

# XR-Venues – Live Theatrical Stage Performance

07 and 17 UTC 12 September 2023





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# About MPAI



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# MPAI stands for Moving Picture, Audio, and Data Coding by Artificial Intelligence.

International, unaffiliated, non-profit SDO.

Developing AI-based data coding standards.

With clear Intellectual Property Rights licensing frameworks.



### The MPAI organisation



### The MPAI standard development process



- Develop Use Cases and Functional Requirements.
- Develop Commercial Requirements (Framework Licence).
- Issue Call for Technologies with attached:
  - Functional Requirements.
  - Commercial Requirements.
- Develop standard (MPAI members only).
- SEP holders select patent pool administrator.



### MPAI standards for a better AI

- MPAI's data coding standards make explicit the computing workflow of AI applications.
- An MPAI standard breaks up monolithic AI applications into a set of interacting components of known data semantics (as far as possible).
- Developers compete offering "improved" performance "standard" components.
- Humans can select applications whose internal operation they can somehow understand.

MPAI's AI

standardisation is

"component-based".

An AI application is:

- Subdivided in smaller components: AI modules (AIM).
- Aggregated in one or more AI workflows (AIW).
- Executed in a standard environment (AIF).

1 foundational Technical Specification AI Framework (MPAI-AIF)

### The MPAI AI Framework



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community

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### A sustainable MPAI Ecosystem

- MPAI standards create an ecosystem composed of:
  - **Developers**: develop components
    - $\rightarrow$  require interoperability to bring their components to the market.
  - Integrators: assemble components
    - $\rightarrow$  require ability to assemble third party components.
  - Consumers: use assembled components
    - $\rightarrow$  require that the assembled components be trusted.
- ► The MPAI Store guarantees that AIMs/AIWs are:
  - Interoperable.
  - Trusted.
  - Available.

**1 system Technical Specification**: Governance of the MPAI Ecosystem (MPAI-GME).

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### The MPAI ecosystem



Has established the MPAI Store, not-for-profit commercial entity distributing implementations.



### **More published MPAI standards**

**4** Technical Specifications

- 1 Context-based Audio Enhancement (MPAI-CAE)
- 2 Compression and Understanding of Financial Data (MPAI-CUI)
- 3 Multimodal Conversation (MPAI-MMC)

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4 - Neural Network Watermarking (MPAI-NNW)

2 Technical Reports

1 - MPAI Metaverse Model (MPAI-MMM) – Functionalities

2 - MPAI Metaverse Model (MPAI-MMM) – Functionality Profiles



# Five standards published for Community Comments to become standards on 29 September

Existing MPAI standards extended

1 - AI Framework V2 (MPAI-AIF)

2 - Multimodal Conversation V2 (MPAI-MMC)

New MPAI standards being approved

3 - Avatar Representation and Animation V1 (MPAI-ARA)

4 - Connected Autonomous Vehicles V1 (MPAI-CAV) – Architecture

5 - MPAI Metaverse Model V1 (MPAI-MMM) – Architecture



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### **Brewing in the pot**

**Calls for Technologies issued** 

- 1 Artificial Intelligence for Health (MPAI-AIH)
- 2 Object and Scene Description (MPAI-OSD)
- 3 Extended Reality Venues (MPAI-XRV) Live Theatrical Stage Performance

New opportunities being explored

- 1 AI-based End-to-End Video Coding (MPAI-EEV)
- 2 AI-Enhanced Video Coding (MPAI-EVC)
- 3 Server-based Predictive Multiplayer Gaming (MPAI-SPG)



### **MPAI and IEEE**

MPAI Technical Specifications adopted as IEEE standards

- 1. MPAI-AIF 3301-2022
- 2. MPAI-CAE 3302-2022
- 3. MPAI-MMC 3300-2022
- 4. MPAI-CUI 3303-2023
- 5. MPAI-NNW (on its way)

### All this achieved in less than 3 years!





# About XR Venues



### What is an XR Venue?

**"XR":** Extended Reality (Virtual Reality, Augmented Reality, Mixed Reality etc.) **"Venue":** Synonym for real and virtual environments.

- XR venues can host events integrating both Real and Virtual Environments
  Elements of the Real Environment are mirrored in the Virtual Environment
  Digital twins (including avatars and environmental elements)
  - Elements of the Virtual Environment are mirrored in the Real Environment
    - Immersive displays/domes
    - AR glasses
    - Projection mapping

Participants can Attend and Interact in Real or Virtual Environment



### XR Venue Example





Concurrent Event

Virtual Environment (Metaverse)



### Trends in Live Theatrical Stage Performance

- More use of video scrims, backdrops, and projection mapping in theatrical stage performances (Broadway theatres, musicals, dramas, operas, etc.) to create digital sets in lieu of physical stage sets.
- Immersion domes especially LED volumes –surround audiences with virtual environments that the live performers can inhabit and interact with.
- Live Theatrical Stage Performance can extend into the metaverse as a digital twin of the stage.
- Elements of the *Virtual* Environment experience  $\rightarrow$  the *Real* Environment.
- Elements of the *Real* Environment experience → the *Virtual* Environment (metaverse).



