



IEEE Standard Adoption of Moving Picture, Audio and Data Coding by Artificial Intelligence (MPAI) Technical Specification Portable Avatar Format (MPAI-PAF)—Version 1

Developed by the
Collaborative Activities Governance Board

IEEE SA Industry Affiliated Network (IAN)
Base specification contributed by MPAI community



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IEEE Standard Adoption of Moving Picture, Audio and Data Coding by Artificial Intelligence (MPAI) Technical Specification Portable Avatar Format (MPAI-PAF)—Version 1

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Collaborative Activities Governance Board
of the
IEEE SA Board of Governors

Approved 26 September 2024

IEEE SA Standards Board

Abstract: This standard adopts MPAl Technical Specification Version 1 as an IEEE Standard. The Technical Specification MPAl Portable Avatar Format (MPAl-PAF) specifies the following: a) the PAF and data-related formats that allow a sender to enable a receiver to decode and render an avatar as intended by the sender, b) the personal status display composite AI module allowing the conversion of a text and a personal status to a portable avatar, and c) the artificial intelligence framework conforming AI workflows and AI modules composing the avatar-based videoconference use case also using data types from other MPAl technical specifications.

Keywords: adoption, avatar, IEEE 3306™, MPAl-PAF, PAF, portable avatar format

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At the time this standard was completed, the MPAI Portable Avatar Format Working Group had the following membership

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by Artificial Intelligence
www.mpai.community

MPAI Technical Specification

Portable Avatar Format MPAI-PAF

V1

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Readers are invited to review Annex 3 - Notices and Disclaimers.

Technical Specification

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1 Introduction (Informative)

There is a long history of computer-created objects called “digital humans”, i.e., digital objects having a human appearance when rendered. In most cases the underlying assumption of these

objects has been that creation, animation, and rendering is done in a closed environment. Such digital humans had little or no need for standards.

In a communication and more so in a metaverse context, there are many cases where a digital human is not constrained within a closed environment thus requiring forms of standardisation. *Technical Specification: Portable Avatar Format (MPAI-PAF)* – in the following also called MPAI-PAF – is a first response to the requirements of new usage contexts. MPAI-PAF specifies a standard for Portable Avatar Format (PAF) enabling a receiving party to render a digital human as intended by the sending party.

MPAI-PAF has been developed by MPAI – Moving Picture, Audio, and Data Coding by Artificial Intelligence [10], the international, unaffiliated, non-profit organisation developing standards for Artificial Intelligence (AI)-based data coding with clear Intellectual Property Rights licensing frameworks in compliance with the rigorous MPAI Process [11] in pursuit of the following policies:

1. Be friendly to the AI context but, to the extent possible, agnostic to the technology – AI or Data Processing – used in an implementation.
2. Be attractive to different industries, end users, and regulators.
3. Address three levels of standardisation: data types, components (called AI Modules), configurations of components (called AI Workflows) all exposing standard interfaces with an aggregation level decided by the implementer.
4. Specify the data exchanged by components with a clear semantic to the extent possible.

MPAI Application Standards are designed to enable a User to obtain, via standard protocols, an Implementation of an AIW and of the set of corresponding AIMs and execute it in an AIF Implementation. The Store in *Figure 8* is the entity from which Implementations are downloaded. MPAI Standards assume that the AIF, AIW, and AIM Implementations may have been developed by independent implementers. A necessary condition for this to be possible, is that any AIF, AIW, and AIM implementations be uniquely identified. MPAI has appointed an ImplementerID Registration Authority (IIDRA) to assign unique ImplementerIDs (IID) to Implementers.¹

Technical Specification: AI Framework (MPAI-AIF) V2 [1] enables an effective implementation of some of the policies. Figure 1 depicts the Reference Model.

