# D4.3

# Activity Recording for the Exercise Debriefing

**Version**
V1.0

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MED1stMR

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30.09.2022

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# Versions

| Version | Date | Author(s) | Description |
|---|---|---|---|
| **V0.1** | 27/07/2022 | Helmut Schrom-Feiertag (ORG) | First Draft |
| **V0.2** | 09/09/2022 | Dervis Demirtas (D2D) | Current ADAM-X debriefing system and data. |
| **V0.3** | 16/09/2022 | Ronny Tobler (RFNS) | VR debriefing system, data from VR system and concept for data storage. |
| **V0.4** | 25/09/2022 | Helmut Schrom-Feiertag | Various amendments and summaries, version for review by D2D and RFNS. |
| **V1.0** | 30/09/2022 | Helmut Schrom-Feiertag | Formatting and finalisation for submission. |

# Report Review

| Version | Date | Reviewer(s) | Statement |
|---|---|---|---|
| **V0.4** | 26/09/2022 | Dervis Demirtas (D2D)<br>Ronny Tobler (RFNS) | Incorporation of feedbacks. |
| **V1.0** | 30/09/2022 | Helmut Schrom-Feiertag (AIT) | Final review, ok for submission. |

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# List of Acronyms and Abbreviations

| Acronym/ Abbreviation | |
|---|---|
| API | Application Programming Interface |
| MCI | Mass Casualty Incident |
| MR | Mixed Reality |
| VR | Virtual Reality |

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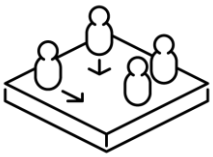
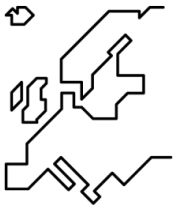
# Relation to Objectives

| Objective | Description |
|---|---|
|  | **Obj. 1: Pioneering MR training approach for enhanced realism**<br>MR training will achieve a high degree of realism by integrating physical objects and the training manikin into the VR system, thus enhancing training experiences and opening up new opportunities for skills training. The developed activity recording collects and stores the data from the manikin and all these additional objects and forms the basis for the debriefing system and supports the debriefing with objective data |
|  | **Obj. 2: Effective training scenarios and a training curriculum**<br>Objective data from activity recording help to demonstrate the validity of MR training scenarios and supports the creation of guidelines and concepts for the implementation of MR training in first responder organisations and the transfer in a new MR training curriculum. |
|  | **Obj. 3: Physiological signal and trainee behaviour feedback loop and smart scenario control**<br>Movement data from the VR system, physiological data of the trainees from biosignal sensors, and the medical data and treatments of the manikin are all data sources for activity recognition and serve as input for the intelligent scenario control. |
|  | **Obj. 4: Position the pioneering MR training approach across Europe**<br>The collection of all data in a common database for the debriefing and an export for statistical analysis enables new dimensions of performance measurement, in real-time and in post-processing. This opens up completely new possibilities in training debriefing and scenario control that have not existed before, and this novelty supports the positioning of the MR training system as an innovative approach. |

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# Executive Summary

This document D4.3 describes the activity recording for the exercise debriefing. The data of activity recording are stored and can be accessed for debriefing using the MR training system for interactive training review. The data include motion data of any tracked trainee, device, object and manikin, audio data, vital data of the trainees from PLUX biosignal sensors, an intelligence layer with semantical activity information (e.g. opening door, touching the manikin, checking pulse, etc.) and the ADAM-X manikin simulation data (victim condition and vital data). All these data are stored in the Refense Framework acting as central conductor that collects, stores and exports training data. In the current system, all position data are stored frame-wise. In the future, this will be reduced and interpolated for intermediate steps to reduce data volume to be transferred and increase performance.

D4.3 covers efficient data collection, storage and access to create the data basis for debriefing. Subsequently, the debriefing system itself will be developed. For this purpose, the data will be analysed to determine which activities and performance criteria can be evaluated analytically and improve the debriefing with objective data. In addition to analysis methods, a user front-end must be designed that presents the relevant information in an optimised way. This application is still new in medical training. While several video cameras were usually used for patient simulation training, there were hardly any such comprehensive and easily analysable recordings for MCI training. Together with the end users, the objective is to determine the essential criteria for the debriefing and to develop concepts for the presentation and interaction. With the results, prototypes will be created, iteratively evaluated with the end users and further developed. The final result will be implemented as the user front end of the MR debriefing system (D5.6).

