Metaverse Standards Forum
Medical Device Assembly Technician Training

Last Update: June 06, 2025

Status: Approved for Public Distribution

Version: 1.0

Reviewer	Due Date	Status	Contact
Industrial Metaverse Working Group	March 06, 2025	Complete	industrial_metaverse@lists.metaverse-standards.org
MSF Domains (Peer Review)	March 27, 2025	Complete	oversight@lists.metaverse-standards.org
Use Case Taskforce	June 06, 2025	Complete	use_case_task_force@lists.metaverse-standards.org

The purpose of this template is to provide a structured framework for collecting and documenting use cases within the Metaverse Standards Forum (MSF). Use cases are essential for understanding real-world scenarios where metaverse technologies are applied and where interoperability challenges may arise. This template guides MSF members in providing a concise yet comprehensive description of a use case, including its title, identifier, and summary. It also encourages contributors to list the benefits of the use case, identify actors or entities involved, and describe the use case scenario in detail, emphasizing interactions, challenges, and requirements. Additionally, it prompts the inclusion of relevant technical information, such as implementations, success metrics, and challenges faced. This template aims to facilitate the gathering of valuable use-case data to inform standards development and foster collaboration within the MSF community.

MSF members and MSF Domain Groups are invited to submit use cases.

NOTE: Organizations such SDOs who want to submit and add a use case would need a sponsor that is an MSF member. This process is established in order to have a contact person in MSF that can handle discussions and resolve open issues within regular meetings.

Eligible submitters:

- MSF Domain Groups
- MSF Members (Principal and Participant)
- External Organizations with Liaison Agreements (with the support of a MSF member that acts as sponsor)
- Standard Development Organizations (with the support of a MSF member that acts as sponsor)

Minimum Requirements for MSF Member Submissions not part of a Domain Group:

- Minimum required number of proposers: 3
- Minimum required number of supporters: 5

NOTE: Use cases submitted by SDOs and Liaison Organizations would also need to fulfill the same requirements (and would need a sponsor) unless they are submitted by a Domain Group.

MSF: *Metaverse Standards Forum*
POG: *Pre-qualified Organizations and Groups*
SPP: *Standards Related Publications and Projects*
DWG: *Domain Working Groups*
WG: *Working Group*
SDO: *Standards Development Organization*

Use Case Title

Medical Device Assembly Technician Training (MDATT)

Use Case Identifier

MSF2024-MDATT-001

- Version 1.0
- Year of Release: 2025

Summary of Use Case

Description: This Use Case focuses on training technicians who assemble Medical Devices using immersive, 3D and interactive simulations with haptic feedback components. The system provides real-time, in-context feedback, reducing the need for physical components to be utilized (and wasted) during training and enabling remote certification of technician competencies. This virtual training also aims to replace a significant portion of the physical training required for technicians on assembling new Medical Devices.

Benefits:

- **Time Efficiency:** Streamlines the training and certification process through virtual environments, minimizing downtime.
- **Real-Time Kinesthetic Learning and Feedback:** Delivers instant guidance during the assembly process, catching mistakes and immediately providing trainees detailed feedback for continuous improvement.
- **Reduced Waste:** Lowers material consumption by eliminating the need for physical parts to be utilized during training.
- **Effective Documentation:** Training sessions can be recorded for compliance, review, and skill verification purposes.

- **Minimized Training Costs:** traditional training involves hands-on assembly with physical components, which is costly (materials, potential damage), and hence building such a use case will minimize the cost of technician training quite significantly

Contributors and Supporters

- Industrial Metaverse Working Group
- MSF Domains (Peer Review)
- Use Case Taskforce

Keywords

Training; Spatial Awareness; Accuracy; Certifications, and Kinesthetic Learning

Actors/Entities

- **SDOs:** building standards that can guide technician training organizations in the development of inclusive, interoperable, and accessible MDATT Metaverse Platforms
- **Technicians**: may also be referred to as "**Trainees**" or "**Users**" who receive training on the Platform. They follow visual, auditory and, in some cases, haptic guidance and physically perform steps in a detailed protocol using head-worn display and, if provided, gloves to track gestures and provide tactile inputs and feedback
- **Trainers:** may also be called "**Engineers**" or "**Instructors**", and are qualified professionals with the required level of technical training and competence to supervise the training environment and deliver instructions to "**Technicians**" or "**Trainees**" throughout their learning process
- **MDATT Platform Developers:** those who build and enhance Metaverse Platforms to meet MDATT requirements

Detailed Description of Use Case/Scenario

Preconditions:

- **SDOs Collaborate with Industry and Academia in Issuing Metaverse Standards:** that fit the needs of the MDATT industry. These standards can act as an effective entry point towards better development of Medical Device Technician Assembly Training Platforms.
- **Technician Prerequisites:** the technician has basic technical skills and an understanding of Medical Device Handling Procedures. They have also completed any required preliminary training modules (e.g., safety protocols, cleanroom procedures). They also must be trained on the use of the Virtual Training Platform. The technician has completed a brief introductory tutorial on navigating the Metaverse Training Environment and using the Haptic Interfaces.

