



Moving Picture, Audio and Data Coding
by Artificial Intelligence
www.mpai.community

MPAI Reference Software

Context-based Audio Enhancement MPAI-CAE

V1.4

WARNING

Use of the technologies described in this Technical Specification may infringe patents, copyrights or intellectual property rights of MPAI Members or non-members.

MPAI and its Members accept no responsibility whatsoever for damages or liability, direct or consequential, which may result from use of this Technical Specification.

Readers are invited to review Annex 2 - Notices and Disclaimers.

Reference Software: Context-based Audio Enhancement

1	Introduction (Informative).....	2
2	Scope of the MPAI-CAE Reference Software.....	3
3	Terms and definitions.....	4
4	Terms and Definitions.....	5
5	References.....	7
5.1	Normative References.....	7
5.2	Informative References.....	7
6	Reference Architectures and I/O Data.....	8
6.1	Audio Recording Preservation (ARP).....	8
6.1.1	Reference Architecture.....	8
6.1.2	I/O Data.....	8
6.1.3	Use of Reference Software.....	9
6.2	Enhanced Audioconference Experience (EAE).....	9
6.2.1	I/O Data.....	9
6.2.2	Use of Reference Software (Version v0.1).....	9
	Annex 1 - MPAI-wide terms and definitions.....	11
	Annex 2 - Notices and Disclaimers Concerning MPAI Standards (Informative).....	14
	Annex 3 - The Governance of the MPAI Ecosystem (Informative).....	16
	Annex 4 - Patent declarations.....	18

1 Introduction (Informative)

Moving Picture, Audio and Data Coding by Artificial Intelligence (MPAI) is an international Standards Developing Organisation with the mission to develop *AI-enabled data coding standards*. Compression and feature-based description are notable examples of coding. Research has shown that data coding with AI-based technologies is generally *more efficient* than with existing technologies and MPAI AI-based data coding standards enable the development of AI-based products, applications, and services.

In the following, Terms beginning with a capital letter are defined in **Error! Reference source not found.** if they are specific to this Standard and in *Table 4* if they are common to all MPAI Standards.

Implementations of MPAI Application Standards operate in the AI Framework (AIF) specified by *Technical Specification: AI Framework (MPAI-AIF)* [**Error! Reference source not found.**]. *Figure 1* depicts the MPAI-AIF V1 Reference Model. This Introduction only describes the basic processing elements called AI Modules (AIM) which make up an AI Workflow (AIW) executed in an AI Framework (AIF).

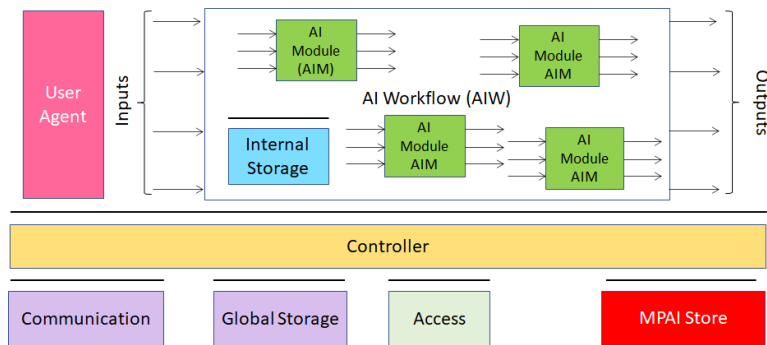


Figure 1 – The AI Framework (AIF) Reference Model and its Components

MPAI Application Standards normatively specify:

1. For the AIMs: the Function, the Semantics and the Formats of the input and output Data but not the internal architecture, which may be based on AI or data processing, and implemented in software, hardware or hybrid software and hardware technologies.
2. For the AIWs: the Function, the Semantics and Formats of the input and output data, and the AIM Topology.

MPAI defines Interoperability as the ability to replace an AIW or an AIM Implementation with a functionally equivalent AIW or AIM Implementation. An AIW *executed in an AIF* may have one of the following MPAI-defined 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 is the root of trust of the MPAI Ecosystem [**Error! Reference source not found.**] offering 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. Additional information is provided by Annex 3.

The chapters and the annexes of this Technical Specification are Normative unless they are labelled as Informative.

2 Scope of the MPAI-CAE Reference Software

Reference Software Specification: Context-based Audio Enhancement (MPAI-CAE) V2 analyses the AIWs and the AIMs composing a subset of the Use Cases of *Technical Specification: Context-based Audio Enhancement (MPAI-CAE) V2* [**Error! Reference source not found.**] and implemented in the companion Reference Software Implementation (in the following “Software”). The Software implements those AIMs and AIWs in a manner that is Conformant with [**Error! Reference source not found.**] and is Normative in the sense that the expression of the computer code in the Software is equivalent to the expression of the natural language in [**Error! Reference source not found.**]. The Software is available at <https://experts.mpai.community/software/mpai-cae/>.

