

# LoomaXR: A Multi-User Platform for Performing Arts Co-Creation, Streaming and Interaction

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Figure 1: Use Cases of Remote Co-creation and Rehearsal (Left Images) and Live XR-Enhanced Performance (Right Image).

## Abstract

Performing arts are increasingly exploring digital technologies to support artistic creation, rehearsal, and dissemination. However, existing solutions are often fragmented, limiting real-time collaboration across distributed performers and audiences. We present LoomaXR, a novel multi-user platform designed for remote co-creation, rehearsal, and live streaming of performing arts. Our integrated system supports real-time synchronization of multiple performers, combining multimodal capture properties (motion, face, audio, lighting), and an interactive scene editing tool. Performances can be streamed live to remote audiences via VR headsets or browsers, while metadata and assets are stored in a Content Management System for archiving and reuse. We used LoomaXR

in PREMIERE [11] project through two representative use cases: (i) live XR-enhanced performance, and (ii) remote co-creation and rehearsal. These pilots highlight the platform's potential to expand creative collaboration, enrich audience experience, and open new avenues for education, preservation, and cultural exchange.

## CCS Concepts

• **Computing methodologies** → **Virtual reality; Motion capture; Animation; Rendering;** • **Applied computing** → **Performing arts.**

## Keywords

Virtual Reality, Performing Arts, Real-time Collaboration, Motion Capture, Immersive Streaming, XR

## ACM Reference Format:

Mercè Álvarez de la Campa, Kalli Koulloufidou, Fotos Frangoudes, Chrysostomos Chadjiminis, Ismail Hadjri, Theodoros Kyriakou, Alex Baldwin, Kleanthis Neokleous, and Panayiotis Charalambous. 2025. LoomaXR: A Multi-User Platform for Performing Arts Co-Creation, Streaming and Interaction. In *Proceedings of ACM SIGGRAPH Conference on Motion, Interaction and Games (MIG '25)*. ACM, New York, NY, USA, 3 pages. <https://doi.org/XXXX.XXXX>

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MIG '25, Zurich, Switzerland

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ACM ISBN 978-x-xxxx-xxxx-x/YYYY/MM  
<https://doi.org/XXXX.XXXX>

## 1 Introduction

Digital technologies are transforming the performing arts, but existing solutions remain fragmented, lacking support for real-time collaboration and immersive streaming across multiple locations. To address this, we present LoomaXR, a unified platform designed for remote co-creation, rehearsal, and live performance.

Built on Unreal Engine and Epic Online Services, our system integrates multimodal performance capture (motion, face, audio, lighting) with synchronous collaboration and immersive delivery to VR headsets and web browsers. LoomaXR supports the entire performance lifecycle through an embedded 3D Scene Editing Tool and a Content Management System for asset management and archival. This paper summarizes the platform's architecture and two distinct use cases that validate its capabilities: a live XR-enhanced dance performance and a remote co-creation and rehearsal.

## 2 Related Work

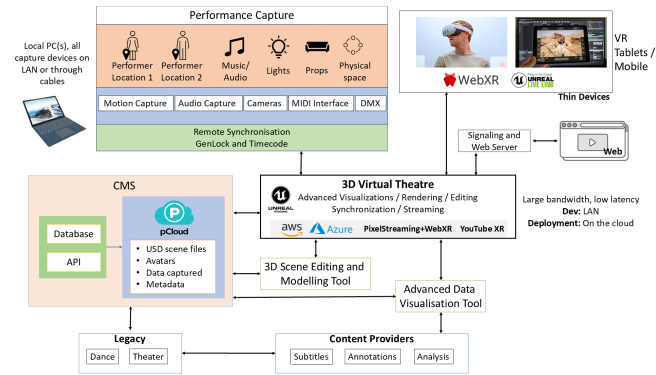
Research on shared virtual environments has produced several platforms enabling multi-user interaction and collaboration. A prominent example is Ubiq, an open-source platform providing real-time communication for shared VR/AR experiences [9]. While Ubiq demonstrates flexible networking for distributed collaboration, its focus is on general-purpose XR rather than the domain-specific workflows of the performing arts.

Other frameworks for networked virtual worlds, such as OpenSimulator [1], Mozilla Hubs [8], or VRChat [4], offer large-scale shared spaces but often lack the deep integration of multimodal performance capture and interactive editing required in artistic contexts. Closer to our domain, previous work has explored collaborative XR for remote performing arts education [5], showing the potential of immersive environments for teaching and rehearsal. LoomaXR builds on these foundations by creating an integrated ecosystem tailored specifically for the co-creation, rehearsal, and dissemination lifecycle in the performing arts.

## 3 System Architecture

The LoomaXR platform, implemented in Unreal Engine 5, connects distributed clients via a client-server architecture managed via Epic Online Services (EOS) [2]. As illustrated in Figure 2, the 3D Virtual Theater is the hub integrating several key layers: (1) *Performance Capture*, where local data (motion, facial, audio, lighting) are captured with devices such as Xsens, Rokoko, Meta Quest Pro and through DMX / OSC protocols. These streams are processed locally and transmitted for synchronization; (2) *Networking and Synchronization*, where a Live Sync Server ensures a consistent virtual state for all participants. Synchronization occurs at three levels: (a) local device sync at each stage, (b) global sync across remote performers, and (c) streamed sync for audiences; (3) *3D Scene Editing Tool* which allows artists to create and manipulate virtual environments, including props, lights, and cameras, in real time for collaborative stage design; (4) *Advanced Visualization Tool* to project into the environment analytical data like motion qualities or sentiment cues, allowing creators to reflect on performance data during live sessions; (5) *Streaming*, which supports delivery to VR clients and web browsers using technologies like Pixel Streaming (WebRTC) [3] or YouTube; and a (6) *Content Management System (CMS)* for asset

management, metadata and archiving sessions via GraphQL APIs, ensuring reproducibility and preservation.