- **System Availability:** The Virtual Training Platform is operational and accessible. This includes the Metaverse Environment, Virtual Reality (VR) Headsets, Haptic Gloves, and supporting software.
- **Account Setup:** the technician has a Valid Account on the Virtual Training Platform and has been assigned the appropriate training module for the Specific Medical Device.
- **Hardware Calibration:** the VR Headset and Haptic Gloves have been calibrated and are functioning correctly.
- **Network Connectivity:** A Stable and Low-Latency Network connection is available to ensure smooth interaction within the metaverse environment.
- **Training Module Availability:** the specific Virtual Training Module for the Medical Device Assembly is available and up-to-date.

Main Flow:

1. **Logs into the Virtual Training Platform:** the technician, wearing a VR headset and haptic gloves, logs into the Virtual Training Platform. The Platform exists within a dedicated "training room" in the metaverse. The room is designed to resemble a cleanroom environment, familiarizing the technician with the real-world setting.
2. **Interact with the Device for Familiarization:** before assembly, the technician interacts with a virtual 3D model of the Medical Device components. They can manipulate the model, zoom in on components, and access information about each part via interactive annotations. For example, clicking on a specific screw displays its name, material, and torque specifications.
3. **Begin Guided Assembly Training:** the training module guides the technician step-by-step through the assembly process. Instructions are displayed visually (within the VR environment) and audibly. The technician uses their haptic gloves to "pick up" virtual components from a virtual workbench. The haptic feedback simulates the weight and size of the real components, and the force necessary for completing the task, to enhance the realism of the training.
4. **Learn through Interactive Simulations:** as the technician proceeds, the system simulates the assembly process. For instance, when connecting two parts, the system checks for proper alignment and fit. If the technician makes a mistake (e.g., applies incorrect torque, misaligns components), the system provides real-time feedback. This could involve visual cues (e.g., highlighting the error), haptic feedback (e.g., a "vibration" indicating incorrect force), and textual instructions explaining the error and how to correct it.
5. **Obtain Real-time Feedback and Assessment:** the system continuously tracks the technician's progress, providing real-time feedback on their performance. This includes metrics like time taken for each step, accuracy of assembly, and adherence to procedures. The system also assesses the technician's understanding of the underlying principles by asking questions at critical points in the assembly process.
6. **Receive Haptic Guidance:** for complex tasks, the system can provide haptic guidance. For example, when tightening a screw, the haptic gloves can simulate the resistance of the screw and provide feedback when the correct torque is reached. This helps the technician develop the "feel" for the task without damaging any real components.
7. **Acquire Remote Certification:** once the technician completes the virtual assembly, they can be remotely certified. The system generates a detailed report of their performance, which can be reviewed by instructors or used for compliance purposes. This removes the

need for in-person assessments and reduces the logistical challenges of traditional certification processes.

8. **Perform Scenario Variations:** the virtual training environment allows for easy creation of scenario variations. Technicians can be trained on assembling different versions of the device, handling specific malfunctions, or working in different environmental conditions (e.g., simulated temperature changes).

Postconditions

- **Training Completion:** the technician successfully completes the Virtual Assembly Training for the Medical Device.
- **Performance Data:** the system records detailed performance data for the technician, including time taken for each step, accuracy of assembly, errors made, and responses to assessment questions.
- **Certification Status:** the system generates a certification status for the technician, indicating whether they have met the required competency level. This could be a "Pass," "Fail," or "Needs Further Training" status.
- **Skill Improvement:** the technician gains practical experience in assembling the medical device without the need for physical components, reducing the risk of damage to real devices and improving their assembly skills.
- **Data Storage:** the training data and certification status are stored securely within the training platform's database.
- **Feedback Submission (Optional):** the technician has the option to provide feedback on the virtual training module, which can be used to improve future training content.
- **System Log:** the system logs all relevant events during the training session, including user actions, system responses, and any errors encountered.
- **Resource Availability:** the virtual training resources (e.g., 3D models, simulation data) are available for other technicians to use.