**Relation to other deliverables and tasks in MED1stMR**

*Table 1: The work and the document build on results from the following deliverables.*

| No. | Title | Information on which to build |
|---|---|---|
| D2.2 | End Users Perspective: Requirements Report, Stakeholder Map and Expectation Summary for Smart Wearables, MR Training Framework and Curriculum | In D2.2 the needs of the end users are summarized and provides input into what trainers need to know, see, adapt, and annotate during training in the live-action dashboard and which features are needed for debriefing and evaluation in the debriefing dashboard. From this, it can be deduced which data are needed and must be stored for this purpose. |
| D2.4 | High-Level System Architecture | High level system architecture describing the integration of the modules that compose the MR trainings system, the VR training system, manikin ADAM-X, wearable PLUX biosignal sensors, and dashboard application. It describes the details of the integration between these modules and the expected |

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| | | |
|---|---|---|
| | | data flow. On this basis, the activity recording for the exercise debriefing was realised |
| D5.1 | VR System Design Document and Evaluation Plan for MED1stMR MR Trainings Environment | It defines the basic structure of the MR training system in the very beginning and served as a foundation for the high-level architecture D2.4. |
| D9.3 | PODP – Requirements No. 3 | D9.3 addresses ethical risks related to data gathering including sensitive data like biosignals or voice recordings. |

*Table 2: The results of this work will be incorporated into following work and developments*

| No. | Title | Basis for |
|---|---|---|
| D4.4 | Physiological signals Acquisition Hardware and Software Framework | The recording of the biosignals is included with the activity recordings and must be integrated into the MR system accordingly. |
| D4.6 | Generic Integration Framework for Incorporation of Novel First Responder Technologies in MR | Every technology that is integrated and provides data for the evaluation in the debriefing has to interface with the activity recording. |
| D5.6 | MR Debriefing System for Training Performance Evaluation and Output for Evaluation and Field Trials | The results of this deliverable provide the basis for the MR debriefing system. It stores all data and allows efficient access to the data for debriefing. |

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# 1 Introduction

The Mixed Reality (MR) training system is built upon the RFNS multiuser VR training platform, it allows the simulation training of scenarios performed in the project as well a training debriefing. The user interface of the current debriefing system is shown in Figure 1. There are rich controls for pausing playback, skipping to a specific point in time, or fast-forwarding or rewinding. This supports well the evaluation of the training session and deepens the learning for the trainees.

For such an exercise debriefing, the training system must record all trainee activities and relevant data required for the review. This data will enhance the debriefing by quantitative indicators. In MED1stMR where the training system is extended by biosignal sensors for the trainees and by the integration of medical devices and human-manikins with dynamic patient simulation, this additional data must also be saved for the debriefing. These data include the tracking and movement data of the full body tracking, the tracking and operation of physical as well as virtual objects, the biosignal data of the trainees as well as the data from the manikin.

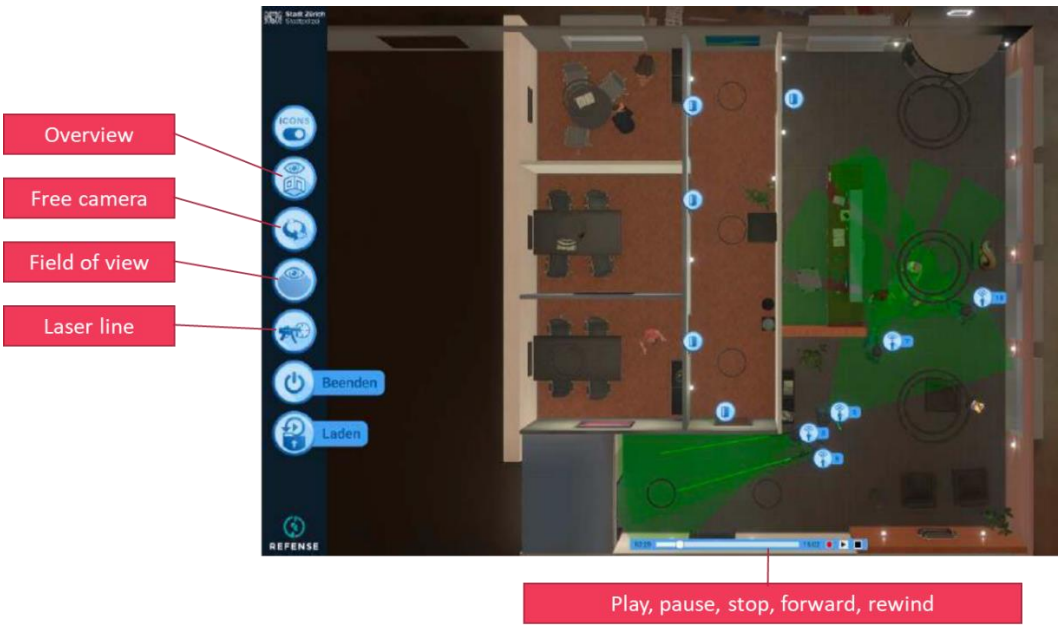


*Figure 1: User Interface of the current Refense debriefing system*

The ADAM-X high fidelity patient simulator manikin also has its own a debriefing system. Therefore, in the ADAM X the following actions and data are recorded during the training:

