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

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# Introduction

MPAI’s standards development is based on projects evolving through a workflow extending on 6 + 1 stages.

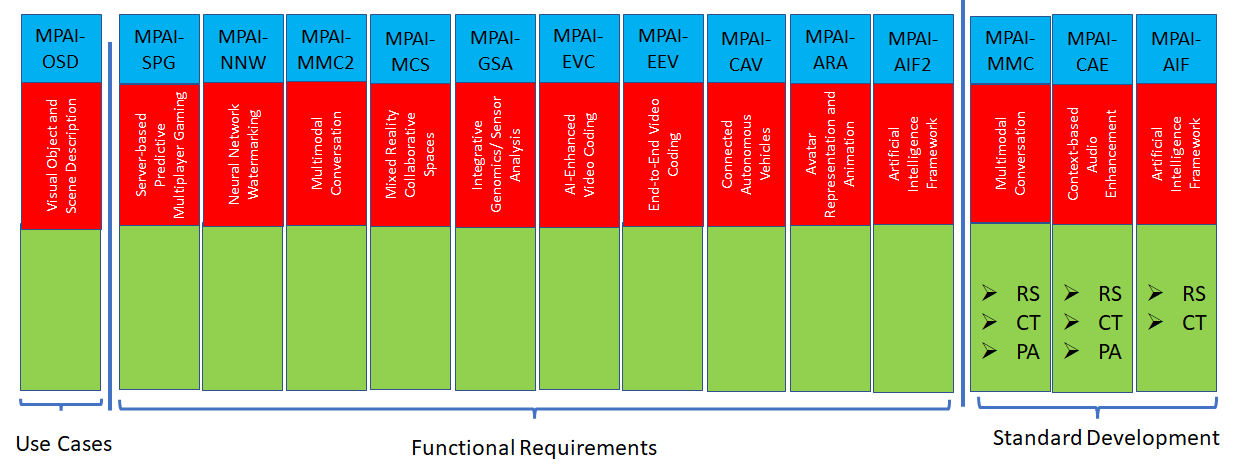
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| **#** | **Acr** | **Name** | **Description** |
| 0 | IC | Interest Collection | Collection and harmonisation of use cases proposed. |
| 1 | UC | Use cases | Proposals of use cases, their description and merger of compatible use cases. |
| 2 | FR | Functional Reqs | Identification of the functional requirements that the standard in­cluding the Use Case should satisfy. |
| 3 | CR | Commercial Reqs | Development and approval of the framework licence of the stan­dard. |
| 4 | CfT | Call for Technologies | Preparation and publication of a document calling for technologies supporting the functional and commercial requirements. |
| 5 | SD | Standard Development | Development of the standard in a specific Development Com­mit­tee (DC). |
| 6 | CC | Community Comments | When the standard has achieved sufficient maturity it is published with request for comments. |
| 7 | MS | MPAI standard | The standard is approved by the General Assembly. |

A project progresses from one stage to the next by resolution of the General Assembly.

The stages of currently (MPAI-20) active MPAI projects are graphically represented by

.

TS: Technical Specification, RS: Reference Software, CT: Conformance Testing, PA: Performance Assessment.



*Figure 1 – Snapshot of the MPAI work plan*

# Approved standards

## MPAI-CUI

Compression and understanding of industrial data (MPAI-CUI) aims to enable AI-based filtering and extraction of key information to predict company performance by applying Artificial Intellig­ence to governance, financial and risk data. This is depicted in Figure 2.

A picture containing chart

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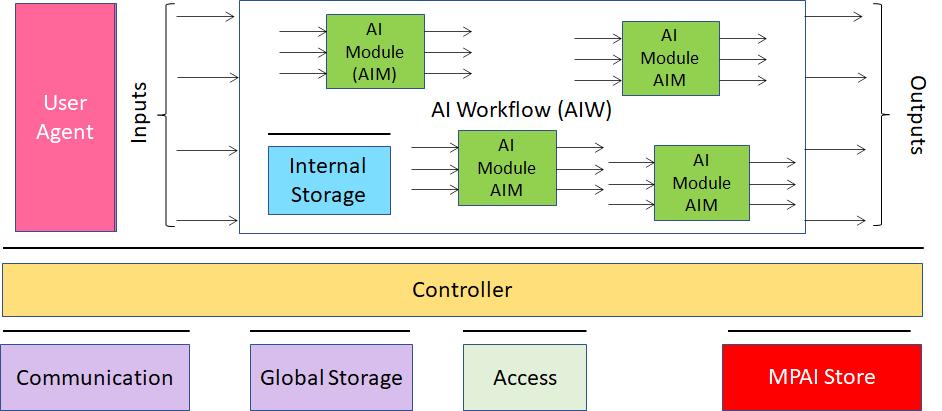
*Figure* 2 – *The MPAI-CUI Use Case*

The collection of publicly available MPAI-CUI documents is [here](https://mpai.community/standards/mpai-cui/). The set of specifications composing the MPAI-CUI standard is avail­able [here](https://mpai.community/resources/).