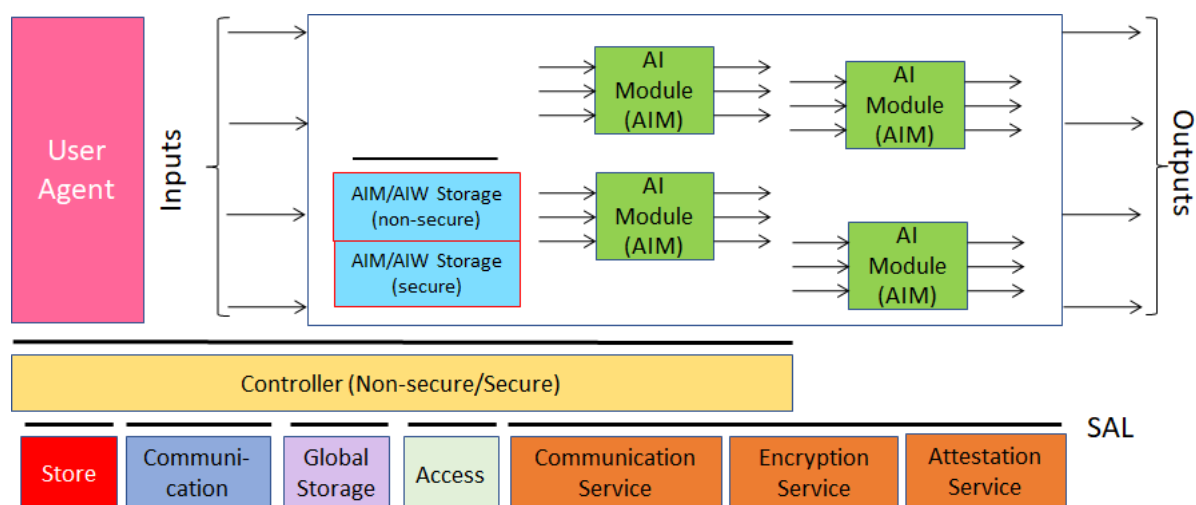


Figure 1 - The AI Framework (MPAI-AIF) V2 Reference Model

¹ At the time of publication of this Technical Specification, the MPAI Store was assigned as the IIDRA.

MPAI-AIF specifies an environment called AI Framework (AIF) enabling the secure execution of AI Workflows (AIW) that can be constituted by AI Modules (AIM). Thus, users can have machines whose internal operation they understand to some degree, rather than machines that are just “black boxes” resulting from unknown training with unknown data and component developers can provide components with standard interfaces that can have improved performance compared to other implementations.

An AIW and its AIMs may have 3 interoperability levels:

Level 1 – Implementer-specific and satisfying the MPAI-AIF Standard.

Level 2 – Specified by an MPAI Application Standard.

Level 3 – Specified by an MPAI Application Standard and certified by a Performance Assessor.

MPAI offers Users access to the promised benefits of AI with a guarantee of increased transparency, trust and reliability as the Interoperability Level of an Implementation moves from 1 to 3.

AI Modules can execute data processing or Artificial Intelligence algorithms and can be implemented in hardware, software, or hybrid hardware/software.

The MPAI-PAF Technical Specification can be implemented in one of the following modalities:

1. As a specific AIW implementing a Use Case, as specified in this document.
2. As a specific AIM, as specified in this document.
3. As a specific data type, as specified in this document.

However, MPAI does not mandate the choice of modality, which remains the sole decision of the implementer.

The MPAI-PAF Technical Specification will be accompanied by the Reference Software, Conformance Testing, and Performance Assessment Specifications. Conformance Testing specifies methods enabling users to ascertain whether a data type generated by an AIM, an AIM, or an AIW conform with this Technical Specification.