The Software is composed of:

1. A Reference Software Implementation of MPAI-AIF.
2. The AIWs and AIMs.
3. Associated JSON metadata.
4. Conformance Testing datasets.

The Software Implementations of the AIMs composing the AIWs of the MPAI-CAE Use Cases are made available in one or more than one of the following Software Forms (SF):

1. As source code providing a satisfactory user experience and/or functionality.
2. As source code providing a more limited user experience, sufficient to assess the value of the standard.
3. As compiled AIMs providing a satisfactory user experience and/or functionality.
4. As source code software wrapping access to a third-party service enabling a conforming AIM Implementation (Wrapper AIM).

The AIMs are released with the following *disclaimers*:

1. The Software is released according to the MPAI modified BSD licence as provided by the General Licence for MPAI Software 1.0 [**Error! Reference source not found.**].
2. The Software does not aim to provide a ready-to-use product, rather to provide an Implementation exposing the correct input/output interfaces of the MPAI-CAE AIMs and their AIWs.
3. The Software shall be tested for security. MPAI does not provide any guarantee of Software security.
4. Unless the provider of the compiled AIM agrees otherwise, a compiled AIM of the Software may not be used in commercial products or services.
5. Sample input data or a data generating environment or endpoint for trialling the reference software are also provided if required to operate the Software.
6. In case an AIM requires use of a knowledge base, access to a knowledge base conforming with MPAI-CAE is provided.
7. Until further notice, MPAI does not guarantee that AIMs and AIWs of the Software pass Performance Assessment [**Error! Reference source not found.**]. Their only purpose is to provide examples of technically correct Implementations.
8. If Software references third-party software such as FFMPEG, users must verify that they have the right to use such third-party software in conjunction with the Software.
9. A Wrapper AIM is provided only in source code for the part calling the service.
10. Wrapper AIM Software is accompanied by a description and reference to documentation of the third-party service.
11. The submitter of the Wrapper AIM commits to maintain the Software for 12 months after the first publication of this Reference Software.
12. If the third party discontinues the service within 12 months after publication, the submitter of the Wrapper AIM will make its best effort to find a similar third-party service and develop a new Wrapper AIM.
13. If the Wrapper AIM is no longer functioning after 12 months, users, e.g., implementers or knowledgeable programmers, are requested to update the Wrapper AIM code by themselves using the associated documentation and share any updated Wrapper AIM with the MPAI community.

The current version of MPAI-CAE Reference Software supporting the Conversation with Emotion, Multimodal Question Answering, and Unidirectional Use Cases has been developed by the MPAI *Context-based Audio Enhancement* Development Committee (CAE-DC). MPAI may decide to produce new Versions of the MPAI-CAE Reference Software specification.

3 Terms and definitions

The Terms used in this Reference Software specification that are specific of MPAI-CAE and whose first letter is capital have the meaning defined in **Error! Reference source not found.** The general MPAI Terms are defined *Table 4*.

4 Terms and Definitions

The Terms used in this standard whose first letter is capital have the meaning defined in *Table 1*. The general MPAI Terms are defined in *Table 4*.

Table 1 – Table of terms and definitions

Term	Definition
Access Copy Files	Set of files providing the information stored in an audio tape recording, including Restored Audio Files, suitable for audio information access, but not for long-term preservation.
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.
Audio Block	A set of consecutive Audio samples.
Audio Channel	A sequence of Audio Blocks.
Audio File	A .wav file [6].
Audio Object	Direct audio source which is in the audible frequency band.
Audio Scene Geometry	Spatial information for the Audio Objects which are included in an audio scene.
Audio Segment	An Audio Block with Start Time and an End Time Labels corresponding to the time of the first and last sample of the Audio Segment, respectively.
Audio-Visual File	A file containing audio and video according to the MP4 File Format [10].
Capstan	The capstan is a rotating spindle used to move recording tape through the mechanism of a tape recorder.
Damaged List	A list of strings of Texts corresponding to the Damaged Segments (if any) requiring replacement with synthetic segments.
Damaged Section	An Audio Segment which is damaged in its entirety and is contained in a Damaged Segment.
Damaged Segment	An Audio Segment containing only speech (and not containing music or other sounds) which is either damaged in its entirety or contains one or more Damaged Sections specified in the Damaged List.
Degree	Strength of a feature, specifically, with respect to Emotion, “High,” “Medium,” or “Low.”
Editing List	The description of the speed, equalisation and reading backwards corrections occurred during the restoration process.
Emotion	One of the human emotions listed in <i>Error! Reference source not found.</i> , or in an augmented or alternate version of this <i>Error! Reference source not found.</i> .
Emotionless Speech	An Audio File containing speech without music and other sounds, and in which little or no identifiable emotion is perceptible by native listeners.
Interleaved Multi-channel Audio	A data structure containing at least 2 time-aligned interleaved Audio Channels.
Irregularity	An event of interest to preservation from in <i>Error! Reference source not found.</i> and <i>Error! Reference source not found.</i>

