A toolset for hyper-realistic and XR-based human-human and human-machine interactions, PRESENCE

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D5.1 Integration and Demonstration I - Initial definition and planning

DISSEMINATION LEVEL

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[1] Due to a partial takeover, beneficiary nº 11 Unity Technologies was replaced by Capgemini. The edition of this deliverable was initially carried by UNITY and completed by Capgemini as foreseen in the Grant Agreement [Ref. 1]

CHANGE HISTORY

VERSION	DATE	PARTNERS	DESCRIPTION/COMMENTS
V0.1	16-05-2024	All	First iteration of the document expected by all partners.
V0.2	29-05-2024	All	Second iteration of the document expected by all partners.
V0.3	12-06-2024	All	Third iteration of the document expected by all partners following IMEC first review
V1.0	20-08-2024	Capgemini, i2CAT	Consolidated version based on the review. Final formatting, cross references, submission to the EC through the Participant Portal

Executive summary

The primary aim of Work Package (WP) 5 is to develop and validate two demonstrators that highlight the technological advancements achieved in WP2 (Holoportation), WP3 (Haptics), and WP4 (Intelligent Virtual Humans). These advancements will be demonstrated through four distinct use cases: (i) Professional Collaboration, (ii) Manufacturing, (iii) Health (Pain Relief), and (iv) Cultural Heritage. The validation will be done by showing higher usability and acceptance rates in studies and interviews conducted for all sectors targeted in the use cases.

Deliverable D5.1 provides a comprehensive outline of the goals, objectives, KPIs, and timelines. It also includes detailed descriptions and deployment diagrams of the four use cases, emphasizing the integration and development plan crucial for creating the two demonstrators.

Table of contents

List of Tables

List of Figures

1. Introduction

1.1. Purpose of the Document

The aim of Deliverable 5.1 is to present a detailed overview of the objectives and tasks outlined in Work Package 5 (WP5). This document serves as a roadmap, guiding the efforts to integrate and demonstrate the technological advancements made in previous work packages—namely WP2 (Holoportation), WP3 (Haptics), and WP4 (Intelligent Virtual Humans). The integration and demonstration efforts focus on real-world applications, illustrated through four specific use cases. Ultimately, WP5 seeks to validate these technological advancements in two demonstrators, targeting both professional and social XR applications, thereby highlighting the practical capabilities and benefits of the PRESENCE project.

1.2. Scope of this Document

This document aims to fulfil Milestone 2 by delivering Integration & Demonstration - Initial Planning & Definition. It provides a comprehensive overview of the objectives and tasks within Work Package 5 (WP5), detailing the processes, use cases, and evaluations planned. By outlining these elements, the document sets the groundwork for integrating and demonstrating the technological advancements achieved in the previous work packages, thereby ensuring a structured approach towards achieving the project goals.

1.3. Status of this Document

This document is in progress and is being developed to meet Milestone 2. It reflects the ongoing efforts to compile, integrate, and plan the technological advancements and demonstrations within the PRESENCE project, ensuring alignment with the overall project goals and timelines.

1.4. Relation with other activities in the Presence Project

This document synthesizes the contributions from WP1, WP2, WP3, and WP4, which serve as foundational inputs for WP5. Each work package plays a critical role in developing different technological components—Holoportation (WP2), Haptics (WP3), and Intelligent Virtual Humans (WP4). These components are integrated within WP5 to create two demonstrators. WP1 provides the experimental protocols and requirements necessary to guide this integration and ensure that the demonstrations are aligned with the overall project objectives

2. Work Package 5

2.1. Objectives of Work Package 5

The primary objectives of Work Package 5 (WP5) are:

1. **Provide APIs for Integration**: Develop a set of APIs to enable seamless integration of the technological components—Holoportation (WP2), Haptics (WP3), and Intelligent Virtual Humans (WP4)—into external Extended Reality (XR) applications, specifically focusing on the two project demonstrators.

2. **Define, Implement, and Validate Demonstrators**: Outline, create, and evaluate two demonstrators that integrate the technological components. These demonstrators will facilitate comprehensive validation and assessment of the PRESENCE solutions from an end-user perspective.

3. **Enable Integration and Collaboration**: Align with the other work packages to enhance collaboration among partners, streamline the integration of technologies, define and generate APIs, and finalize integration within applications used for user experience tests and demonstrations.

4. **Enhance UX Design and Best Practices**: Offer design oversight, technical support, and best practices to ensure consistent design, interoperability, performance, and accessibility across the integrated technologies. This includes conducting usability and presence evaluation tests.

5. **Execute Demonstrators**: Efficiently execute two demonstrators—one for professional XR setups focusing on collaboration and manufacturing training, and another for social XR setups emphasizing health and cultural heritage. The demonstrators will be developed through a phased approach, from initial planning to final integration and delivery.

Overall, WP5 plays a crucial role in integrating and demonstrating the technological advancements developed within the PRESENCE project, with the ultimate aim of advancing XR technology and enhancing user experiences in various domains.

2.2. Overview of Work Package 5

Work Package 5 (WP5) spans from Month 4 (M04) to Month 36 (M36), is structured around three key milestones as outlined below and contains deliveries at Milestones 1 (M06), 4 (M18) and 7 (M36) as also visualized in Figure 1.

MS1 (M07): Deliverable 5.1 - Integration & Demonstration I - Initial Definition and Planning

MS4 (M18): Deliverable 5.2 - Integration & Demonstration II - Intermediate Integration, Testing & Validation

MS7 (M36): Deliverable 5.3 - Integration & Demonstration - Final Integration, Testing & Validation

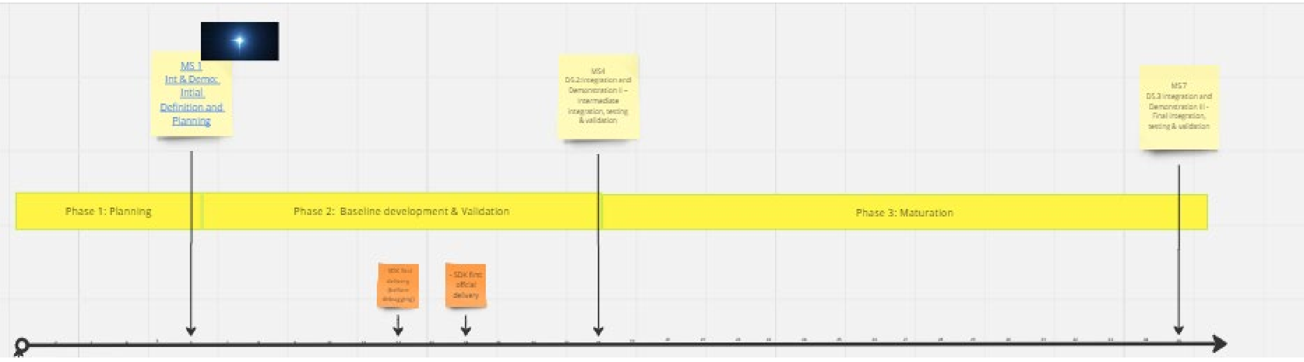


Figure 1: WP5 timeline

The main purpose of WP5 is to integrate and demonstrate the technological advancements made in WP2 (Holoportation), WP3 (Haptics), and WP4 (Intelligent Virtual Humans) through two demonstrators. These demonstrators will focus on both professional and social services, encompassing four use cases:

- **Professional Services:**
  - Collaboration
  - Manufacturing
- **Social Services:**
  - Health (Pain Relief)
  - Cultural Heritage