The MPAI-PAF Technical Specification applies the technologies to the Avatar-Based Videoconference (PAF-ABV) Use Case where:

1. **Transmitting clients** send PAFs containing:
 - 1.1 At the beginning: Avatar Models and Language Preferences.
 - 1.2 Continuously: Avatar Descriptors, and Speech and Face Objects to a Server.
2. **Server:**
 - 2.1 At the beginning:
 - 2.1.1 Selects an Environment, i.e., a meeting room and equips it with objects, i.e., meeting table and chairs.
 - 2.1.2 Places Avatar Models around the table.
 - 2.1.3 Distributes a PAF containing Environment, Avatar Models, and their positions to receiving clients.
 - 2.2 Continuously sends to receiving clients:
 - 2.2.1 Translated Speech from participants according to Language Preferences.
 - 2.2.2 Sends PAFs containing Avatar Descriptors and translated Speech.
3. **Receiving clients:**
 - 3.1 At the beginning: receive Environment and PAFs containing Avatar Models and Language Preferences
 - 3.2 Continuously:
 - 3.2.1 Receive PAFs containing Avatar Descriptors and translated Speech.

3.2.2 Create Audio and Visual Scene Descriptors.

3.2.3 Render the Audio-Visual Scene as seen from the human-selected Point of View.

MPAI-PAF utilises MPAI technologies specified by other MPAI standards to specify the Avatar-Based Videoconference Use Case. Similarly, other MPAI standards utilise standard MPAI-PAF technologies in other Use Cases such as Human-Connected Autonomous Vehicle (CAV) Interaction (CAV-HCI).

Chapters, Sections, and Annexes are Normative unless they are explicitly identified as Informative.

2 Scope

Technical Specification: Portable Avatar Format (MPAI-PAF) specifies:

1. The Portable Avatar Format and related Data Formats allowing a sender to enable a receiver to decode and render an Avatar as intended by the sender.
2. The Personal Status Display Composite AI Module allowing the conversion of a Text and a Personal Status to a Portable Avatar.
3. The AI Framework (MPAI-AIF)-conforming AI Workflows and AI Modules [1] composing the Avatar-Based Videoconference Use Case also using Data Types from other MPAI Technical Specifications.

The Use Case normatively defines:

1. The Functions of the AIWs and of the AIMs.
2. The Connections between and among the AIMs
3. The Semantics and the Formats of the input and output data of the AIW and the AIMs, in particular Avatar Descriptors.

The word *normatively* implies that an Implementation claiming Conformance to:

1. An *AIW*, shall:
 - a. Perform the function specified in the appropriate Section of Chapter 5.
 - b. Use AIMs connected with the topology and connections conform with the AIW Architecture specified in Chapter 5.
 - c. Have input and output data with the formats specified in Chapter 7.
2. An *AIM*, shall:
 - a. Perform the AIM function specified by the appropriate section of Chapter 5.
 - b. Be composed of AIMs as specified in Chapter 6.
 - c. Receive and produce the data specified in Chapter 7.
3. A data *Format*, the data shall have the format specified in Chapter 7.

Users of this Technical Specification should note that:

1. This Technical Specification defines Interoperability Levels but does not mandate any.
2. Implementers decide the Interoperability Level their Implementation satisfies.
3. Implementers can use the Reference Software of this Technical Specification to develop their Implementations.
4. The Conformance Testing specification can be used to test the conformity of an Implementation to this Standard.
5. Performance Assessors can assess the level of Performance of an Implementation based on the Performance Assessment associated with the MPAI-PAF Technical Specification.
6. Implementers and Users should consider the notices and disclaimers of Annex 2.

This Technical Specification includes the following elements:

1. Scope (This Chapter)
2. Terms and Definitions
3. References
4. Avatar-Base Videoconference Use Case
5. Composite AI Modules
6. Data Formats.

The current version of the Standard has been developed by the Portable Avatar Format (PAF) of the Requirements Standing Committee. MPAI may issue new versions of MPAI-PAF that extend or replace the current Technical Specification.

3 Terms and Definitions

In this document, the following conventions apply:

1. Words beginning with a capital letter are defined in *Table 1*.
2. Words beginning with a small letter have the normal meaning consistent with the relevant context.