Irregularity File	A JSON file containing information about Irregularities of the ARP inputs.
Irregularity Image	An Image corresponding to an Irregularity.
JSON	JavaScript object notation [13].
Microphone Array Geometry	Description of the position of each microphone comprising the microphone array and specific characteristics such as microphone type, look directions, and the array type.
Model Utterance	An Audio Segment used as a model or demonstration of the Emotion to be added to Emotionless Speech in order to produce Speech with Emotion.
Multichannel Audio	A set of multiple time-aligned Audio Channels
Multichannel Audio + Audio Scene Geometry	Multichannel Audio packaged with Audio Scene Geometry.
Neural Network Speech Model	A Neural Network Model trained on Speech Segments for Modelling and used to synthesize replacements for the entire Damaged Segment or Damaged Sections within it.
Passthrough AIM	An AIM with the same input and output data of an AIM without executing the Function of that AIM. E.g., a Noise Cancellation AIM that does not cancel the noise.
Preservation Audio File	The input Audio File resulting from the digitisation of an audio open-reel tape to be preserved and, in case, restored.
Preservation Audio-Visual File	The input Audio-Visual File produced by a camera pointed to the playback head of the magnetic tape recorder and the synchronised Audio resulting from the tape digitisation process.
Preservation Image	A Video frame extracted from Preservation Audio-Visual File.
Preservation Master Files	Set of files providing the information stored in an audio tape recording without any restoration. As soon as the original analogue recordings is no more accessible, it becomes the new item for long-term preservation.
Restored Audio Files	Set of Audio Files derived from the Preservation Audio File, where potential speed, equalisation or reading backwards errors that occurred in the digitisation process have been corrected.
Restored Audio Segment	An Audio Segment in which the entire segment has been replaced by a synthetic speech segment, or in which each Damaged Segment has been replaced by a synthetic speech segment.
Speech Segments for Modelling	A set of Audio Files containing speech segments used to train the Neural Network Speech Model.
Speech With Emotion File	An Audio File containing speech with emotional features.
Spherical Coordinate System	A coordinate system where the position of a point is specified by three numbers: the radial distance of that point from a fixed origin, its polar angle measured from a fixed zenith direction, and the azimuthal angle of its orthogonal projection on a reference plane.
Spherical Grid Resolution	The maximum spherical angle between any two neighbouring sampled points on a sphere.
Time Code	Number of ms from 1970-01-01T00:00:00.000 according to [4].
Time Label	A measure of time from a context-dependent zero time expressed as HH:mm:ss.SSS.
Transform Audio	A frequency representation of Audio

Transform Denoised Speech	Transform Audio whose samples are Denoised Speech samples.
Useful Signal	Digital signal resulting from the A/D conversion of the analogue signal recorded in an audio tape.

5 References

5.1 Normative References

This standard normatively references the following technical specifications, both from MPAI and other standard organisations:

1. MPAI; Technical Specification: The governance of the MPAI Ecosystem (MPAI-GME) V1; <https://bit.ly/3wtQgDP>
2. MPAI; Technical Specification: Artificial Intelligence Framework (MPAI-AIF) V1; <https://bit.ly/3kLPgZm>.
3. A Universally Unique IDentifier (UUID) URN Namespace; IETF RFC 4122; July 2005.
4. Date and Time on the Internet: Time Stamps; IETF RFC 3339; July 2002.
5. Universal Coded Character Set (UCS): ISO/IEC 10646; December 2020.
6. ITU-R BS.2088-1 (10/2019) - Long-form file format for the international exchange of audio programme materials with metadata.
7. ISO/IEC 14496-10; Information technology – Coding of audio-visual objects – Part 10: Advanced Video Coding.
8. ISO/IEC 23008-2; Information technology – High efficiency coding and media delivery in heterogeneous environments – Part 2: High Efficiency Video Coding.
9. ISO/IEC 23094-1; Information technology – General video coding – Part 1: Essential Video Coding.
10. ISO/IEC 14496-12; Information technology – Coding of audio-visual objects – Part 12: ISO base media file format.
11. ZIP format, <https://pkware.cachefly.net/webdocs/casestudies/APPNOTE.TXT>.
12. Neural Network Exchange Format; <https://www.khronos.org/registry/NNEF/specs/1.0/nnef-1.0.4.pdf>; Khronos.
13. The JavaScript Object Notation (JSON) Data Interchange Format; <https://data-tracker.ietf.org/doc/html/rfc8259>; IETF rfc8259; December 2017.
14. BS EN 60094-1:1994, BS 6288-1: 1994, IEC 94-1:1981 - Magnetic tape sound recording and reproducing systems - Part 1: Specification for general conditions and requirements.
15. K. Bradley, IASA TC-04 Guidelines in the Production and Preservation of Digital Audio Objects: standards, recommended practices, and strategies., 2nd ed. International Association of Sound and Audiovisual Archives, (2009): 2014.
16. MPAI; The MPAI Statutes; <https://mpai.community/statutes/>
17. MPAI; The MPAI Patent Policy; <https://mpai.community/about/the-mpai-patent-policy/>.
18. Framework Licence of the Context-based Audio Enhancement Technical Specification (MPAI-CAE); <https://mpai.community/standards/mpai-cae/framework-licence/>
19. ITU-R BS.2088-1: Long-form file format for the international exchange of audio programme materials with metadata.
20. ITU-T T-81: Information technology — Digital compression and coding of continuous-tone still images: Requirements and guidelines.

