Genba SaVR: A Secure and Scalable Virtual Reality Platform for Industrial Training

Abstract

Genba SaVR is a secure, scalable VR platform for immersive industrial training. Unlike monolithic XR systems, it uses Kubernetes-orchestrated microservices for modular deployment, dynamic scaling, and high availability. MageAI pipelines personalize training by adapting content in real time based on user input. Integrated security mechanisms, such as spanning authentication, session management, and DevSecOps tools, safeguard user data and infrastructure. WebRTC enables low-latency communication (~17 ms), while usability studies show strong user engagement and support for collaborative scenarios.

Adaptive Learning

To enhance training effectiveness, Genba SaVR uses MageAI pipelines to collect user input and dynamically adapt learning content based on performance and engagement. As shown in Figure 2, real-time data from VR interactions is processed through configurable pipelines that generate personalized feedback integrated directly into the training scenario.

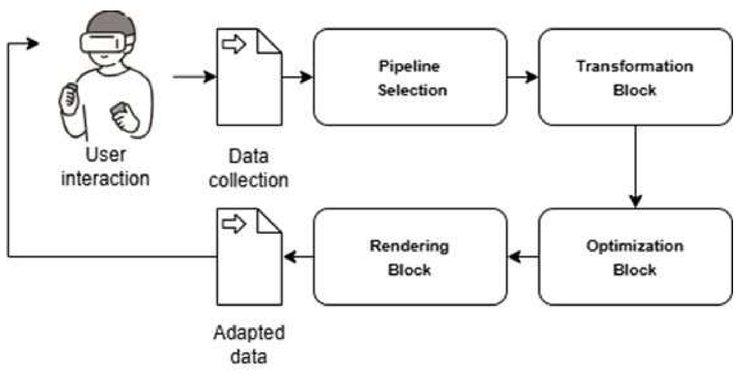

Figure 2. Adaptive learning in Genba SaVR using MageAI for real-time content personalization.

Figure 3. Multi-user collaboration during virtual line inspection.

Introduction

Genba SaVR is a secure and scalable VR platform designed for industrial training. It addresses the limitations of monolithic XR systems by adopting a microservices architecture with containerized services, enabling modular deployment and high availability.

The platform integrates real-time collaboration, adaptive learning with MageAI, and built-in security mechanisms to enhance training effectiveness and system reliability. Figure 3 shows a scenario for such collaboration.

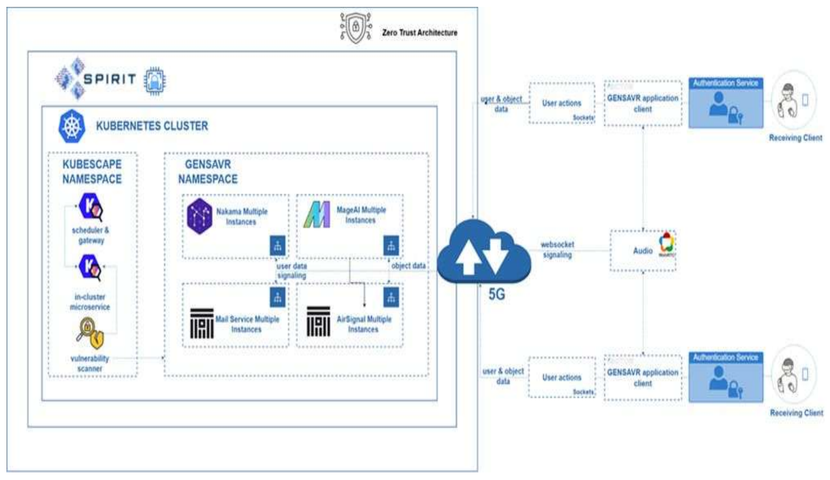

Figure 1. Genba SaVR architecture with microservices, Kubernetes, and core platform components.

Security Implementation

Security is embedded across all layers of Genba SaVR through a combination of:

- Multi-layered authentication (credentials, device validation, session tokens)
- Secure session management via Nakama
- DevSecOps practices integrating Kubescape and ARMO for continuous vulnerability scanning and compliance monitoring

These mechanisms protect user data and system integrity without compromising performance, supporting secure deployment in production training environments.

System Architecture

Genba SaVR is built on a modular microservices architecture, enabling scalable and resilient deployment of VR training environments as presented in Figure 1. Core functionalities are split into containerized services managed by Kubernetes, allowing automated scaling, high availability, and fault isolation.

Key components include:

- Nakama for user authentication and session handling.
- WebSocket/WebRTC for real-time audio, video, and data exchange.
- MageAI pipelines for adaptive learning.
- Kubescape and ARMO for continuous security monitoring and compliance.

Evaluation & Results

Genba SaVR achieved an average latency of ~17 ms using WebRTC, improving real-time responsiveness by over 60% compared to baseline tests, as presented in Figure 4.

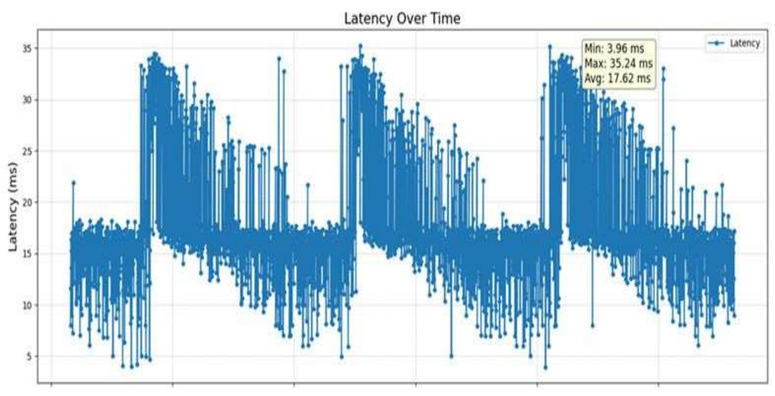

Figure 4. WebRTC latency with Genba SaVR on the SPIRIT platform.

Future developments

Future work will focus on extending the Zero Trust model with OpenZiti by integrating device trust, continuous session validation, and dynamic policy enforcement.

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Contact

Gabriel Danciu
Transilvania University of Brașov
eMail:gabriel.danciu@unitbv.ro
LinkedIn: gabriel-danciu-560b7439

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