WP5 is intrinsically dependent on the outputs from WP2, WP3, and WP4, as illustrated by the workflow and dependencies diagram Figure 2:

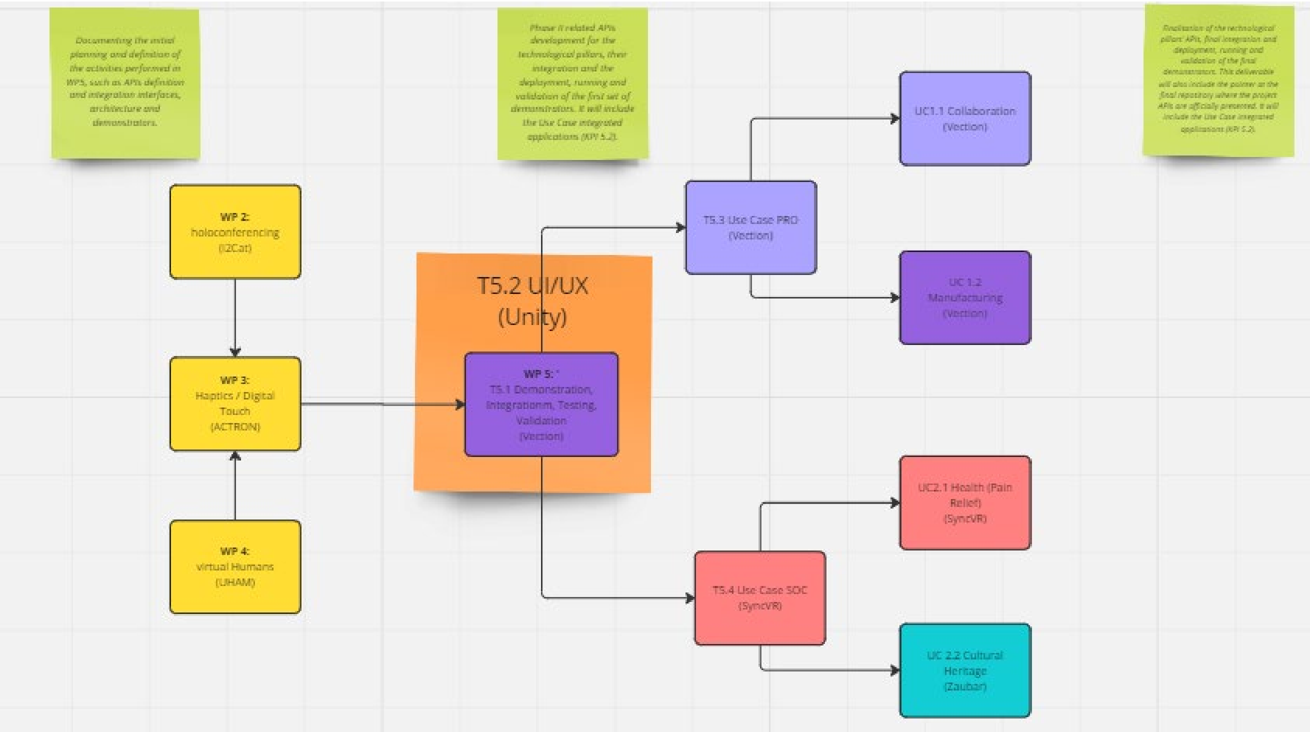


Figure 2: WP Flow and Dependencies

2.3. Tasks & Key Performance Indicators (KPI) in Work Package 5

WP 5 has 4 tasks, which are elaborated on in Section 4.1 , and three KPIs that need to be fulfilled by the end of the project as shown in Table 1:

Table 1: WP5 KPIs

KPI 5.1	Define how the three technologies integrate with each other, and how they can work standalone or in additional scenarios, beyond PRESENCE, delivering the three (3) integration APIs (WP5 - T5.1, T5.2, D5.3)
KPI 5.2	Integrate and demonstrate the pillars in two (2) demonstrators, divided into four (4) Use Cases at a TRL ≥ 5 (WP5 - D5.2, D5.3).
KPI 5.3	Show higher acceptance and usability rates (≥ 20%) in studies and interviews on ≥ four (4) different sectors. This is further defined in D1.1 Methodology & Planning and T1.3 where the studies will be executed.

3. Methodology

3.1. Overview

To effectively integrate and demonstrate the various technological advancements developed in the PRESENCE project, we plan for a process that ensures thorough testing, validation, and refinement. Each work package has their preferred way of working and provides the deliverable (SDK) for the integration. The Integration plan is detailed later in Section 6.

3.2. Approach for Integration and Demonstration

At present we have a “Technical Committee Meeting” recursively with Technical Manager and WP leads. To guarantee agility and a good operative level, the TC Meeting occurs remotely.

Also it is planned to organise an additional meetings for partner collaboration, to monitor i) the integration of the technologies developed within each technological pillar (WP2, WP3, WP4), facilitating the CI/CD (Continuous Integration and Continuous Delivery) practices for the alignments of the inputs and the outputs of each component; ii) the definition and generation of the technological pillars APIs, for a transparent and flexible integration between technologies and final XR applications and iii) the final integration within the applications that will be used for user experiences tests (WP1) and for the demonstrators (T5.3 and T5.4). This process will be aligned with the three project phases in an iterative way.

4. Work Package 5 Activities

4.1. Overview of Work Package 5 tasks

WP5 consists of 4 concrete tasks:

4.1.1. Task 5.1 APIs for Technology Development

Focuses on creating APIs for the technology developed in previous work packages (WP2, WP3, and WP4). These APIs will help integrate the technology into various applications for testing and demonstration purposes. The task also involves defining how these technologies will work together and designing the software architecture needed for implementation. By using the regular alignment meetings this will be achieved.

4.1.2. Task 5.2 UI/UX

Focuses on improving user experience and design for interactive Extended Reality (XR) environments. Capgemini leads this task, with support from other project contributors. The goal is to enhance the integration of three key technologies: Holoportation, Haptics, and Virtual Humans, developed in previous work packages. Capgemini will provide guidance, best practices, and technical support to ensure a seamless execution of Task 5.2. This includes ensuring that the technology can be applied to a wide range of XR use cases beyond the initial demonstrations. Additionally, the task aims to maintain a consistent design across the three technologies, ensuring cohesive user interfaces and experiences. As part of Task 5.2, a template project will be created, allowing demonstrators to build upon and share their work with the wider developer community. This template will focus on enhancing interoperability, performance, and accessibility. Furthermore, usability, user experience, and presence evaluation tests can be conducted using the template project and samples provided.

4.1.3. Task 5.3 XR for Professional XR Activities

Focuses on creating immersive XR environments for professional collaboration and manufacturing training. VECTION leads this task, with support from other project contributors. The goal is to efficiently execute Demonstrator 1 for XR Professional Setups, following the guidelines and achievements of previous technology development work packages. This task aligns its activities with the experimental protocol T1.4 and is divided into two use cases: Use Case 1.1 focuses on collaborative environments, while Use Case 1.2 centers on manufacturing industry training scenarios. The implementation of this task follows a phased approach, including initial planning and definition, baseline development and validation, and final maturation stages.

4.1.4. Task 5.4 XR for Social & Cultural XR Activities

Focuses on developing XR environments for social and cultural activities related to health and cultural heritage. SVR leads this task, with support from other project contributors. Following the guidelines and technology developed in previous work packages (WP2, WP3, WP4), this task ensures the efficient execution of Demonstrator 2 for XR Social Setups. The goal is to create two scenarios outside the professional corporate sphere: Use Case 2.1 focuses on developing an XR application for the health domain, specifically demonstrating immersive technologies in a pain relief scenario.