- Actions done on ADAM X, this will be presented in the logs
- Trainer feedback and comments, this will be presented in the logs
- Patient monitor
- Camera feed, up to 3 cameras

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The debriefing summing all these above-mentioned data in one overview (Figure 2), including a timeline where an overview of what happened in the past, current and future is shown. All data streams are in sync. The session could be played in real-time or with increased speed to go through the points faster. Since only limited medical equipment is used in the context of a mass casualty incident (MCI) and primarily the examination and first aid are carried out, it is not necessary that all data must be presented in the debriefing.

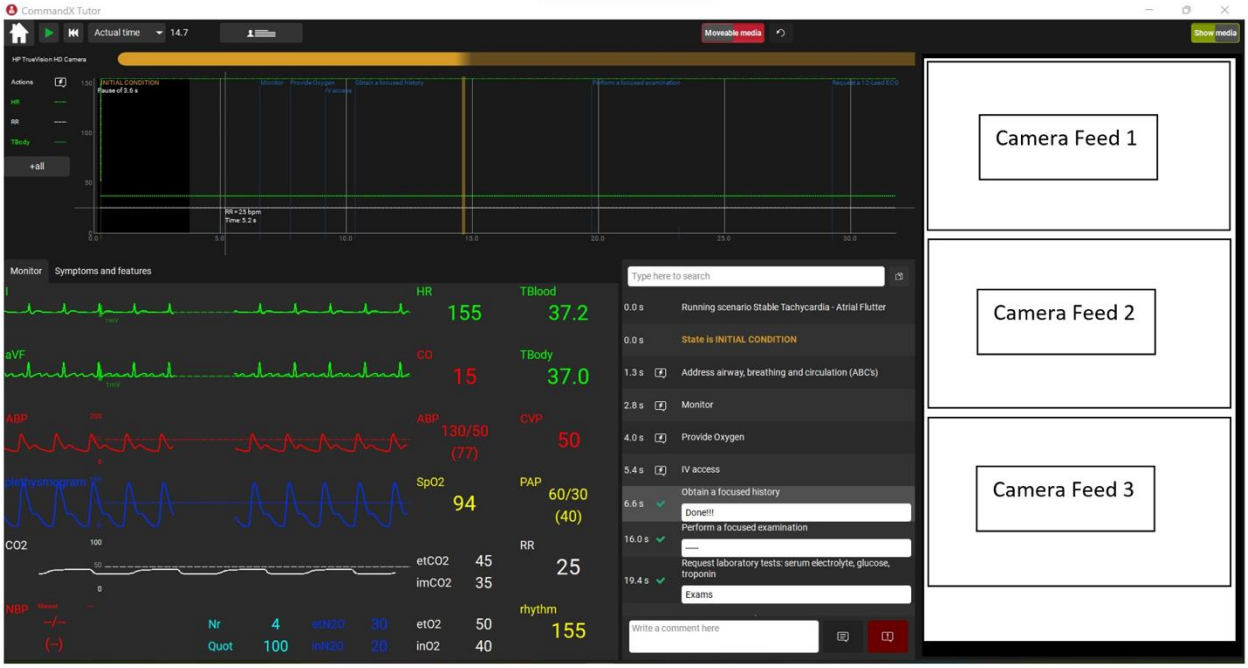


*Figure 2: User Interface of the ADAM-X debriefing system*

The basis for the MED1stMR debriefing system is the Refense debriefing system (Figure 1). The essential data and activities of the manikin are transmitted to the Refense system and recorded. The Refense Framework acting as central hub that collects, stores and exports debriefing data. The recorded data of activity can be accessed for debriefing using the MR training system for interactive training review. In the following chapter 2 the data and activities are described and in chapter 3, the concept for the central storage of data is presented.

# 2 Data and activities

The core components of the MR training system generating relevant data for the debriefing are 1) VR training system, 2) manikin ADAM-X and, 3) wearable PLUX biosignals sensor system. The integration of these subsystems focusing on the data flow can be found in D2.4, Figure 3. The various types of data from the different subsystems are provided in different formats and temporal resolutions.

The individual subsystems are listed in the following, together with a description of the data supplied.