5.2 Informative References

The references provided here are for information purpose.

21. Ekman, Paul (1999), "Basic Emotions", in Dalgleish, T; Power, M (eds.), Handbook of Cognition and Emotion (PDF), Sussex, UK: John Wiley & Sons.

6 Reference Architectures and I/O Data

6.1 Audio Recording Preservation (ARP)

6.1.1 Reference Architecture

Figure 2 depicts the Audio Recording Preservation Reference Model.

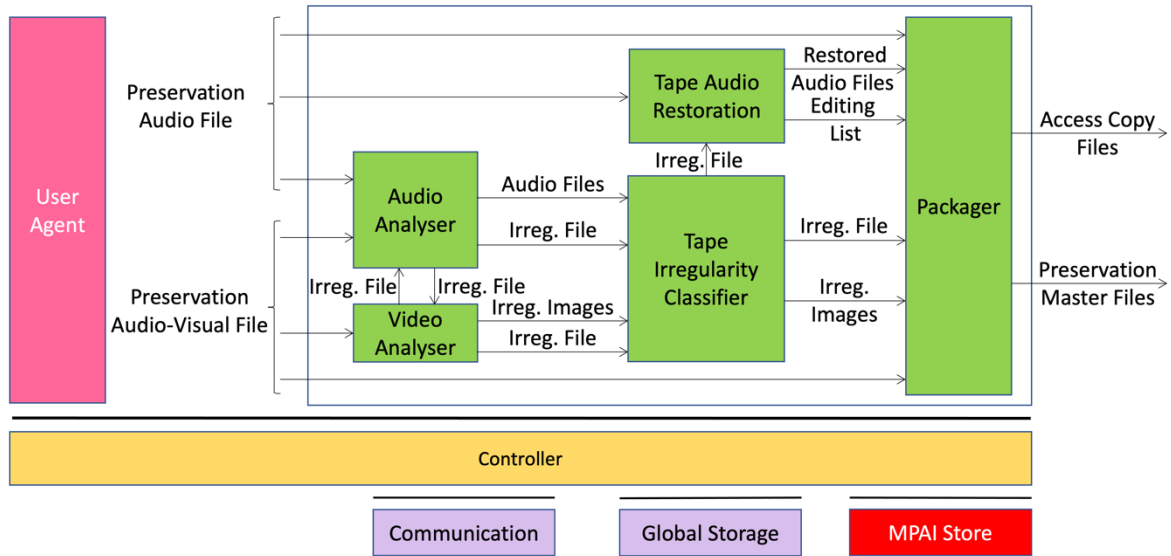


Figure 2 – Audio Recording Preservation Reference Model

6.1.2 I/O Data

Table 2 – CAE-ARP AIMs and their data

AIM	Input Data	Output Data
Audio Analyser	Preservation Audio File Preservation Audio-Visual File Irregularity File	Audio Files Irregularity File
Video analyser	Preservation Audio-Visual File Irregularity File	Irregularity File Irregularity Images
Tape Irregularity classifier	Audio Files Irregularity Images Irregularity File	Irregularity File Irregularity Images
Tape Audio Restoration	Irregularity File Preservation Audio File	Editing List Restored Audio Files
Packager	Preservation Audio File Restored Audio Files Editing List Irregularity File Irregularity Images Preservation Audio-Visual File	Access Copy Files Preservation Master Files

6.1.3 Use of Reference Software

6.2 Enhanced Audioconference Experience (EAE)

Figure 3 shows the Workflow for the EAE.