Use Case 2.2 covers the cultural heritage domain, integrating technological pillars into a touristic cultural experience. Similar to Task 5.3, the implementation of this task follows three phases: initial planning and definition, integration of technological pillars, and final delivery. Activities are aligned with the experimental protocol (WP1), focusing on validating and evaluating the PRESENCE technology, with particular attention to integration-related parameters.

For all use cases a specific hardware and software evaluation will be conducted on the integrated technologies to assess parameters relevant for the integration process, such as level of detail, API/SDK definition and documentation quality, computational resource usage, frame rate, robustness, security, and module interconnection. The activities will be aligned to the experiment planning and protocol developed within WP5.

4.1.5. API Definition and Integration Interfaces

Since no external APIs are planned to be used (beside the 3 pillars SDKs), the focus will be on defining the internal APIs between the different SDKs and the local application.

This will involve specifying the data formats and protocols used for communication between the components.

Target Platforms
• Windows Desktop using a VR head-mounted display (Meta Quest 3)
System Components:
• Intelligent Virtual Humans SDK: Manages Intelligent Virtual Agents (IVAs) that can move and interact with players.
• Holoconferencing SDK: Creates realistic avatars from live camera feeds for realistic interactions.
• Photon: Networking solution for multiplayer capabilities.
• Unity: Client Application

API Definitions

Haptics SDK API

Category	Function	Description
Initialization	void InitializeHaptics()	Initialize the Haptics SDK.
Configuration	void ConfigureGlove(string gloveID, GloveSettings settings)	Configure the glove with specified settings
	void ConfigureVest(string vestID, VestSettings settings)	Configure the vest with specified settings
Interaction	void TriggerHapticFeedback(string deviceID, FeedbackPattern pattern)	Trigger haptic feedback on a device
	bool IsDeviceConnected(string deviceID)	Check if a device is connected.
	void OnPlayerTouch(string toucherID, string touchedID)	Handle player touch interaction

Intelligent Virtual Humans SDK API

Category	Function	Description
Initialization	void InitializeIVH()	Initialize the Intelligent Virtual Humans SDK
Configuration	void ConfigureAgent(string agentID, AgentSettings settings)	Configure an agent with specified settings
Interaction	void MoveAgent(string agentID, Vector3 position)	Move an agent to a specified position
	void InteractWithObject(string agentID, string objectID)	Make an agent interact with an object

Category	Function	Description
	void OnAgentInteract(string agentID, string objectID)	Handle agent interaction with an object

Holoconferencing SDK API

Category	Function	Description
Initialization	void PipelinesInitializer()	Initialize pipelines for holoconferencing
	BasePipeline AddPipelineComponent(GameObject dst, UserRepresentationType type)	Add a component to the pipeline
	BasePipeline Init(object _user, SourceType source, bool preview = false)	Initialize a pipeline with user and source.
Configuration	void JoinSession(string sessionID, string playerName, UserRepresentationType _playerRepresentationType)	Join a holoconferencing session
	void SocketConnect(List<SocketEvent> eventsToManage, string _nsp)	Connect to a socket room
Interaction	void InstantiatePlayer(Player _player)	Instantiate a player in the session

4.2. Architecture Design

The system architecture will be designed to accommodate the interaction between the various SDKs (Haptics, Intelligent Virtual Humans, and Holoconferencing) and the local application. The architecture will need to ensure real-time communication between the components and handle data exchange in real-time.

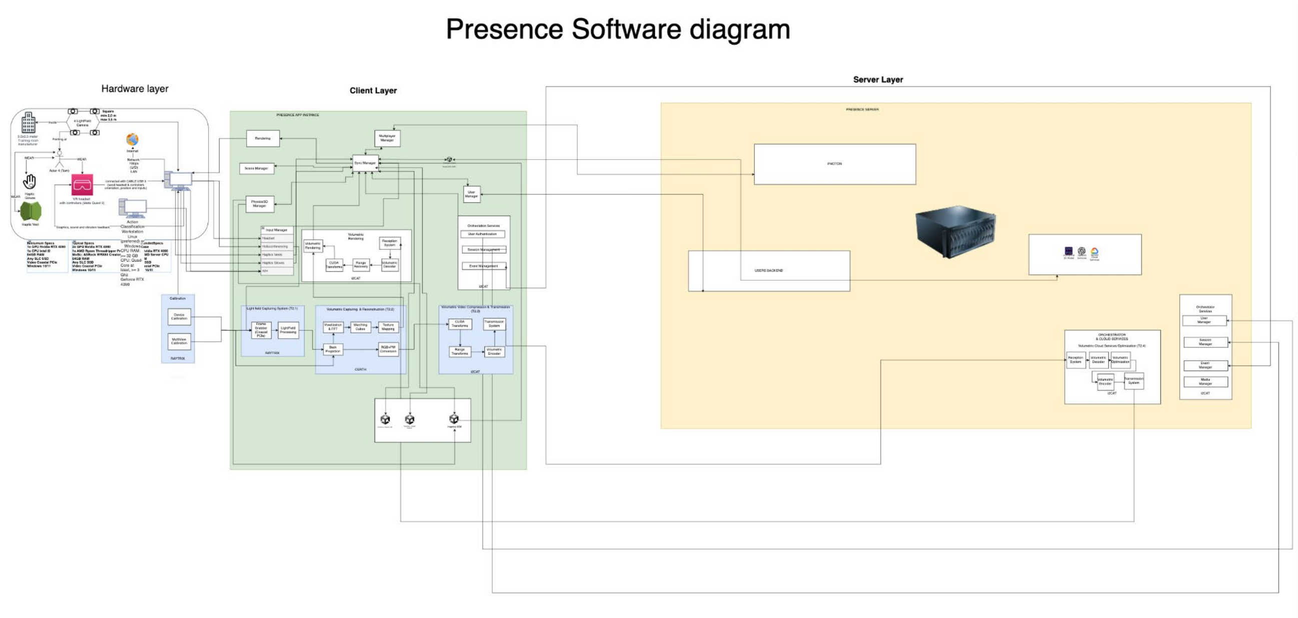


Figure 3: System Architecture

4.3. Development of Demonstrators

4.3.1. Software Development

- Unity 2022 will be used as the primary development tool for the application.
- The custom SDKs for Haptics, Intelligent Virtual Humans, and Holoconferencing will be integrated with Unity.
- The applications logic will be developed to handle user interactions, data exchange between the SDKs, and multiplayer functionality using Photon.
- Will be created the 2 use cases described in sections 5.1.1 and 5.1.2.

4.3.2. Deployment of Demonstrators

- The demonstrators will be deployed on Windows desktops and Meta Quest 3 VR devices.
- The deployment process will ensure that all necessary components, including the SDKs, are installed correctly.
- The deployment will be a folder containing an executable file and all the file needed.

