STRUCTURED ABSTRACT

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Enhancing XR Platform Performance, Security, and Scalability with a Microservices Architecture

CONTEXT

Nowadays, thanks to virtual and augmented reality, industrial environments are continuously digitalized via training platforms, which have become essential tools for an efficient, secure, and scalable professional development and evolution. Recent advancements related to digital twin, artificial intelligence, and real-time communications (WebRTC) have made it possible to transform these solutions into a revolutionary alternative to traditional training methods, particularly in branches like production and manufacturing, where security, performance, and adaptability hold high priority. In this context, an extended reality (XR) platform was designed, implemented, and tested ensuring performance, security and scalability through a systematic backend optimization.

PURPOSE OR GOAL

The purpose of this work is to provide a functional scalable and secure XR platform that integrates an architecture based on microservices and ensure low-latency and real-time immersive interactions. Cutting-edge technologies are an advantage in this context (e.g., 5G connectivity, containerizations, data pipelines, or WebRTC). Moreover, security components contribute essentially to the platform transforming it into a next-generation application.

APPROACH

The XR platform is designed to integrate a selection of cutting-edge technologies: (1) Nakama for secure authentication, (2) MageAI pipelines for effective data processing, (3) WebSocket-based communication to get real-time interactivity, and (4) Kubernetes for containers orchestration and microservices load balancing. Moreover, the designed platform follows to integrate a distributed microservices architecture satisfying the low-latency interactions over the 5G networks.

ACTUAL OR ANTICIPATED OUTCOMES

This work includes several key outcomes implemented and tested, demonstrating that the platform provides good training and learning outcomes. Besides the completed key outcomes, the following could be enumerated: (i) Personalized microservices for resetting passwords with secure token verification via e-mail; (ii) Dynamic data pipelines based on MageAI for contextual transformations over the objects and based on the user input; (iii) Extended WebRTC capabilities through a personalized ICE server; (iv) Complete Nakama integration into the VR application; (v) Performance optimizations related to frame rates, adjusting transform synchronization and interaction responsiveness for both VR and desktop users; (vi) Performance evaluations to identify latency and stress levels; (vii) Security assessments and continuous monitoring using Kubescape and the ARMO Dashboard.

CONCLUSIONS/RECOMMENDATIONS/SUMMARY

The XR platform was designed to meet technical and user-oriented requirements in the context of advancing field of immersive digital experiences and technologies. Analysing the XR platform's design and architecture, it can be demonstrated the high scalability obtained from containerized deployments, load balancing, or resilient mechanisms. Security components were embedded at multiple stages, assuring a balance between usability and security, and enabling real-time user engagements while maintaining a strong security framework.

KEYWORDS

Extended Reality (XR), Scalability, Security.