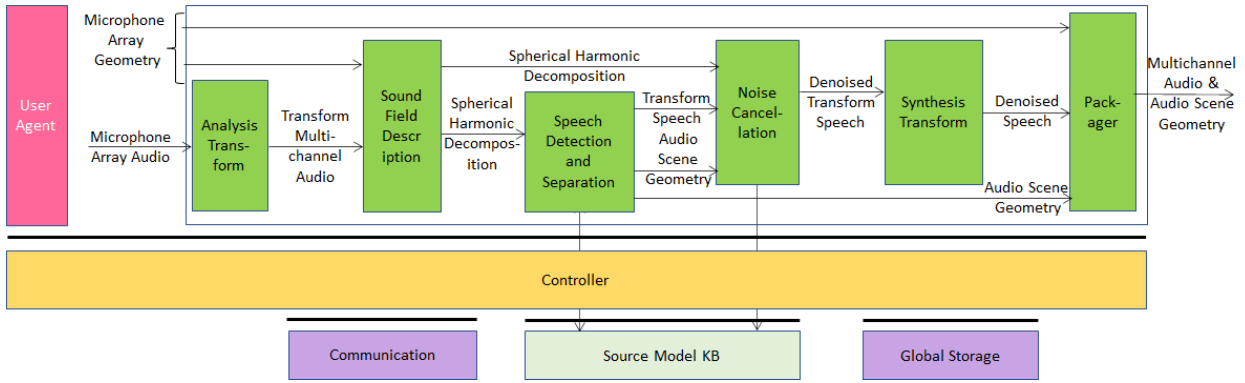


Figure 3 - Enhanced Audioconference Experience Reference Model

6.2.1 I/O Data

Table 3 – CAE-EAE AIMs and their data

AIM	Input Data	Output Data
Analysis Transform	Multichannel Audio	Transform Multichannel Audio
Sound field Description	Transform Multichannel Audio Geometry Information	Spherical Harmonic Decomposition
Speech Detection and Separation	Spherical Harmonic Decomposition	Transform Speech Audio Scene Geometry
Noise Cancellation	Spherical Harmonic Decomposition Transform Speech Audio Scene Geometry	Denoised Transform Speech
Synthesis Transform	Denoised Transform Speech	Denoised Speech
Packager	Denoised Speech Audio Scene Geometry	Multichannel Audio Audio Scene Geometry

6.2.2 Use of Reference Software (Version v0.1)

The EAE repository comprises 4 AIM source codes (Analysis Transform, Sound Field Description, Synthesis Transform, and Packager) and 2 AIM executable (Speech Detection and Separation, Noise Cancellation) files.

For each AIM the installation is described in their ReadMe files which also specify its specific:

- Configuration
- Dependencies
- Database configuration
- How to run tests
- Deployment instructions

Contact: MPAI secreteriat, secretariat@mpai.community, MPAI

Annex 1 - MPAI-wide terms and definitions

The Terms used in this standard whose first letter is capital and are not already included in *Table 1* are defined in *Table 4*.

Table 4 – MPAI-wide Terms

Term	Definition
Access	Static or slowly changing data that are required by an application such as domain knowledge data, data models, etc.
AI Framework (AIF)	The environment where AIWs are executed.
AI Module (AIM)	A processing element receiving AIM-specific Inputs and producing AIM-specific Outputs according to its Function. An AIM may be an aggregation of AIMs.
AI Workflow (AIW)	A structured aggregation of AIMs implementing a Use Case receiving AIW-specific inputs and producing AIW-specific outputs according to its Function.
AIF Metadata	The data set describing the capabilities of an AIF set by the AIF Implementer.
AIM Metadata	The data set describing the capabilities of an AIM set by the AIM Implementer.
Application Programming Interface (API)	A software interface that allows two applications to talk to each other
Application Standard	An MPAI Standard specifying AIWs, AIMs, Topologies and Formats suitable for a particular application domain.
Channel	A physical or logical connection between an output Port of an AIM and an input Port of an AIM. The term “connection” is also used as a synonym.
Communication	The infrastructure that implements message passing between AIMs.
Component	One of the 9 AIF elements: Access, AI Module, AI Workflow, Communication, Controller, Internal Storage, Global Storage, MPAI Store, and User Agent.
Conformance	The attribute of an Implementation of being a correct technical Implementation of a Technical Specification.
Conformance Tester	An entity authorised by MPAI to Test the Conformance of an Implementation.
Conformance Testing	The normative document specifying the Means to Test the Conformance of an Implementation.
Conformance Testing Means	Procedures, tools, data sets and/or data set characteristics to Test the Conformance of an Implementation.
Connection	A channel connecting an output port of an AIM and an input port of an AIM.
Controller	A Component that manages and controls the AIMs in the AIF, so that they execute in the correct order and at the time when they are needed.
Data	Information in digital form.
Data Format	The standard digital representation of Data.
Data Semantics	The meaning of Data.