Implementations and Demonstrations or Technical Feasibility

Implementations and Demonstrations

- To our knowledge, public implementations of this demonstration are not yet available. However, the Use Case has been studied and is technically feasible, provided the training is realistic (e.g., components the technician is learning to assemble are not too small or large). In circumstances where the components are microscopic, the technician will need a microscope to enlarge the pieces and simulate the real components.
- Success for this Use Case is measured as completion of the assembly task by a trained technician, repeatedly, without guidance or feedback and without errors.

Challenges:

- **Rigorous Planning and Collaboration:** overcoming MDATT Use Case challenges requires adequate preparation and alignment with the various stakeholders involved (e.g., engineers, trainers, technicians), and a commitment to continuous improvement throughout the Training Program.

- **Significant Initial Investment:** acquiring and assembling the various MDATT Program components is key, including costs related to:
  - **Immersive Hardware:** VR Headsets, Haptic Gloves, and High-Performance Computers are required for each training station. This can be a significant upfront expense, especially for large-scale deployments
  - **Software Development:** creating a realistic and effective virtual training environment requires specialized software development expertise. This includes 3D modeling, simulation engine development, haptic feedback integration, and user interface design
  - **Content Creation:** developing high-quality training modules with interactive simulations, assessments, and feedback mechanisms is time-consuming and requires recruitment of subject matter experts and instructional designers
- **Cost-Benefit Analysis:** companies need to conduct a thorough cost-benefit analysis to ensure that the high initial investment in virtual training will result in a positive return, including reducing training costs, improving technicians' performance, enhancing training effectiveness, safety, and reducing the risk of potential damage to real devices.
- **Navigating Technical Complexities:** associated with establishing a highly effective Medical Device Virtual Training Platform, considering the following major aspects:
  - **Platform Integration:** integrating the Metaverse Training Platform with existing enterprise systems (e.g., LMS, HRMS) can be technically complex, especially if those systems use different data formats and communication protocols
  - **Virtual Environment Maintenance:** maintaining the virtual training environment, updating software, and ensuring hardware compatibility requires ongoing technical support and expertise
  - **Network Latency Requirements:** a stable and low-latency network connection is crucial for a smooth and responsive training experience. This can be a challenge in some environments
- **Elevating User Adoption and Training:** necessitates closer alignment between MDATT Platform Developers, Technicians and Instructors to achieve the following objectives:
  - **Building Acquaintance:** as technicians may need time to adapt to the Virtual Training Environment and learn how to use the VR Equipment and Haptic Interfaces effectively
  - **Reducing Resistance to Change:** as some technicians may be resistant to adopting new training methods, especially if they are accustomed to traditional hands-on training
  - **Optimizing "Train the Trainer Programs":** whereby "Instructors" or "Trainers" receive adequate training on how to use the virtual training platform and how to support "technicians" or "trainees" in the metaverse environment
- **Overcoming Content Development Bottlenecks:** enroute to exemplifying robust real-world MDATT scenarios, requires a higher-degree of focus on the following attributes:
  - **Installing Realism:** by creating a virtual environment that accurately replicates the real-world assembly process and provides realistic haptic feedback
  - **Increasing Accuracy Levels:** by ensuring that the virtual simulations are accurate and reflect the actual behavior of the Medical Device for more effective training outcomes

- **Experimenting with Scenario Variations:** by developing a wide range of training scenarios to cover different assembly variations, malfunctions, and environmental conditions which can be resource-intensive

- **Interoperability Across Platforms and Streamlining Standards:** the absence of standardized data formats for 3D models, haptic feedback, training scenarios, and communication protocols can limit integration and interoperability between metaverse applications and different training platforms, systems, and hardware (for e.g., haptic devices)
- **Data Privacy and Security:** the Training Platform must ensure that Sensitive User Data (e.g., medical device design, assembly procedures, and technician performance data) is Protected against Unauthorized Access and Breaches. The challenge lies in implementing robust encryption methods and maintaining privacy in a remote environment
- **Lack of Realism:** the Training Platform may not fully replicate the conditions the technician will encounter when performing actual assembly in production environments
- **Haptic Device Compatibility:** ensuring compatibility between different haptic devices and the training platform can be challenging
- **Network Latency:** real-time interaction and feedback require low network latency. High latency can negatively impact the training experience
- **Regulatory Compliance:** companies must ensure that their virtual training program complies with relevant regulations and data privacy laws (e.g., HIPAA)
- **Evaluation and Validation:** gauging effectiveness of the Virtual Training compared to the traditional hands-on training is key. This requires developing reliable methods for assessing and certifying technician competency in the Metaverse Environment
- **Scalability:** ensuring the Training Platform can Handle a Large Number of Remote Training and Simulation Sessions, run by Users from diverse geographies, without Degrading Performance, Leading to Delays, or Reducing Reliability of the Training Experience, might pose a significant challenge