5. Use Cases - Immersive Scenarios

5.1. Selection Criteria

5.1.1. Use Case: Professional Collaboration

Description: **Collaborative Armchair Design Discussion in XR Environment**

In this XR-based professional collaboration scenario, four actors wearing VR headsets come together in a virtual meeting room while physically being in different places to discuss the design of an armchair. The meeting room is equipped with a meeting table, a pedestal showcasing a 3D model of the armchair under review, a whiteboard, and a wall panel displaying a PDF document detailing the chair's specifications. **Actor 1** updates colleagues on recent chair modifications, while **Actor 2** visually illustrates these changes on the whiteboard. **Actor 3** consults the PDF document, indicating to **Actor 4** the required functionalities of the armchair. Actor 4 interacts with the virtual armchair, verifying its rotation and height adjustment as per the document's instructions. All actors inspect the armchair's features, confirming its capabilities and exploring material alternatives presented on a menu. After collaborative discussion, they reach a consensus on the preferred material and conclude the meeting, exchanging farewells before disconnecting from the application.

Actor name	Function / role	Represented in experience via…	Location + HW needed
Emma (actor 1)	Furniture Designer	Avatar	Design studio + VR Headset
Tom (actor 4)	Materials Specialist	Avatar	Home Office + VR Headset, Haptic glove
Lisa (actor 2)	Industrial Engineer	Holoportation	Meeting room + VR Headset

Actor name	Function / role	Represented in experience via…	Location + HW needed
Alex (actor 3)	Sales Representative	Avatar	Home office + VR headset

Step 1: Starting the experience

Actor 1 logs into the PRESENCE platform for professional collaboration from her studio. In setting up the meeting, Actor 1 is assisted by Actor 2 takes notes on the whiteboard, visually illustrating Actor 1's explanations. Actor 1 is joined by three colleagues: Actor 4, a materials specialist from her office; Actor 2, an industrial engineer from the company meeting room; and Actor 3, a sales representative from his home. They are all wearing VR headsets. Actor 4 is wearing haptic gloves. Actor 1 in VR, Actor 4 is in VR with Digital Touch and can feel the digital environment, Actor 2 is in VR with Holoportation, Actor 3 in VR. As they enter the virtual meeting room, they see a meeting table surrounded by chairs, a pedestal showcasing a 3D model of an armchair, a whiteboard, and a wall panel displaying a PDF document detailing the chair's specifications.

Step 2: Completing tasks in the experience

Actor 1 starts the meeting by updating her colleagues on recent modifications to the armchair design. She gestures towards the 3D model while explaining the changes. Actor 4 nods in agreement, while Actor 2 take notes about Actor 1's explanation that will immediately be displayed on a whiteboard. In the meanwhile, Actor 3 accesses the PDF document on the wall panel, reviewing the chair's functionalities and features. Actor 3 points out specific requirements to Actor 4 in the PDF document, who adjusts his material suggestions accordingly.

On the table, there will be three spheres that represent the three different possible materials, with different consistencies that Actor 4 can feel with his haptic gloves **(haptics).** Actor 4 interacts with the virtual armchair, verifying its rotation and height adjustment features as per the document's instructions. He gives feedback on the material alternatives presented on the table, exploring their suitability for the design.

Throughout the discussion, all actors inspect the armchair's features and capabilities, sharing insights and suggestions. They collaborate on refining the design, exploring different options until they reach a consensus on the preferred material.

Step 3: Concluding the experience

After a productive discussion, they conclude the meeting and exchange farewells before disconnecting from the application, all satisfied with the progress made in designing the armchair. Thanks to PRESENCE, the team was able to discuss, evaluate, and refine the armchair design efficiently in a virtual environment, leveraging XR technology for effective communication and collaboration. They successfully reached a consensus on the preferred material, ensuring that the project will continue moving forward smoothly.

Tech pillar	Summary of how it is integrated in the use case
Holoportation	Actor 2 needs to be holoported because this allows her to…
Haptics	Actor 4 uses the haptic glove to manipulate the chair

Figure 4: Professional Collaboration' Use Case

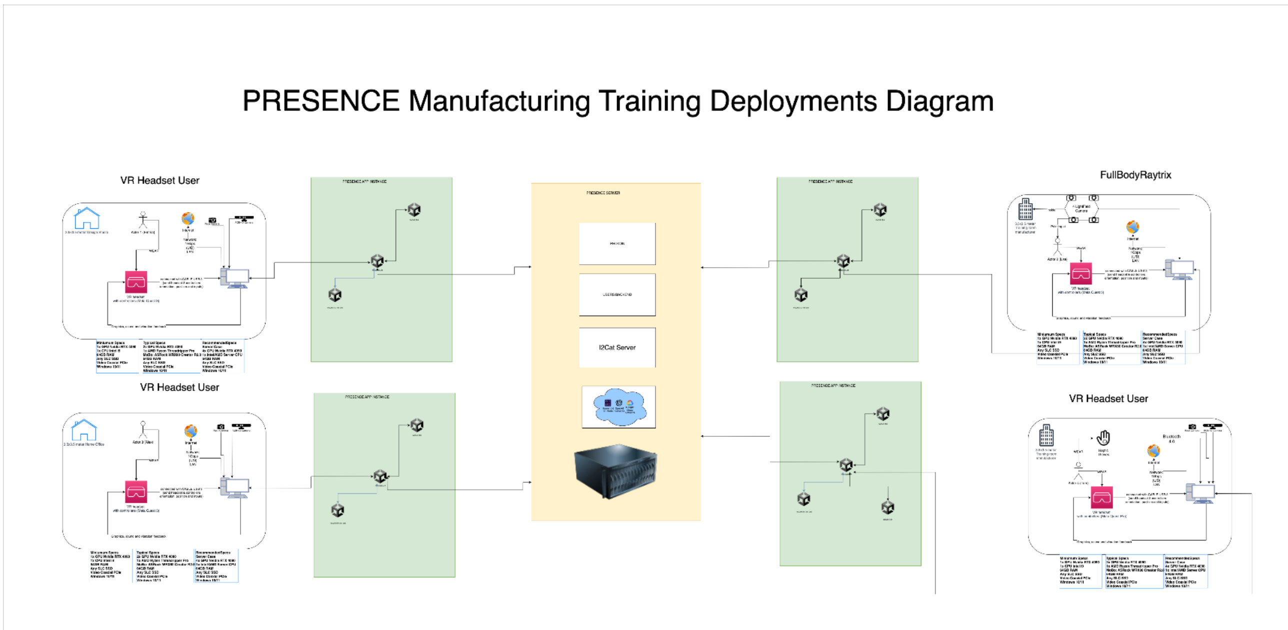


Figure 5: Deployment Diagram Professional Collaboration

5.1.2. Use Case: Manufacturing

Description: **XR-Based Training for Safe Operation of Hydraulic Press**

There are four actors in this use case scenario: **one virtual trainer** and **four trainees**. All of them are physically located in the training room and put their VR headsets on to participate in this training scenario. They all enter a virtual environment that has the appearance of a production department of industrial manufacturing where the hydraulic press will be placed and users will be trained on its safe usage. The virtual trainer will explain the general operation of the machine and indicate the three main systems that users will have to learn to use: (i) hydraulic clamp for the placement of the heavy sheet of steel inside the press and for the removal of the scrap after pressing, the actor must wait 60 seconds to let the sheet cool down before taking it to avoid being burned (Alex, the person with haptic gloves will feel vibration from the sheet if they touch the sheet before the 60 second interval), (ii) safety door (opening/closing, locking/unlocking), and (iii) pressing two buttons to start the blanking action. The virtual trainer (IVA) showcases the incorrect usage and the potential consequences of each of these actions in VR while the other actors stay still and observe the virtual trainer. After that, the trainer invites the trainees to carry out all these actions on their own in VR. While they do so, the Supervisor (Tom) evaluates the correctness of what has been done by them to make a judgment on the level of preparation achieved. In the end, they agree to conclude the training and disconnect from the VR application.