Device	A hardware and/or software entity running at least one instance of an AIF.
Ecosystem	The ensemble of the following actors: MPAI, MPAI Store, Implementers, Conformance Testers, Performance Testers and Users of MPAI-AIF Implementations as needed to enable an Interoperability Level.
Event	An occurrence acted on by an Implementation.
Explainability	The ability to trace the output of an Implementation back to the inputs that have produced it.
Fairness	The attribute of an Implementation whose extent of applicability can be assessed by making the training set and/or network open to testing for bias and unanticipated results.
Function	The operations effected by an AIW or an AIM on input data.
Global Storage	A Component to store data shared by AIMs.
Identifier	A name that uniquely identifies an Implementation.
Implementation	<ol style="list-style-type: none"> 1. An embodiment of the MPAI-AIF Technical Specification, or 2. An AIW or AIM of a particular Level (1-2-3).
Internal Storage	A Component to store data of the individual AIMs.
Interoperability	The ability to functionally replace an AIM/AIW with another AIM/AIW having the same Interoperability Level
Interoperability Level	<p>The attribute of an AIW and its AIMs to be executable in an AIF Implementation and to be:</p> <ol style="list-style-type: none"> 1. Implementer-specific and satisfying the MPAI-AIF Standard (<i>Level 1</i>). 2. Specified by an MPAI Application Standard (<i>Level 2</i>). 3. Specified by an MPAI Application Standard and certified by a Performance Assessor (<i>Level 3</i>).
Knowledge Base	Structured and/or unstructured information made accessible to AIMs via MPAI-specified interfaces
Message	A sequence of Records.
Normativity	The set of attributes of a technology or a set of technologies specified by the applicable parts of an MPAI standard.
Performance	The attribute of an Implementation of being Reliable, Robust, Fair and Replicable.
Performance Assessment	The normative document specifying the procedures, the tools, the data sets and/or the data set characteristics to Assess the Grade of Performance of an Implementation.
Performance Assessment Means	Procedures, tools, data sets and/or data set characteristics to Assess the Performance of an Implementation.
Performance Assessor	An entity authorised by MPAI to Assess the Performance of an Implementation in a given Application domain
Port	A physical or logical communication interface of an AIM.
Profile	A particular subset of the technologies used in MPAI-AIF or an AIW of an Application Standard and, where applicable, the classes, other subsets, options and parameters relevant to that subset.
Record	Data with a specified structure.
Reference Model	The AIMs and their Connections in an AIW.
Reference Software	A technically correct software implementation of a Technical Specification containing source code, or source and compiled code.
Reliability	The attribute of an Implementation that performs as specified by the Application Standard, profile and version the Implementation refers to, e.g.,

	within the application scope, stated limitations, and for the period of time specified by the Implementer.
Replicability	The attribute of an Implementation whose Performance, as Assessed by a Performance Assessor, can be replicated, within an agreed level, by another Performance Assessor.
Robustness	The attribute of an Implementation that copes with data outside of the stated application scope with an estimated degree of confidence.
Scope	The domain of applicability of an MPAI Application Standard.
Service Provider	An entrepreneur who offers an Implementation as a service (e.g., a recommendation service) to Users.
Specification	A collection of normative clauses.
Standard	The ensemble of Technical Specification, Reference Software, Conformance Testing and Performance Assessment of an MPAI application Standard.
Technical Specification	(Framework) the normative specification of the AIF. (Application) the normative specification of the set of AIWs belonging to an application domain along with the AIMs required to Implement the AIWs that includes: <ol style="list-style-type: none"> 1. The formats of the Input/Output data of the AIWs implementing the AIWs. 2. The Connections of the AIMs of the AIW. 3. The formats of the Input/Output data of the AIMs belonging to the AIW.
Testing Laboratory	A laboratory accredited by MPAI to Assess the Grade of Performance of Implementations.
Time Base	The protocol specifying how AIF Components can access timing information.
Topology	The set of AIM Connections of an AIW.
Use Case	A particular instance of the Application domain target of an Application Standard.
User	A user of an Implementation.
User Agent	The Component interfacing the user with an AIF through the Controller
Version	A revision or extension of a Standard or of one of its elements.
Zero Trust	A cybersecurity model primarily focused on data and service protection that assumes no implicit trust.

Annex 2 - Notices and Disclaimers Concerning MPAI Standards (Informative)

The notices and legal disclaimers given below shall be borne in mind when [downloading](#) and using approved MPAI Standards.

In the following, “Standard” means the collection of four MPAI-approved and [published](#) documents: “Technical Specification”, “Reference Software” and “Conformance Testing” and, where applicable, “Performance Testing”.

Life cycle of MPAI Standards

MPAI Standards are developed in accordance with the [MPAI Statutes](#). An MPAI Standard may only be developed when a Framework Licence has been adopted. MPAI Standards are developed by especially established MPAI Development Committees who operate on the basis of consensus, as specified in Annex 1 of the [MPAI Statutes](#). While the MPAI General Assembly and the Board of Directors administer the process of the said Annex 1, MPAI does not independently evaluate, test, or verify the accuracy of any of the information or the suitability of any of the technology choices made in its Standards.

MPAI Standards may be modified at any time by corrigenda or new editions. A new edition, however, may not necessarily replace an existing MPAI standard. Visit the [web page](#) to determine the status of any given published MPAI Standard.

Comments on MPAI Standards are welcome from any interested parties, whether MPAI members or not. Comments shall mandatorily include the name and the version of the MPAI Standard and, if applicable, the specific page or line the comment applies to. Comments should be sent to the [MPAI Secretariat](#). Comments will be reviewed by the appropriate committee for their technical relevance. However, MPAI does not provide interpretation, consulting information, or advice on MPAI Standards. Interested parties are invited to join MPAI so that they can attend the relevant Development Committees.