### **Typical Configuration**



#### **Remote Performers XR Venue** LED WALL System LED FLOOR XR Stage Mocap Stage Volumetric Stage Web5 XR Decentralized **XR** Dome Metaverse Backend **Participants Participants** XR **Social Networks** Virtual Environment **Real Environment** PAI. **Remote Participants** 20 **community**

### Advantages of AI for Live Theatrical Stage Performance

- **Rapid mounting** of shows into a wide variety of real and virtual venues.
- Orchestration of the complex lighting, video, audio, and stage set cues that must adapt to the pace of live performers without extensive staff.
- Large shows to tour to smaller venues that otherwise could not support complex productions.
- Live performances spanning both Virtual- and Real-Environments, including inperson or remote participants and performers with enhanced participant interactivity.
- A more direct connection between the artist and participants by consolidating many complex experiential modalities into a simple user interface.
- Artists to access a large amount of data from opted-in individuals and which can be incorporated into the visual and musical performance. Each show can thus be unique for each audience.





# About MPAI-XRV



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# About MPAI-XRV – Live Theatrical Stage Performance Call for Technologies

**Call seeks technologies** for some/preferably all Functional Requirements.

- AI Module (AIM) functionality
- Protocols
- Data formats
- MPAI intends to use the technologies to develop the planned MPAI-XRV Specification.
- Proposers shall state their availability to license their technologies, if adopted by MPAI, in conformity with the Framework Licence.



### A Real-Virtual Interaction Model







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- 1. A physical stage.
- 2. Lighting, projections (e.g., dome, holograms, AR goggles), and Special Effects (FX).
- 3. Audience (standing or seated) in the real and virtual venue and external audiences via interactive streaming.
- 4. Interactive interfaces to allow audience participation (e.g., voting, branching, real-virtual action generation).
- 5. Performers on stage, platforms around domes or moving through the audience (immersive theatres).
- 6. Multisensory experience delivery system (immersive video and spatialised audio, touch, smell).



- 7. Capture of biometric data from audience and/or performers from wearables, sensors embedded in the seat, remote sensing (e.g., audio, video, lidar).
- 8. Show operator(s) to allow manual augmentation and oversight of an AI that has been trained by show operator activity.
- 9. Virtual Environment (metaverse) that mirrors selected elements of the Real Environment. For example, performers on the stage are mirrored by digital twins in the metaverse, using:
  - a. Capture body motion (MoCap) to animate an avatar.
  - b. Keyed 2D image mapped on a plane.
  - c. Volumetrically captured 3D images producing photorealistic digital embodiments.



- 10. Real Environment can also mirror selected elements of the Metaverse, similar to in-camera visual effects/virtual production techniques. Elements of the Metaverse such as, avatars, landscape, sky, objects can be represented in the Real Environment through:
  - a. Immersive displays (domes, LED volumes, panoramic screens or backdrops)
  - b. The entire stage and set pieces may be projection-mapped or wrapped with LED to integrate them into the immersive environment. 3D elements may be extracted from the metaverse and projected into the real-world immersive environment.
  - c. Augmented reality overlays using AR glasses, "hologram" displays or scrims.d. Lighting and FX.



- 11. The physical stage and set pieces blend seamlessly into the virtual 3D backdrop projected onto the immersive display such that the spectators perceive as a single immersive environment.
- 12.Real performers enter the stage. As they move about the stage, whether dancing, acting, etc., their performance may be mirrored in the Virtual Environment (metaverse) by tracking performer's motion, gesture, vocalisation, and biometrics. The performance is accompanied by music, lighting, and FX.
- 13. In addition, virtual performers in the Virtual Environment (metaverse) may be projected onto the real-world immersive environment via immersive display, AR, etc.
- 14.The Script or cue list describes the show events, guiding and synchronising the actions of all AI Modules (AIM) as the show evolves from cue to cue and scene to scene. In addition to performing the show, the AIMs might spontaneously innovate show variations amplify the actions of performers or respond to commands from operators by modifying the Real or Virtual Environment within scripted guidelines.



### Benefits of AI in Live Theatrical Stage Performance

- **1. Rapid mounting** of a show into a variety of real and virtual venues.
- **2. Orchestration** of the complex lighting, video, audio, and stage set cues adapting to the pace of live performers without extensive staff.
- **3. Large shows** can tour to **smaller venues** unable to support complex productions.
- 4. Facilitate live performances spanning both Virtual- and Real-Environments, including in-person or remote participants and performers with enhanced participant interactivity.
- 5. A more direct **connection between the artist and participants** (many complex experiential modalities consolidated into a simple user interface).
- 6. Artists to access a **large amount of data** from opted-in individuals and which can be incorporated into the visual and musical performance.
- 7. Each show can thus be **unique for each audience**.