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*Table 3: Subsystems and data provided for activity recording.*

| Subsystem | Data description |
|---|---|
| VR training system | The VR training system provides motion data from all objects and trainees being tracked (NPC, trainee, actor, manikin, other moveable objects like medical devices). For all these object position data, rotation data, status are provided. Additional data are audio data and voice recordings, activities and events. |
| Manikin ADAM-X | On ADAM-X the patient simulation is running and synchronising the medical data to the VR system. These medical data consist of: blood pressure, heart rate, respiratory rate, chest expansion, cyanosis in face and fingers, pulse, electrocardiogram, CPR frequency, depth and release time, tears, drooling, sweating, eyelids open, closed, blinking, access points touched, treatments, etc. |
| Wearable PLUX biosignals sensor system | The wearable PLUX biosignals sensor system provides live streams with data from the sensor and processed features. These data are: electrocardiogram, heart rate, heart rate variability and electrodermal activity. |

# 3 Concept for the Storage of Data

The Refense Framework is the central conductor that collects, stores and exports training data. As low latency of the training is key to enable virtual reality training in real-time, the system needs to be as efficient as possible. The following Figure 3 shows a breakdown of data inputs collected for further analysis:

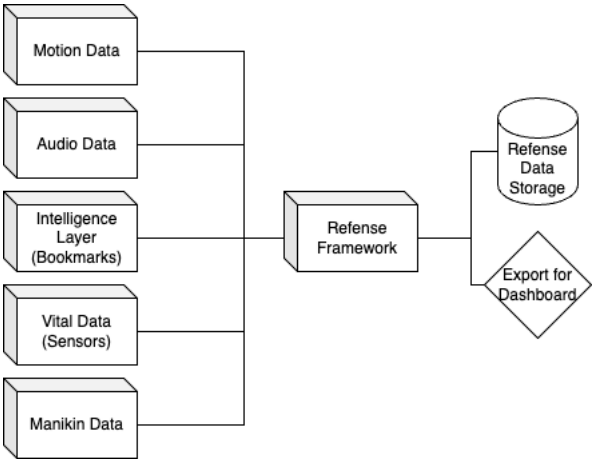


*Figure 3: Overview on Data Collected and Stored*

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For efficiency purposes in speed and size, all data are stored in a binary file. Only the sound files will be stored separately. On the one hand, for the simple reason that the processing of audio files is already very standardised and existing audio libraries can be used, on the other hand, for reasons of data privacy. Voice recordings can be used to identify people and are very relevant in terms of data privacy. With an extra file, after the training and debriefing, the voice recordings can be deleted easily.

In the current Refense VR system all position data is stored by frame. Once the training frameworks are settled, the system will further be optimized by storing data not by frame but in larger intervals to reduce data amount. For the replay the data will be interpolated to generate data points for each frame.

The binary file is structured as follows:

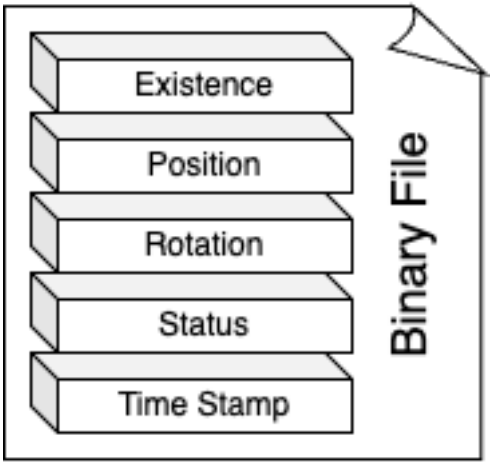


*Figure 4: Binary File Structure*

The master is the object that is tracked in the VR system (NPC, participant, actor, manikin, all movable objects from props to tools). Underneath per object follow existence, position data, rotation data, status and time stamp.

# 4 Summary

For the Refense VR training system, there is already a debriefing solution for police training that mainly has to store the movement data of the trainees and individual events. For ADAM-X is also a debriefing solution available. But for MED1stMR one common debriefing solution (D5.6) will be developed based on the Refense VR system and the data from ADAM-X and the biosignals from the trainees must also be stored for debriefing in the Refense system. The integration of the different systems and sensors creates a lot of data that has to be stored centrally for debriefing. The existing system must therefore be adapted accordingly in order to be able to process the different data and the increased amount of data. The data is stored in binary files.

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Since the data is stored per frame, very large amounts of data can be expected at a frame rate of over 90 frames per second. However, this high temporal resolution is not absolutely necessary. Work is therefore being carried out to reduce the recording rate. For the playback of the data in the debriefing, the data is interpolated for high playback quality. This reduces the amount of data to store and increases the performance when accessing the data.

Based on the activity recording the debriefing system itself will be developed. For this purpose, the data will be analysed to determine which activities and performance criteria can be evaluated analytically and improve the debriefing with objective data. Together with the end users, the objective is to determine the essential criteria for the debriefing and to develop concepts for the presentation and interaction. With the results, prototypes will be created, iteratively evaluated with end user partners and further developed. The final result will be implemented as the user front end of the MR debriefing system (D5.6). Additionally, an export function to the dashboard application (see D2.4 for details) for statistical analysis will be implemented.

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