Actor name	Function / role	Represented in experience via	Location + HW needed
Alex	Trainee	Avatar	Training room manufacturer + VR headset, haptic glove
Sarah	Trainee	Avatar	Joining from home + VR headset
Lisa	Trainee	Avatar	Joining from home + VR headset
Tom	Supervisor	Holoportation	Training room manufacturer + VR headset
TBA	Virtual trainer	IVA	NA

Step 1: Starting the experience

Alex, Sarah, and Lisa are new hires at a steel factory. They are about to undergo training on the safe operation of a hydraulic press. This training is crucial as the proper handling of machinery is essential to ensure their safety. All four trainees are aware of the potential risks involved in operating the hydraulic press, and they understand the importance of receiving thorough training before starting their work. To provide them with comprehensive training in a safe and controlled environment, their supervisor, Tom, has arranged the PRESENCE VR-based training session with a virtual trainer **(IVA)**. The trainees (**avatars**) put on their headsets, and haptic glove (Alex only), immersing themselves in the virtual environment that simulates a production department of industrial manufacturing. In this virtual space, they see the hydraulic press they'll be trained to operate.

Figure 6: Manufacturing Use Case Avatars

Step 2: Completing tasks in the experience

The supervisor, Tom (**holoportation**), introduces the trainees to the general operation of the hydraulic press. Tom explains the three main systems that the trainees will need to learn: the hydraulic clamp, safety door, and double buttons for starting the blanking action.

Figure 7: Manufacturing Use Case Hydraulic Clamp

While Tom is explaining how to use the hydraulic clamp, open/close the safety door, and initiate the blanking action, the virtual trainer (IVA) is showcasing how to operate the systems in an incorrect and correct way.

After the demonstration, Tom invites the trainees to carry out the actions themselves in VR. One by one, each trainee, starting from Alex (with haptics), takes turns practicing the operation of the hydraulic clamp(i), safety door(ii), and double buttons(iii) while the supervisor observes their performance.

> (i) Hydraulic clamp: for the placement of the heavy sheet of steel inside the press and for the removal of the scrap after pressing, the actor must wait 60 seconds to let the sheet cool down before taking it to avoid being burned. All participants receive strong and intense haptic vibrations caused by the heat of the sheet through the gloves or controllers if they touch it before the 60-second interval has elapsed.
>
> (ii) Safety door: the actors take turns in opening/closing and locking/unlocking the safety door. Alex, the person with haptic gloves receives force feedback from the physical elements of the door he touches while all others receive slight vibrations via the controllers.
>
> (iii) Pressing two buttons: the actors take turns in pressing both buttons to start the blanking action. Alex, the person with haptic gloves receives force feedback from the buttons he touches while all others receive slight vibrations via the controllers.

As the trainees perform the actions, the supervisor Tom evaluates the correctness of their movements and procedures. They provide feedback and guidance to help the trainees improve their skills and ensure they understand the proper operation of the hydraulic press.

Step 3: Concluding the experience

Once all trainees have had the opportunity to practice and receive feedback, the supervisor Tom concludes the training session. He comments on the trainees' efforts and progress, emphasizing the importance of safety in the workplace. The trainees thank the virtual trainer for their guidance. Thanks to the PRESENCE XR-based training, Alex, Sarah, and Lisa feel more confident and prepared to operate the hydraulic press safely in their workplace.

Tech pillar	Summary of how it is integrated in the use case
Holoportation	Tom + role/advantages of holoportation for Tom
Haptics	Alex needs a haptic vest to feel when the steel is still too hot or cold enough to handle
IVA	Shows the proper /improper way to safely conduct the tasks that are part of the training

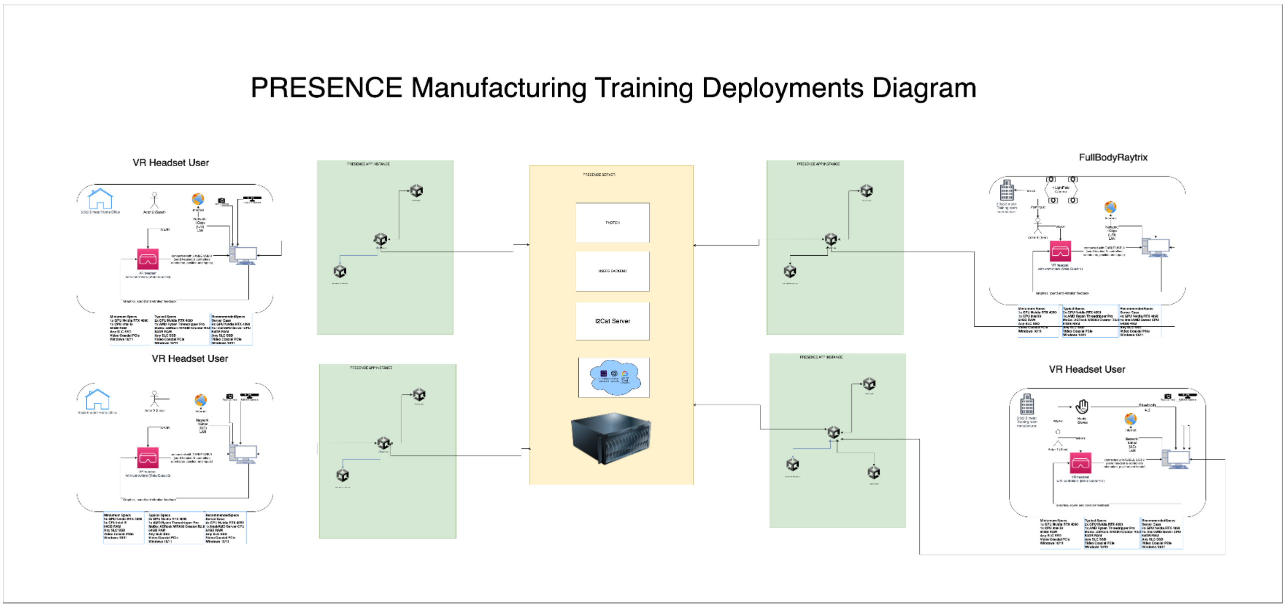


Figure 8: Deployment Diagram Manufacturing Use Case

5.1.3. Use Case: Pain Relief in the Health Sector

Description: **Pain/Stress Relief**

Manuel, a 46-year-old with a strong fear of needle procedures, is at the clinic today for a joint injection procedure. To aid him, Dr. Garcia, his doctor aware of his needle phobia, has prepared a specialized session using PRESENCE technology designed to help Manuel cope effectively during the procedure. Unfortunately, Manuel's usual source of support, his long-time friend Ben, is unable to be present physically this time. However, through the use of PRESENCE technology, Ben can be virtually holoported into the VR environment to provide Manuel with his customary support and reassurance during the procedure.

Upon arriving at the clinic, Manuel is visibly tense, dreading the upcoming procedure. Dr. Garcia greets him with a comforting smile and gives him a professional briefing on how to use the PRESENCE technology. With the help of Dr. Garcia, Manuel puts on a VR Headset and dives into a distracting virtual environment where he finds his friend Ben and Ava, a virtual assistant, ready to support him throughout the procedure. The virtual environment is seamlessly synced with the medical procedure and guided by Ava, ensuring Manuel receives the ideal distractions and support tailored to his needs. This allows Dr. Garcia to concentrate on the procedure, which can be successfully completed without any complications, as Manuel is kept in a state of comfort and reassurance.

