


Plugin User Interface

INCLUDED MENU (CARVR)



CUSTOM MENU EXAMPLE (CAD2VR)



AR/VR Software Using CARVR

An overview of AR/VR Software leveraging CARVR to create networked experiences, and a look at our plans to expand the plugin's reach and capabilities

SEIS AR/ VR | Virtual Reality Teleconference

SAVR VRTC

- Customer-driven effort to increase communication while reducing travel between enterprise sites
- Multiple users can be in the same virtual environment and interact with the same virtual objects

PROOF OF CONCEPT

- Building proof-of-concept client-side application
- Integrating with SAVR Core Framework for UI, interactions, and data management

CAD2VR | Atomic Weapons Establishment

SANDIA | AWE

- Unclassified and classified demo of Collaborative VR Capability, using CAD2VR, between Sandia and the Atomic Weapons Establishment (AWE)

MOTIVATION

- Strengthen the partnership between Sandia and the AWE
- Use immersive Virtual Reality collaboration in CAD2VR
- Learn from each other and build better software and relationships in the process

Kansas City NSC | Collaborative Digital Ecosystem

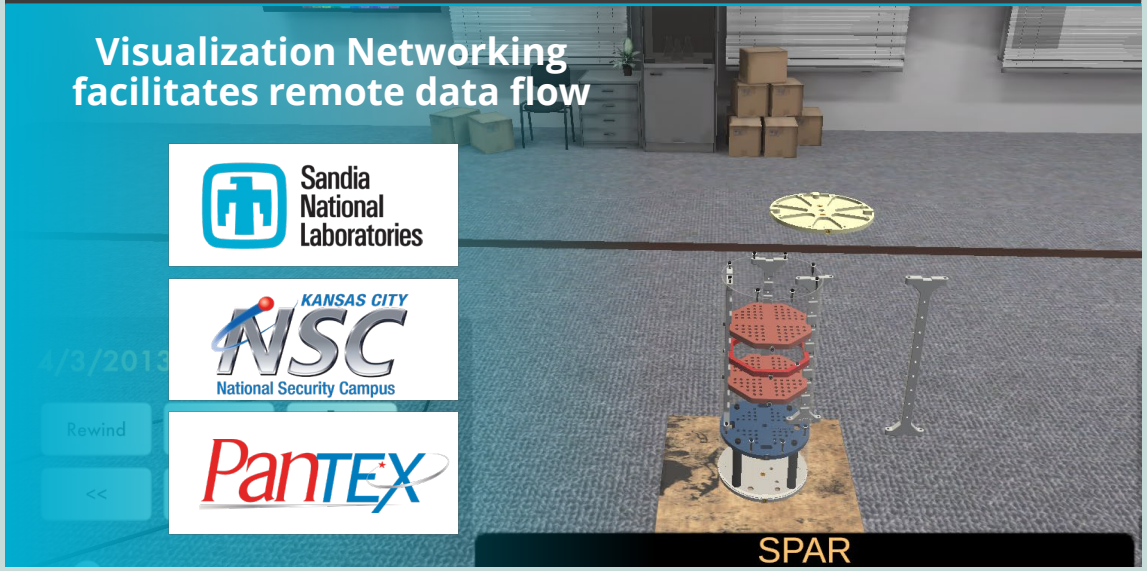
GRAPHICAL VISUAL DIGITAL ECOSYSTEM

t = FY23+

t = FY22–23

t = FY21–22

SINGLE COLLABORATIVE VIRTUAL ENVIRONMENT



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Timeline

FY21

PATH FORWARD

Research and develop connection solutions using secure network protocols

Define network strategies, begin requesting approvals, and deploy tests locally

FY22

UNCLASSIFIED CAPABILITY

Stand up unclassified connections for internal and external partners

Create an external Azure server for international connections, research internal solution for enterprise partners

CLASSIFIED CAPABILITY

Provide classified networking strategy for most sites

Support classified connections, investigate and fix proxy issues with Azure server

FY23+

FUTURE PARTNERSHIPS

Find other partners interested in integrating CARVR

Find new applications for CARVR and integrate with other groups interested in using the plugin

How To Get Involved

PREREQUISITES

- Unity 2019 or greater
- Utilize Mixed Reality Toolkit or SteamVR
- Get in touch with our team

ENCOURAGE PLUGIN DEVELOPMENT

- Do you have a project that might help other groups if it was made into a plugin?
- Plugins are easy to make and import at runtime
- Make your app plugin-ready to take advantage of new and exciting developments from the XR community

Thank You!

We’d like to thank all of our partners within Sandia, Pantex, Kansas City NSC, and the AWE, for their continued support and enthusiasm for this project