Coverage and Applicability of MPAI Standards

MPAI makes no warranties or representations of any kind concerning its Standards, and expressly disclaims all warranties, expressed or implied, concerning any of its Standards, including but not limited to the warranties of merchantability, fitness for a particular purpose, non-infringement etc. MPAI Standards are supplied “AS IS”.

The existence of an MPAI Standard does not imply that there are no other ways to produce and distribute products and services in the scope of the Standard. Technical progress may render the technologies included in the MPAI Standard obsolete by the time the Standard is used, especially in a field as dynamic as AI. Therefore, those looking for standards in the Data Compression by Artificial Intelligence area should carefully assess the suitability of MPAI Standards for their needs.

IN NO EVENT SHALL MPAI BE LIABLE FOR ANY DIRECT, INDIRECT, INCIDENTAL, SPECIAL, EXEMPLARY, OR CONSEQUENTIAL DAMAGES (INCLUDING, BUT NOT LIMITED TO: THE NEED TO PROCURE SUBSTITUTE GOODS OR SERVICES; LOSS OF USE, DATA, OR PROFITS; OR BUSINESS INTERRUPTION) HOWEVER CAUSED AND ON ANY THEORY OF LIABILITY, WHETHER IN CONTRACT, STRICT LIABILITY, OR

TORT (INCLUDING NEGLIGENCE OR OTHERWISE) ARISING IN ANY WAY OUT OF THE PUBLICATION, USE OF, OR RELIANCE UPON ANY STANDARD, EVEN IF ADVISED OF THE POSSIBILITY OF SUCH DAMAGE AND REGARDLESS OF WHETHER SUCH DAMAGE WAS FORESEEABLE.

MPAI alerts users that practicing its Standards may infringe patents and other rights of third parties. Submitters of technologies to this standard have agreed to licence their Intellectual Property according to their respective Framework Licences.

Users of MPAI Standards should consider all applicable laws and regulations when using an MPAI Standard. The validity of Conformance Testing is strictly technical and refers to the correct implementation of the MPAI Standard. Moreover, positive Performance Assessment of an implementation applies exclusively in the context of the [MPAI Governance](#) and does not imply compliance with any regulatory requirements in the context of any jurisdiction. Therefore, it is the responsibility of the MPAI Standard implementer to observe or refer to the applicable regulatory requirements. By publishing an MPAI Standard, MPAI does not intend to promote actions that are not in compliance with applicable laws, and the Standard shall not be construed as doing so. In particular, users should evaluate MPAI Standards from the viewpoint of data privacy and data ownership in the context of their jurisdictions.

Implementers and users of MPAI Standards documents are responsible for determining and complying with all appropriate safety, security, environmental and health and all applicable laws and regulations.

Copyright

MPAI draft and approved standards, whether they are in the form of documents or as web pages or otherwise, are copyrighted by MPAI under Swiss and international copyright laws. MPAI Standards are made available and may be used for a wide variety of public and private uses, e.g., implementation, use and reference, in laws and regulations and standardisation. By making these documents available for these and other uses, however, MPAI does not waive any rights in copyright to its Standards. For inquiries regarding the copyright of MPAI standards, please contact the [MPAI Secretariat](#).

The Reference Software of an MPAI Standard is released with the [MPAI Modified Berkeley Software Distribution licence](#). However, implementers should be aware that the Reference Software of an MPAI Standard may reference some third party software that may have a different licence.

Annex 3 - The Governance of the MPAI Ecosystem (Informative)

Level 1 Interoperability

With reference to *Figure 1*, MPAI issues and maintains a standard – called MPAI-AIF – whose components are:

1. An environment called AI Framework (AIF) running AI Workflows (AIW) composed of interconnected AI Modules (AIM) exposing standard interfaces.
2. A distribution system of AIW and AIM Implementation called MPAI Store from which an AIF Implementation can download AIWs and AIMs.

A Level 1 Implementation shall implement the MPAI-AIF Technical Specification executing AIWs composed of AIMs able to call the MPAI-AIF APIs.

Implementers' benefits	Upload to the MPAI Store and have globally distributed Implementations of
	- AIFs conforming to MPAI-AIF.
	- AIWs and AIMs performing proprietary functions executable in AIF.
Users' benefits	Rely on Implementations that have been tested for security.
MPAI Store's role	- Tests the Conformance of Implementations to MPAI-AIF.
	- Verifies Implementations' security, e.g., absence of malware.
	- Indicates unambiguously that Implementations are Level 1.

Level 2 Interoperability

In a Level 2 Implementation, the AIW must be an Implementation of an MPAI Use Case and the AIMs must conform with an MPAI Application Standard.