Actor name	Function/role	Representation	Location	Hardware
Manuel	Patient with needle phobia undergoing the procedure	Virtual hands	Hospital	VR headset, haptic gloves, haptic vest
Dr. Garcia	Doctor performing procedure	-	Hospital	-
Ava	Virtual assistant	IVA	-	-

Actor name	Function/role	Representation	Location	Hardware
Ben	Supporting friend	Holoportation	Quiet room	Holoportation camera, VR headset

Step 1: Starting the experience

Three weeks before the scheduled injection, Dr. Garcia arranges a phone consultation with Manuel to explain the upcoming joint injection procedure and introduce the PRESENCE technology. During the call, they discuss the role of VR in reducing anxiety and how holoportation will allow Manuel to receive support from his friend Ben, despite Ben being unable to attend physically due to a business trip. Manuel later contacts Ben, who confirms his virtual availability during the procedure. Thereupon, Dr. Garcia also provides Ben with information about the PRESENCE technology and the necessary equipment to attend the procedure virtually.

On the day of the procedure, Manuel arrives at the clinic and is greeted by Dr. Garcia, who provides reassurance and guides him to the specially prepared treatment room. The room is equipped with PRESENCE technology, including a VR headset, haptic gloves, and a haptic vest. It is designed to be calming and controlled, minimizing external stimuli that could increase Manuel's anxiety. Ben has received a call from Dr. Garcia's secretary to ensure he will be there at the planned time of the procedure.

Step 2: Participating in the experience

Upon putting on the VR headset, Manuel is greeted by Ava, a virtual assistant. Ava's purpose is to guide Manuel through the VR experience, offering information such as the purpose of the injection, expected outcomes, duration, and what to expect from the VR experience. Her presence is designed to relieve Dr. Garcia of the information she would otherwise have to provide. The virtual environment represents a beautiful nature setting, which serves to relax and distract Manuel from the procedure. During the instruction by Ava, Manuel's friend Ben is also present in the environment, holoported from a quiet room he chose to attend. Seeing Ben helps Manuel remain comfortable and ease the stress he would otherwise feel.

As Manuel engages with Ava and Ben in the virtual environment, Dr. Garcia begins preparing the joint injection. Dr. Garcia first ensures that all medical instruments required for the joint injection are sterilized and neatly arranged for easy access during the procedure. She then prepares the medication, calculating the correct dosage based on Manuel's medical history and specific needs related to his meniscus condition. The medication is then drawn into a syringe, ensuring it's ready for administration. Lastly, Dr. Garcia selects the optimal site for the injection on Manuel's knee. She marks the site and cleans it thoroughly with an antiseptic solution to prevent any infection.

As the procedure nears the actual injection phase, the haptic vest Manuel is wearing begins to gently inflate and deflate, guiding him to take deep, calming breaths. This not only helps in reducing anxiety but also stabilizes his body for the injection. Concurrently, the haptic glove on his arm activates. Manuel feels gentle, soothing sensations on his skin, which are synchronized with visuals in the VR environment. For instance, as he sees a visual of a gentle waterfall in VR, he feels corresponding sensations through the haptic devices, enhancing the distraction from the injection.

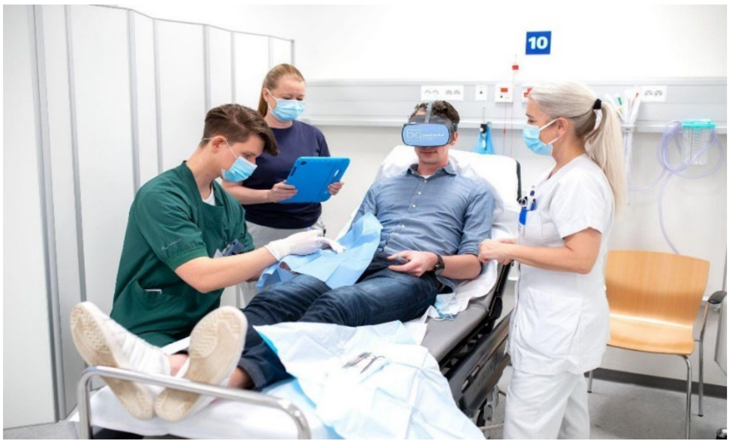
Throughout the session, Ben holds Manuel's hand, while having an informal chat as they do so often. While Manuel is deeply engaged with the virtual environment and conversing with Ben, Manuel holds

Manuel's hand a little tighter and Dr. Garcia carefully administers the joint injection. Manuel feels the injection and experiences a light level of pain, but due to the relaxation and support, he handles it without the usual stress and panic.

Step 3: Concluding of the experience

After the injection has been performed, Ben congratulates Manuel, says goodbye, and leaves the virtual environment. Ava informs Manuel about the required restriction of strenuous activity, the option to use ice in case of swelling, and other practical points. She further seeks feedback from Manuel and gathers feedback about his experience such as his level of comfort throughout the procedure. Manuel's responses are overwhelmingly positive, noting a significant reduction in anxiety and an increased sense of control over the situation.

Finally, Dr. Garcia then takes off the devices from Manuel and guides him to the exit of the procedure room. Dr. Garcia has only had to focus on the procedure, while Ava provided relevant information and Ben gave comforting support. After Dr. Garcia gave the devices to Manuel, she did not have to control anything other than the medical equipment required for the procedure, which was a great support for her.