# Reference model and data





**MPAI Store** 

AIM name	Function		Input		Output
Participants Description	Descriptors extraction	-	Audio, Video, Controllers, Apps, Venue Data	-	Participants Descriptors
Performance Description	Descriptors extraction Separate and track the individual (R or V) performers	-	Lidar/Video of the stage, MoCap data, Volumetric data, Sensor data, Biometric data, Audio, Venue Data	-	Scene Descriptors
Participants Status	Extract Participants Status from Descriptors	-	Participants Descriptors	-	Participants Status
Performance Status	Interpret of Scene Description including Performers, e.g., to create a digital twin and control environment	-	Scene Descriptors	-	Cue Points
Operator Command Interpreter	Interprets operator commands from control surfaces / computers	-	Operator consoles (DJ consoles VJ, lighting and show control console/computer)	-	Interpreted Operator Commands
Action Generator	Generates Action Descriptors for RE and VE based on interpretation of participants, performers, operators, and Cue Point according to the Script, and accessing stored assets	-	Participants Status, Cue Point, Interpreted Operator Control, Scene Descriptors	-	Action Descriptors for RE &VE. Descriptors have a generic data format.
RW Experience Generation	Creates RW multisensory experience for participants (RW/live streaming)	-	Camera orientation Multisensory Scene and Actions Descriptors.	- -	FX Lighting AV
VW Experience Generation	Creates VW multisensory experience for participants (VW)	-	Camera orientation Multisensory Scene and Actions Descriptors.	-	VE Descriptors AV

#	Technologies				
7.1	Scene Descriptors				
7.2	Participant Descriptors				
7.3	Participant Status		•••		
7.4	Script				
7.5	Cue point		Virtual		
7.6	Interpreted Operator Control				
7.7	Action Descriptors				
7.8	Real Experience Generation				
7.8.1	Lighting		Envire		
7.8.2	FX (Effects)				
7.8.3	Audio-Visual (A/V)				
7.8.4	Real Experience Venue specification				
7.9	Virtual Experience Generation				
7.9.1	Virtual Experience Descriptors				
7.9.2	Audio-Visual (A/V)				
7.9.3	Virtual Experience Venue specification				
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# Technologies include: protocols, data formats, AIM functionality



#### **Scene Descriptors**

The Scene Descriptors have the following features:

- 1. The descriptors describe, within both the real and virtual (immersive) environment:
  - a. Visually:
    - i. Position and skeletal orientation of immersive performers
    - ii. Position and orientation of immersive objects
  - b. Audio:
    - i. Stage/virtual environment audio (instruments, vocal, playback, etc.).
    - ii. Spatial position of source.
    - iii.Text of speech.

#### Cue point

- 1. Expression of the current cue point based on interpretation of Scene Descriptors.
- 2. Cue points may be defined by: phrase, gesture, dance motion, prop status etc. (real or virtual).







#### **Participant Descriptors**

Are expressed by:

- 1. Visual behaviour of the audience (hand waving, standing, etc.)
- 2. Participants audio reaction (clapping, laughing, booing, etc.)
- 3. Audience choice (voting, motion controller, text, etc.)

#### **Participant Status**

Is expressed either with:

- 1. A Format supporting the semantics of a set of statuses over time.
  - a. Sentiment (e.g., measurement of spatial position-based audience reaction)
  - b. Expression of choice (e.g., voting, physical movement of audience)
  - c. Emergent behaviour (e.g., pattern emerging from coordinated movement)
- 2. A Language describing the status both at a time and as a trend.





#### **Interpreted Operator Controls**

Interpreted Controls from manual operator consoles including:

- 1. Show control consoles (may include rigging, elevator stages, prop motions, and pyro).
- 2. Audio control consoles (controls audio mixing and effects).
- 3. DJ/VJ control consoles (real-time AV playback and effects).

All consoles may include sliders, buttons, knobs, gesture/haptic interfaces, joystick, touch pads. Interpreted Controls may be Script-dependent.





#### Action Descriptors

Action Descriptors describe the Actions necessary to create the complete experience – in both the Real and Virtual Environments – in accordance with the script. Action Descriptors are able to express All aspects of the experience including the performers' and objects' position, orientation, gesture, costume, etc.

They can be expressed in a format that may be either existing and known (e.g., text prompts) or new.

Descriptors are generic in the sense that they are independent of the specifications of a particular venue. The Descriptors are processed by the Experience Generation AIM and translated into commands that are actionable in the Real or Virtual Environment.