**Figure 2: High-level architecture of the LoomaXR platform, showing the main data flow from performance capture to audience delivery via the 3D Virtual Theatre hub.**

## 4 Use Cases

The platform has been validated through several pilots. We highlight two representative cases, illustrated in Figure 1:

*Live XR-Enhanced Performance.* We collaborated with the Stocos dance company [7] on their piece "Re-Embodied Machine" [6], capturing and synchronizing a dancer's full-body motion with interactive laser system data (via OSC). LoomaXR rendered the performance, including a realistic avatar and virtual lights, and streamed the composite result live to a remote audience, validating our high-fidelity multimodal capture and delivery pipeline.

*Remote Co-creation and Rehearsal.* We enabled a remote rehearsal of the play "Three Tall Women" [10] with three actors in different locations. Each actor wore motion and facial capture devices, performing together as real-time avatars in a shared virtual set designed with the integrated 3D Scene Editing Tool. A director joined remotely to provide feedback, demonstrating the effectiveness of the platform for synchronous multi-user artistic collaboration.

## 5 Conclusion and Future Work

LoomaXR is a unified, multi-user platform for the performing arts that integrates real-time capture, XR streaming, and a 3D editing environment. Build on the operational instance developed in the PREMIERE project and now moves toward a more scalable, robust, and interoperable architecture suitable for larger audiences and demanding artistic workflows. Upcoming features will incorporate AI-driven analysis and co-creation tools to support intelligent content generation for future projects.

## Acknowledgments

This project has received funding from the European Commission's Horizon Europe program under grant agreement No 101061303 and 10192889; the European Union's Horizon 2020 Research and Innovation Programme under Grant Agreement No 739578 and the Government of the Republic of Cyprus through the Deputy Ministry of Research, Innovation and Digital Policy.

## References

- [1] Nicolas Ducheneaut and Robert J. Moore. 2010. The Social Side of Gaming: A Study of Interaction Patterns in a Massively Multiplayer Online Game. In *Proceedings of the 2010 ACM Conference on Computer Supported Cooperative Work (CSCW '10)*. Association for Computing Machinery, New York, NY, USA, 223–232. doi:10.1145/1718918.1718957
- [2] Epic Games. 2024. Networking Overview for Unreal Engine. <https://dev.epicgames.com/documentation/en-us/unreal-engine/networking-overview-for-unreal-engine>. Accessed: 2025-10-09.
- [3] Epic Games. 2025. Hosting and Networking Guide for Pixel Streaming in Unreal Engine. <https://dev.epicgames.com/documentation/en-us/unreal-engine/hosting-and-networking-guide-for-pixel-streaming-in-unreal-engine>. Accessed: 2025-10-09.
- [4] Guo Freeman, Shaowen Bardzell, and Jeffrey Bardzell. 2020. Designing for Social VR: Lessons from VRChat. *Proceedings of the ACM on Human-Computer Interaction (CSCW)* 4, CSCW2 (2020), 1–28. doi:10.1145/3415185
- [5] Kriti Gupta, Soumyajit Banerjee, and Greg Welch. 2019. Collaborative Mixed Reality for Remote Performing Arts Education. In *Proceedings of the 2019 IEEE Conference on Virtual Reality and 3D User Interfaces (VR)*. IEEE, 1274–1275. doi:10.1109/VR.2019.8798211
- [6] Instituto Stocos. 2025. Re-Embodied Machine. <https://www.stocos.com/page/embodied-machine-2/>. Accessed: 2025-10-09.
- [7] Instituto Stocos. 2025. Stocos Institute | Art, Technology, Body and Cognition. <https://www.stocos.com/>. Accessed: 2025-10-09.
- [8] Blair MacIntyre and Derek Hamilton. 2021. Mozilla Hubs: Lightweight, Accessible, and Social Virtual Reality Spaces. In *Proceedings of the 2021 IEEE International Symposium on Mixed and Augmented Reality Adjunct (ISMAR-Adjunct)*. IEEE, 1–4. doi:10.1109/ISMAR-Adjunct54149.2021.00010
- [9] Anthony Steed, Sebastian Friston, and Ye Pan. 2022. Ubiq: A Platform for Networked Social Mixed Reality. In *Proceedings of the 28th ACM Symposium on Virtual Reality Software and Technology (VRST '22)*. Association for Computing Machinery, New York, NY, USA, 1–2. doi:10.1145/3562939.3565623
- [10] The Edward Albee Society. 2025. Three Tall Women. <https://edwardalbeesociety.org/works/three-tall-women/>. Accessed: 2025-10-09.
- [11] The PREMIERE Project. 2025. PREMIERE - Performing arts in a new era. <https://premiere-project.eu/>. Accessed: 2025-10-09.