Implementers' benefits	Upload to the MPAI Store and have globally distributed Implementations of
	- AIFs conforming to MPAI-AIF.
	- AIWs and AIMs conforming to MPAI Application Standards.
Users' benefits	- Rely on Implementations of AIWs and AIMs whose Functions have been reviewed during standardisation.
	- Have a degree of Explainability of the AIW operation because the AIM Functions and the data Formats are known.
Market's benefits	- Open AIW and AIM markets foster competition leading to better products.
	- Competition of AIW and AIM Implementations fosters AI innovation.
MPAI Store's role	- Tests Conformance of Implementations with the relevant MPAI Standard.
	- Verifies Implementations' security.
	- Indicates unambiguously that Implementations are Level 2.

Level 3 Interoperability

MPAI does not generally set standards on how and with what data an AIM should be trained. This is an important differentiator that promotes competition leading to better solutions. However, the performance of an AIM is typically higher if the data used for training are in greater quantity and more in tune with the scope. Training data that have large variety and cover the spectrum of all cases of interest in breadth and depth typically lead to Implementations of higher “quality”.

For Level 3, MPAI normatively specifies the process, the tools and the data or the characteristics of the data to be used to Assess the Grade of Performance of an AIM or an AIW.

Implementers' benefits	May claim their Implementations have passed Performance Assessment.
------------------------	---

- | | |
|-------------------|---|
| Users' benefits | Get assurance that the Implementation being used performs correctly, e.g., it has been properly trained. |
| Market's benefits | Implementations' Performance Grades stimulate the development of more Performing AIM and AIW Implementations. |
| MPAI Store's role | - Verifies the security of Implementations.
- Indicates unambiguously that Implementations are Level 3. |

The MPAI ecosystem

Figure 4 is a high-level description of the MPAI ecosystem operation applicable to fully conforming MPAI implementations as specified in the Governance of the MPAI Ecosystem Specification [Error! Reference source not found.]:

1. MPAI establishes and controls the not-for-profit MPAI Store.
2. MPAI appoints Performance Assessors.
3. MPAI publishes Standards.
4. Implementers submit Implementations to Performance Assessors.
5. If the Implementation Performance is acceptable, Performance Assessors inform Implementers and the MPAI Store.
6. Implementers submit Implementations to the MPAI Store tested for Conformance and security.
7. Users download and use Implementations and submit experience scores.

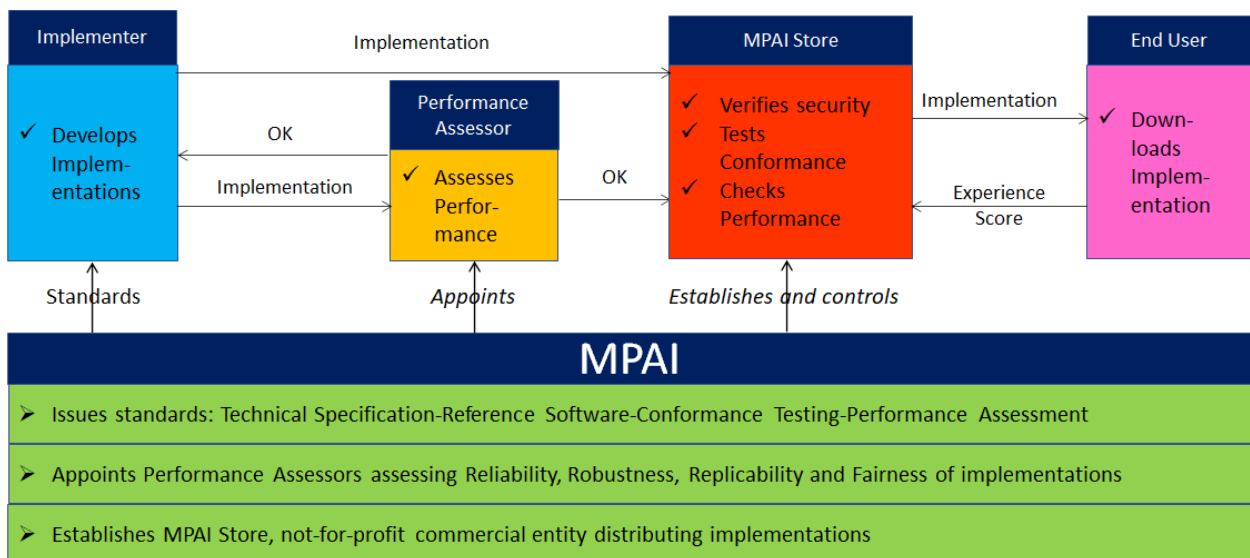


Figure 4 - The MPAI ecosystem operation

Annex 4 - Patent declarations

Technical Specification: MPAI Context-based Audio Enhancement (MPAI-CAE) has been developed according to the process outlined in the MPAI Statutes [**Error! Reference source not found.**] and the MPAI Patent Policy [**Error! Reference source not found.**].

The following entities have agreed to licence their standard essential patents reading on the MPAI Context-based Audio Enhancement (MPAI-AIF) Technical Specification according to the MPAI-CAE V1 Framework Licence []:

Entity	Name	Email address
Speech Morphing, Inc.	Fathy Yassa	fathy@speechmorphing.com