Requirements:

Technical and Functional Requirements

- **Hardware Requirements:**
  - High-performance computers capable of running VR applications with sufficient processing power, RAM, and graphics cards.
  - High-quality VR headsets with accurate tracking and comfortable ergonomics.
  - Haptic gloves that provide realistic tactile feedback and allow for precise manipulation of virtual objects.
  - Network infrastructure with low latency and sufficient bandwidth to support real-time interaction in the metaverse environment.
- **Software Requirements:**
  - A robust Metaverse Platform that can host the virtual training environment and support Multiple Users simultaneously.
  - A sophisticated simulation engine that accurately models the physics and mechanics of

the Medical Device assembly process.
  - 3D modeling software supportive of the creation and effective management of Medical Device components.
  - Deploying software with capabilities to enable design and implementation of interactive training scenarios, assessments, and feedback mechanisms.
  - Cross-platform interoperability that allows an end-to-end integration between the Metaverse Platform and existing enterprise systems (e.g., Learning Management Systems (LMS), and Human Resource Management System (HRMS)).
- **Data Requirements:**
  - Accurate 3D Modeling of all Medical Device Data Components, preferably sourced from existing IT systems and via well-defined APIs.
  - Rich data on the physical properties of the components, such as weight, texture, and material properties, for realistic haptic feedback.
  - Detailed capture of assembly procedures and instructions for each Medical Device.
  - Design performance metrics and assessment criteria for evaluating technician competency.
- **User and Human Factors Requirements:**
  - **Usability:**
    - The Virtual Training Environment should be intuitive and easy to navigate.
    - The VR equipment and haptic interfaces should be comfortable and easy to use.
    - Clear instructions and feedback should be provided throughout the training process.
  - **Accessibility:**
    - The training program should be accessible to technicians with different levels of technical skills and experience.
    - Accommodations should be made for technicians with disabilities.
  - **Motivation and Engagement:**
    - The Training Program should be designed to be engaging and motivating enough for the Technicians.
    - Gamification elements and other interactive features can be used to enhance and enrich the Learning Experience.
- **Safety and Regulatory Requirements:**
  - **Data Security:**
    - Robust security measures to Protect Sensitive Data related to Medical Device design, assembly procedures, and technician performance.
    - Compliance with relevant data privacy regulations (e.g., HIPAA).
  - **Safety Protocols:** clear safety protocols for using VR equipment and interacting in the Metaverse Environment.
  - **Regulatory Compliance Frameworks:** The Virtual Training program should comply with all relevant regulations and standards for Medical Device Training and Certification. This would Prevent Legal issues and Enhance User Trust by ensuring lawful uses in the Metaverse.
- **Organizational and Logistical Requirements:**

- **Infrastructure:**
  - Dedicated training space with sufficient room for VR equipment and movement.
  - Reliable internet access with low latency.
- **Technical Support:** trained technical staff to support technicians with any hardware or software issues.
- **Training and Support for Trainers:** instructors need to be trained on how to use the Virtual Training Platform and how to support technicians in the Metaverse Environment.
- **Evaluation and Continuous Improvement:** deploy mechanisms for evaluating the effectiveness of the Virtual Training Program and making continuous improvements.

- **Scalable Solutions:** develop Scalable Solutions that can Handle a Large Number of Remote training and simulation Sessions without leading to Performance Degradation, while also maintaining the reliability and efficiency of the Training Experiences even as the number of user sessions grows.

Interoperability Requirements:

- **Cross-Platform Compatibility:** the underlying infrastructure and techniques used to create and deliver the experiences should be architected and provided in a manner that supports progress towards interoperability in the metaverse
- **APIs and Data Formats:** adhere to open data standards for 3D models, haptic data, and training scenarios to facilitate interoperability between different systems. Also, implement APIs that enable integration between the Metaverse Training Platform and other enterprise systems (e.g., LMS, HRMS)
- **Standardized Protocols:** Implement Standardized Protocols for Medical Device Technician Assembly Training Metaverse Platforms to ensure high degrees of interoperability. This facilitates seamless Metaverse Experiences, reducing confusion and improving User Experience
- **Avatar Representation:** of the technician within the metaverse and its interaction with the virtual environment is a key aspect of the user experience. Standardization in Avatar Representation and movement could improve training effectiveness
- **Seamless Integration:** The Training Platform can run as a standalone application, though it could potentially integrate with other enterprise systems (e.g., LMS, HRMS) for tracking progress and certifications. However, seamless interoperability is currently limited as the training environment is a self-contained application.
- **Data Exchange:** The 3D model data of the Medical Device could be sourced from existing IT systems, demonstrating some level of data exchange. However, the annotations and interactive elements are likely specific to the training platform.
- **Simulation Engine:** The accuracy in replicating real-world physics and mechanics through the Simulation Engine is crucial to enable higher degrees of interoperability.
- **Remote Certification Data:** enable seamless export of Remote Certificate Data in a standard format (e.g., xAPI) that is interoperable with LMS and HRMS.