In *Table 1*, a dash “-” preceding a Term means the following:

1. If the font of the Term is normal, the Term in the table without a dash and preceding the one with a dash should be placed before that Term. The notation is used to concentrate in one place all the Terms that are composed of, e.g., the word Audio followed by one of the words Object, Scene, and Scene Descriptors.
2. If the font of the Term is *italic*, the Term in the table without a dash and preceding the one with a dash should be placed after that Term. The notation is used to concentrate in one place all the Terms that are composed of, e.g., the word Attitude preceded by one of the words Social or Spatial.

Table 1 – Terms and Definitions

Term	Definition
Attitude	
- <i>Social</i>	A Factor of the Personal Status related to the way a human or Avatar intends to position vis-à-vis the Environment or subsets of it, e.g., “Respectful”, “Confrontational”, “Soothing”.
- <i>Spatial</i>	Position and Orientation and their velocities and accelerations of a Human and Physical Object in a Digital Environment.
Audio	Digital representation of an analogue audio signal sampled at a frequency between 8-192 kHz with a number of bits/sample between 8 and 32, and non-linear and linear quantisation.
Authentication	The process of determining whether a device or a `human is what it states it is.
Avatar	A rendered Digital Human.
- Model	An inanimate Avatar exposing animation interfaces.
- <i>Portable</i>	A Data Type including Avatar ID, Time, Audio-Visual Scene Descriptors, Spatial Attitude, Avatar Model, Body Descriptors, Face Descriptors, Language Preference, Speech Coding, Speech Data, Text, and Personal Status.
Body	A digital representation of a human body, head included, face excluded.

Centre Point	The point of an Object selected to have Local Coordinates (0,0,0).
Cognitive State	An element of the internal status reflecting the way a human or avatar understands the Environment, such as “Confused”, “Dubious”, “Convinced”.
Data	Information in digital form.
- Format	The syntax and semantics of a Data Type.
- Type	A particular type of Data.
Descriptor	The Digital Representation of a feature of an Object.
- Body	A Data Type including the digital representation of the features of the body of a real or digital human.
- Face	A Data Type including the digital representation of a feature of the face of a real or digital human.
Device	A piece of equipment used to interact and have Experience in a Digital Environment.
Digital Representation	Data corresponding to and representing a physical entity.
Emotion	The coded representation of the internal state resulting from the interaction of a human or avatar with the Environment or subsets of it, such as “Angry”, “Sad”, “Determined”.
Environment	A Virtual Space that may be null or may include an Audio-Visual Scene.
Experience	The state of a human whose senses are continuously affected for a meaningful period.
Face	A digital representation of a human face.
Factor	One of Emotion, Cognitive State, and Spatial Attitude.
Gesture	A movement of a Digital Human or part of it, such as the head, arm, hand, and finger, often a complement to a vocal utterance.
Grade	The intensity of a Factor.
Human	
<i>Digital</i>	A Digitised or a Virtual Human in a Virtual Space.
<i>Digitised</i>	An Object in a Virtual Space that has the appearance of a specific human when rendered.
<i>Virtual</i>	An Object in a Virtual Space created by a computer that has a human appearance when rendered but is not a Digitised Human.
Identifier	The label uniquely associated with a human or an Object.
Modality	One of Text, Speech, Face, or Gesture.
Object	A data structure that can be rendered to cause an Experience.
- Audio	Coded representation of Audio information with its metadata. An Audio Object can include other Audio Objects.
- Audio-Visual	Coded representation of Audio-Visual information with its metadata. An Audio-Visual Object can include other Audio-Visual Objects.
- Descriptor	The digital representation of the feature of an Object.
- Digital	A Digitised or a Virtual Object.
- Digitised	The digital representation of a real object.
- Visual	Coded representation of Visual information with its metadata. A Visual Object can include other Visual Objects.
- Virtual	An Object not representing an object in a Real Environment.
Orientation	The 3 Euler angles of an Object in a Virtual Space.