Action

Descriptors

Script

#### **Real Experience Generation**

#### 1. Lighting

Commands and data for all lighting systems, devices, and elements, typically using the DMX protocol or similar.

#### 2. FX (Effects)

Commands and data for all Effects generators (e.g., fog, rain, pyro, mist, etc. machines, 4D seating, stage props, rigging etc.), typically using various standard protocols.

#### 3 Audio-Visual (A/V)

Data and commands for all A/V experiential elements, including audio, video, and capture cameras/microphones.

#### 4. Real Experience Venue specification

An input to the Real Experience Generation AIM defining protocols, data, and command structures for the specific Real Environment Venue. This could include number, type, and placement of lighting fixtures, special effects, sound, and video display resources.







#### **Virtual Experience Descriptors**

A variety of controls for 3D geometry, shading, lighting, materials, cameras, physics, etc. may be used to affect the Virtual Environment. A protocol such as OpenUSD may be used. The actual format used may depend on the current Virtual Environment Venue Specification.

#### Audio-Visual (A/V)

Data and commands for all A/V experiential elements with the virtual environment, including audio and video.

#### **Virtual Experience Venue specification**

An input to the Virtual Experience Generation AIM defining protocols, and data and command structures for the specific Virtual Environment Venue.



### Important note



- MPAI-XRV Live Theatrical Stage Performance involves the collection of large amounts of potentially sensitive Participant Data.
- This document does not address the processes that oversee the collection and processing of Participant Data.
- Rather, it assumes that whatever processing is carried out, it conforms with the necessary and ethical/legal constraints, e.g., with the consent of the right holders of the data<sup>7</sup>.
- Beware:
  - Implementers must take great care in data security, assuring the correct possibility to optin/opt-out offered and proper use of the data.
  - AI Models must be trained and tested to assure conformance with local laws and regulations and to prevent offensive or unintended experiences.





# Framework licence



### Framework Licence: Coverage

- This Framework Licence applies to Technical Specification: XR Venues (MPAI XRV) Live Theatrical Stage Performance in the following "Standard" as it will be defined in document N \_\_\_\_\_ XR Venues (MPAI XRV) Live Theatrical Stage Performance planned to be approved by "Moving Picture, Audio and Data Coding by Artificial Intelligence (MPAI)".
  - <sup>4</sup> All contributors to the Standard shall confirm in writing their intention to make available a Licence for their Essential IPR based on the Conditions of use of the Licence.



### 3 Conditions of use of the Licence/1

The Standard Essential IPR holders commit themselves to issue a Licence with the following conditions:

- 1. The Licence will be in compliance with generally accepted principles of competition law and the MPAI Statutes.
- 2. The Licence will cover:
  - 1. All claims to Essential IPR and copyright of a Licensor that are practised by a Licensee of the Standard.
  - 2. Development Rights and Implementation Rights.
- 3. The Licence will grant access to Essential IPRs of the Standard in a non-discriminatory fashion.
- 4. The scope of the Licence may be subject to legal, bias, ethical and moral limitations.



### Conditions of use of the Licence/2

#### 5. Royalties will apply:

- 1. To a baseline profile of the Standard and to other profiles containing additional technologies.
- 2. To any Implementation that is based on the Standard, with the exclusion of the types of implementations specified in clause 7.1.
- 3. On a worldwide basis.
- 6. An Implementation of the Standard may use other IPR to extend the Implementation Standard or to provide additional functionalities.

#### Exemptions:

- 1. A Licence for Development and Implementation Rights, to the extent it is developed and implemented only for the purpose of evaluation or demo solutions or technical trials, will be free of charge.
- 2. A Licence may be granted free of charge for particular uses if so decided by the licensors.
- 3. A free of charge Licence for a limited time and a limited amount of forfeited royalties will be granted on request.



### Conditions of use of the Licence/3

- 8. A preference will be expressed on the entity that should administer the patent pool of holders of Patents Essential to the Standard.
- 9. The Licence will be issued before commercial implementations of the Standard become available on the market. Commercial implementation implies General Availability to any users and does not include trials.
- 10. The total cost of the Licences issued by IPR holders will be in line with the total cost of the Licences for similar technologies standardised in the context of Standard Development Organisations.
- 11. The total cost of the Licences will take into account the value on the market of the Standard Essential IPR.





# What's next



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### The MPAI-AIH documents



- Anybody is entitled to respond to the XR Venues – Live Theatrical Stage Performance Call for Technologies.
- Responses should reach <u>secretariat@mpai.community</u> by 2023/11/20T23:59 UTC

#### Relevant documents:

Call for Technologies	<u>html, pdf</u>
Use Cases and Functional Requirements	<u>html, pdf</u>
Framework Licence	<u>html, pdf</u>
Template for responses	<u>html, docx</u>





# We look forward to working with you on this exciting MPAI project!

Join MPAI Share the fun Build the future



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