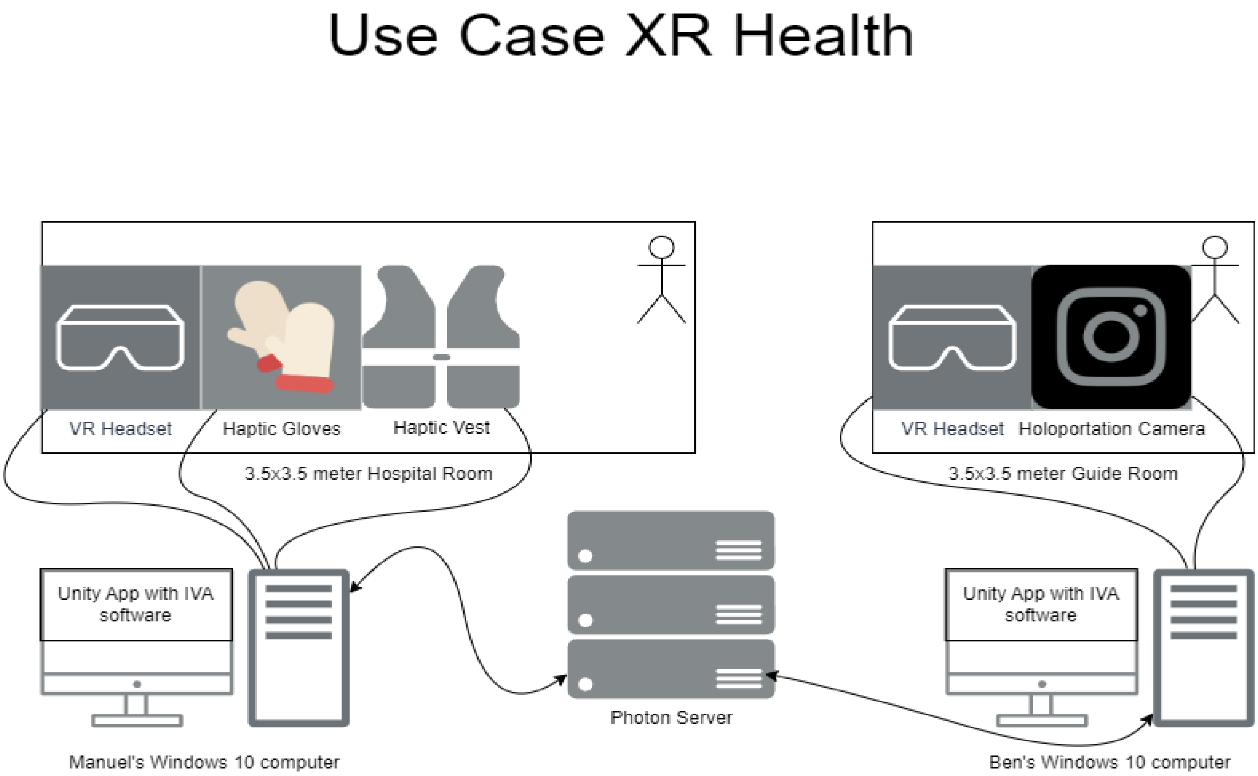


Figure 9: Deployment Diagram Health Use Case

Tech pillar	Summary of how it is integrated into the use case
Holoportation	Ben is holoported into the VR environment to comfort Manuel and allow Dr. Garcia to focus on the procedure.
Haptics	Manuel receives a haptic vest and gloves to create haptic stimuli to distract him from the procedure in sync with the visuals of the virtual environment and help him manage his stress levels while also receiving physical feedback from his friend Ben.
IVA	Ava provides Manuel with the necessary patient information before and after the procedure and guides him through the virtual experience.

5.1.4. Use Case: Cultural Heritage - Tunnel underneath Berlin Wall

Description: **Tunnel 57 Experience**

This use case scenario is about exploring the escape "Tunnel 57" under the former Berlin Wall. The following actors are involved in this scenario: tourist, time witness as a pre-recorded holoportation, and a tour guide as an intelligent virtual assistant with chatbot functionality and corresponding interface.

To start, the tourist puts on the XR headset, haptic gloves, and vest. The virtual environment loads and immerses the tourist in the virtual space (avatar). The tourist enters a replica of a cellar (anteroom of the tunnel in Berlin) with a tour guide (holoported) and can explore the room. The tour guide starts introducing the tourist to the experience and the room and invites the tourist to explore the digital points of interest (POIs).

With the ability to freely explore, interact, and engage with POIs in the room, the tourist delves into the past while conversing with the tour guide (holoportation) and uncovering hidden truths. Upon discovering a triggering POI, a time-witness also appears (recorded holoportation) transporting the tourist deeper into the narrative as the tour guide steps away. Navigating through a virtual tunnel, the tourist experiences the tension and urgency of an escape, culminating in a pivotal moment of decision and consequence. Emerging from the tunnel, the tourist witnesses the aftermath of historical events unfold before their eyes, shedding light on the complexities of division and reconciliation. With immersive haptic feedback from the vest and gloves and audio cues amplifying the emotional journey, the tourist is not merely a spectator but an active participant in revisiting the narrative of the past.

Actor name	Function / role	Represented in experience via	Location + HW needed
Sophia	Tourist	Holoported or avatar	Berlin + VR headset, haptic gloves, vest
Hannes	Historical expert (Time Witness)	Holoported (Pre-recorded)	-
David	Tour guide	Holoported live	(Guide room + VR headset)

Figure 10: Artistic AI rendering

Figure 11: Sophie in equipment

Step 1: Starting the experience

Sophia is a history enthusiast visiting Berlin for the first time. She's always been fascinated by the stories of the Berlin Wall and is eager to explore its history in a unique and immersive way. Today, she's embarking on the PRESENCE "Tunnel 57" XR experience. Sophia arrives at the site, where she's greeted by the PRESENCE staff and equipped with an XR headset, haptic gloves, and a vest.

She is excited to dive into the virtual world and uncover the secrets of Tunnel 57. Sophia puts on the XR headset, haptic vest and glove and is transported into the virtual space of Tunnel 57. She finds herself in a volumetric scan of a cellar, the anteroom of the tunnel in Berlin, with David, who is an expert on Berlin's history and acts as Sophia's virtual tour guide by **holoporting** himself live into the virtual world.

Figure 12: 3D tunnel placed inside the museum at entrance of tunnel & David and Sofia

Step 2: Completing tasks in the experience

David welcomes Sophia to the experience, providing an overview of Tunnel 57 and its significance during the Cold War era. He encourages Sophia to explore the digital points of interest (POIs) in the room and interact with the environment. Sophia teleports freely into the virtual cellar, examining artifacts and listening to David's explanations about each point of interest. **Haptic gloves** are used for simulating interacting with POI that have to be found by the user in order to trigger actions.

She engages in conversation with David, asking questions and sharing her own insights about the historical context. As she delves deeper into the narrative, Sophia stumbles upon a POI that triggers the appearance of Hannes, a virtual time witness (pre-recorded holoportation). Hannes transports them deeper into the story, guiding them through a virtual tunnel as they experience the tension and urgency of an escape. A small physical reconstruction of the former tunnel is rebuilt in order for the user to crawl through. The haptic vest will simulate and underline storyline points:

- Rain and wetness from the tunnel will hit Sophia's shoulders via the haptic west
- Shooting of a gun will have a kickback effect via the haptic gloves
- Tightness in the tunnel will be transmitted via the haptic vest
- Wind is simulated through vest, gloves and fans

Emerging from the virtual tunnel, Sophia witnesses the aftermath of historical events, seeing firsthand the impact of division and the journey toward reconciliation. Immersive **haptic** feedback and audio cues amplify the emotional journey, allowing Sophia to feel connected to the past in a profound way.

Step 3: Concluding the experience

Sophia emerges from this experience and reflects on the lessons learned and the importance of understanding history to shape a better future. As she bids farewell to David and removes her XR gear, she carries with her a newfound appreciation for the power of immersive storytelling in preserving and sharing the past.

Tech pillar	Summary of how it is integrated in the use case
Holoportation	David is a holoported tour guide, he can interact live with the tourist. Hannes is a pre-recorded holoportation, as we want to involve the expert but not as an IVA. Hannes can share his personal experience without worrying about being at the location or about being misrepresented through an IVA or avatar.
Haptics	Simulate interaction with POIs and underline the storyline. Sophia needs a haptic vest and glove as they help her to understand the experience on an emotional and physical level.