Other Key Considerations:

- **Privacy:** options for Users to Manage, Download, and Consent to How their Data Shall be or Not be Used to Improve Experiences. Also, all applicable laws and regulations concerning data use, consent and privacy should be disclosed so Users are aware to which jurisdictions they are submitting their details and fulfilling its regulatory requirements.

- **Robust Cybersecurity Measures:** to Protect Sensitive Data related to Medical Device Design and Assembly against breaches and unauthorized access is critical. This includes deployment of encryption, secure access controls, and provision of audit trails for regular security audits.
- **Identity Verification:** Users should be provided with an option to choose how they would like to represent their identities in the Training Platform (e.g., through custom-made avatars?) and control their visibility features.
- **Networking and Latency:** devise appropriate network infrastructure that supports real-time integration and information flow between the hardware (e.g., haptic gloves) and the Metaverse Platform, while accommodating the various Users' network speeds
- **Ownership:** provide Technicians with the ability to maintain oversight on their data and avatar usage, storage, and sharing to ensure continuous compliance with the consent they have granted.
- **Digital Ethics:** Develop a Universal Code of Conduct that helps the Platform's Users abide by and maintain professional and constructive interactions in the Metaverse
- **Provenance:** establish robust tracking mechanisms that provide Trainees with real-time updates on the health of their data, with clear trails showing how the data is being used by authorized parties within and outside the Training Platform. Trainees should also be notified promptly of data manipulation attempts and kept informed of emerging threats and harms, and the protective measures required to continuously uphold data integrity
- **Accessibility:** build advanced in-app features that enable Trainees unlock functionalities that cater to their specific disability needs, for example, hearing, visual, sensory, and speech needs among others

Relevant Domain Working Group (WGs):

- NA

Relevant Pre-qualified Organizations and Groups (POGs):

- **World Wide Web Consortium (W3C):** develops standards for the web, including API specifications for accessing VR and AR experiences, which are crucial for the interoperability of metaverse technologies (www.w3.org)
- **The Khronos Group:** an open, member-driven consortium that provides a space for the creation of the interoperability standards focused on multiple disciplines, including XR (VR & AR) and the Metaverse (www.khronos.org)
- **Advanced Digital Learning (ADL) Net:** an initiative reporting to the Defense Human Resources Activity (DHRA) of the U.S. Department of Defense, collaborating with public and private sectors to develop learning standards, tools, and systems (www.adlnet.gov)
- **Institute of Electrical and Electronics Engineers (IEEE):** develops global standards for a wide range of industries, including AR learning focused standards (www.ieee.org)

- **Alliance for Universal Scene Description (AOUSD):** an open, non-profit organization dedicated to promoting interoperability of 3D content through OpenUSD (www.aousd.org)

Relevant Specifications, Publications and Projects (SPPs):

While a standard for metaverse-based Medical Device Training does not yet exist, the field draws upon and contributes to several related areas. Here's a breakdown of relevant specifications, publications, and projects, along with summaries and sources where possible:

- **WebXR Device API:** this W3C specification defines an API for accessing VR and Augmented Reality (AR) devices on the web. It is crucial for web-based metaverse experiences.
- **glTF (GL Transmission Format):** a royalty-free specification for the efficient transmission and loading of 3D scenes and models. Essential for Representing Medical Devices in the Metaverse.
- **xAPI (Experience API):** a specification for learning technology that allows for the collection and tracking of learning experiences from a variety of sources, including simulations and virtual environments. Useful for capturing training data in the metaverse.
- **IEEE 1874 (Augmented Reality Learning Experience Model):** while focused on AR, this standard provides a framework for designing and evaluating AR learning experiences, which can be relevant to VR training as well.
- **USD (Universal Scene Description):** authoring and transmission format capturing all elements of a 3D scene/world. Core specification v1.0 to be ratified by end of 2025.

Related Use Cases

- Cleanroom design and simulated environments (via techniques such as digital twins) may be continuously improved using the data acquired from the logs and data collected during the Virtual Technician Training.

Additional Comments

- This document is a living artifact and may be subject to revisions on a periodic basis to reflect the future state of MDATT, and or based on feedback received from MSF stakeholders that warrants an update in the future.