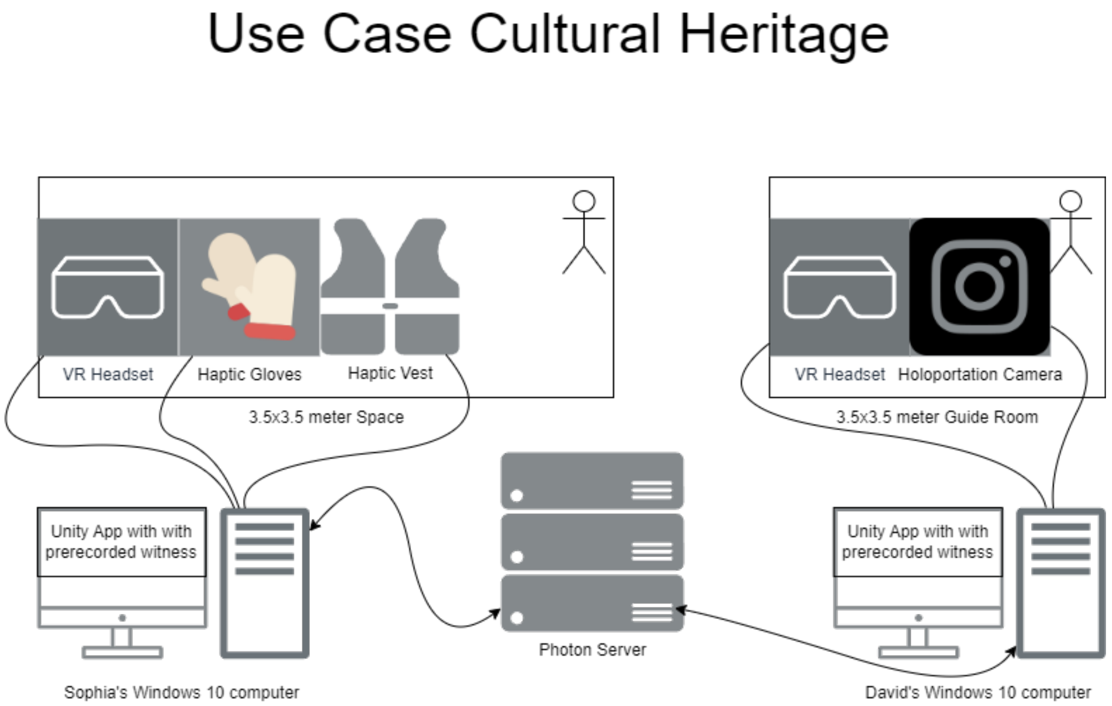


Figure 13: Deployment Diagram Cultura Heritage Use Case

6. WP5 Timeline & Milestones

Table 2: WP5 Milestones

Milestone 1	Delivery of Deliverable 5.1: Integration & Demonstration I - Initial Definition and Planning	Month 06
Milestone 4	Delivery of Deliverable 5.2: Integration & Demonstration II: Intermediate integration, testing & validation	Month 18
Milestone 7	Delivery of Deliverable 5.3: Integration & Demonstration - final integration, testing & validation	Month 36

Figure 14: overviews the timeline of all the PRESENCE's Work Packages including integration timeline for the period M7-M18. The file is accessible in Miro board by clicking on the link[2]

[2] Notice to the attention of the EU officers and external reviewers: this URL links direct to the project Repository and thus with access restricted. The file is available under demand, contact the editors or email maria.sanchez@2cat.net

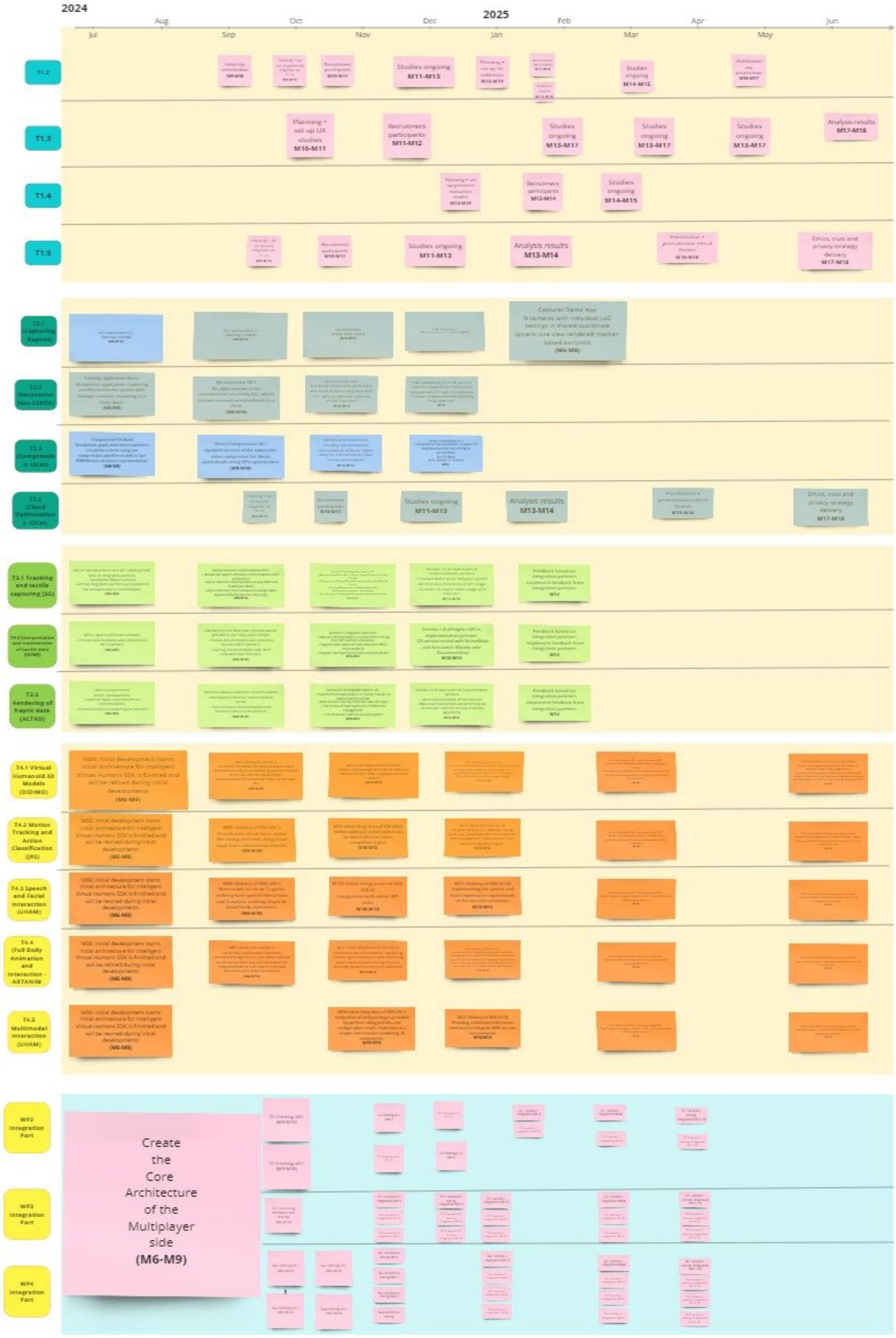


Figure 14: WPs Timeline with Integration Timeline

7. Conclusions

7.1. Summary & Next Steps

Work Package 5 aims to seamlessly integrate, demonstrate and validate the advancements made in Holoportation, Haptics, and Intelligent Virtual Humans (WPs 2-4). By developing two key demonstrators focusing on professional and social XR applications, the project underscores the practical utility and transformative potential of these technologies. The structured approach, including rigorous sprint planning, stand-ups, iterative feedback cycles, and detailed testing plans (WP1) which aim to ensure that the integration process is efficient and responsive to stakeholder needs as addressed in WP6 concerning end users. Ultimately, WP5 not only validates the technological innovations but also paves the way for their real-world application, showcasing the impactful future of XR technologies in various domains.

The next steps toward D5.2 include a cross Work Package Component Definition, a time-line for components and a holistic integration as well as planning for the V1 by month 18 and release of first integration.

8. Abbreviations and definitions

8.1. Abbreviations

AI	Artificial Intelligence
API	Application Programming Interface
HW	Hardware
IVA	Intelligent Virtual Agents
MS	Milestone
SDK	Software Development Kit
TC	Technical Committee
TRL	Technology Readiness Level
UX	User Experience
VR	Virtual Reality
WP	Work Package
XR	eXtended Reality

9. References

Ref. 1 Grant Agreement nº 101135025 (incl. DoA Description of the Action, Parts A and B)