# Areas at stage 6 (SD)

## MPAI-AIF

Artificial Intelligence Framework (MPAI-AIF) enables creation and automation of mixed Artif­icial Intelligence – Machine Learning – Data Processing workflows for the application areas cur­rently considered by the MPAI work plan. MPAI-AIF will be extended to support new applic­ations areas, if the need will arise. Figure 3 shows the general MPAI-AIF Reference Model.



*Figure 3 – Reference model of the MPAI AI Framework*

The MPAI-AIF Technical Specification has been approved and is available [here](https://mpai.community/resources/).

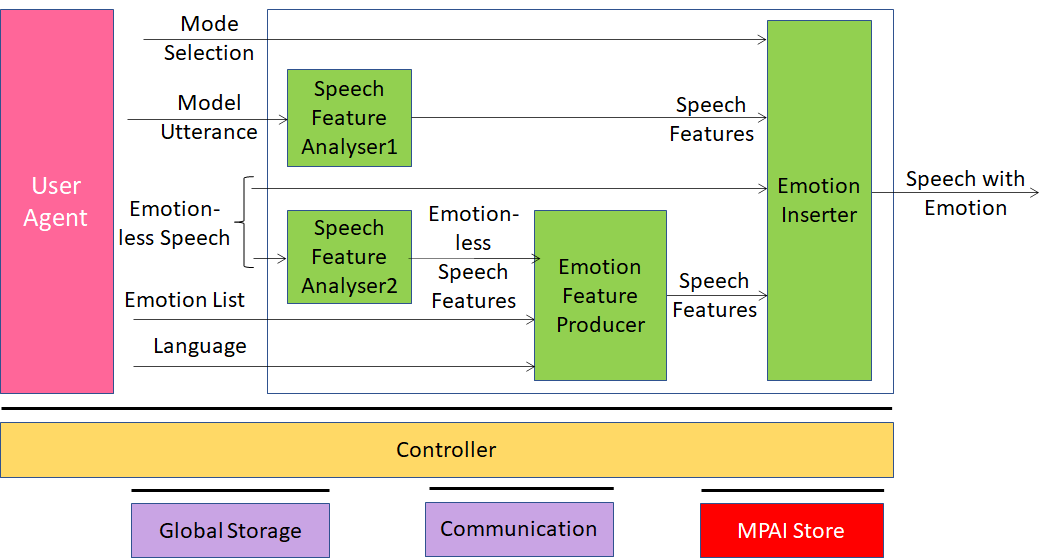
MPAI is developing Use Cases and Requirements for Version 2.

The collection of public documents is available [here](https://mpai.community/standards/mpai-aif/).

## MPAI-CAE

Context-based Audio Enhancement (MPAI-CAE) improves the user experience for several audio-related applications including entertainment, communication, teleconferencing, gaming, post-production, restoration etc. in a variety of contexts such as in the home, in the car, on-the-go, in the studio etc. using context information to act on the input audio content using AI.

Figure 4 is the reference model of Unidirectional Speech Translation.



*Figure* 4 – *An MPAI-CAE Use Case: Emotion-Enhanced Speech*

The MPAI-AIF Technical Specification has been approved and is available [here](https://mpai.community/resources/).MPAI is developing Use Cases and Requirements for Version 2.

The collection of public documents is available [here](https://mpai.community/standards/mpai-cae/).

## MPAI-MMC

Multi-modal conversation (MPAI-MMC) aims to enable human-machine conversation that emul­ates human-human conversation in completeness and intensity by using AI.

So far, 5 Use Cases have been identified for MPAI-MMC: Conversation with emotion, Multimodal Question Answering (QA) and 3 Automatic Speech Translation Use Cases.

Figure 5 depicts the Conversation with Emotion Use Case Reference Model.

Graphical user interface

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*Figure* 5 – *An MPAI-MMC Use Case: Conversation with Emotion*

The MPAI-MMC Technical Specification V1.1 has been approved and is available [here](https://mpai.community/resources/).

MPAI is developing Use Cases and Requirements for Version 2.

The collection of public documents is available [here](https://mpai.community/standards/mpai-cui/).

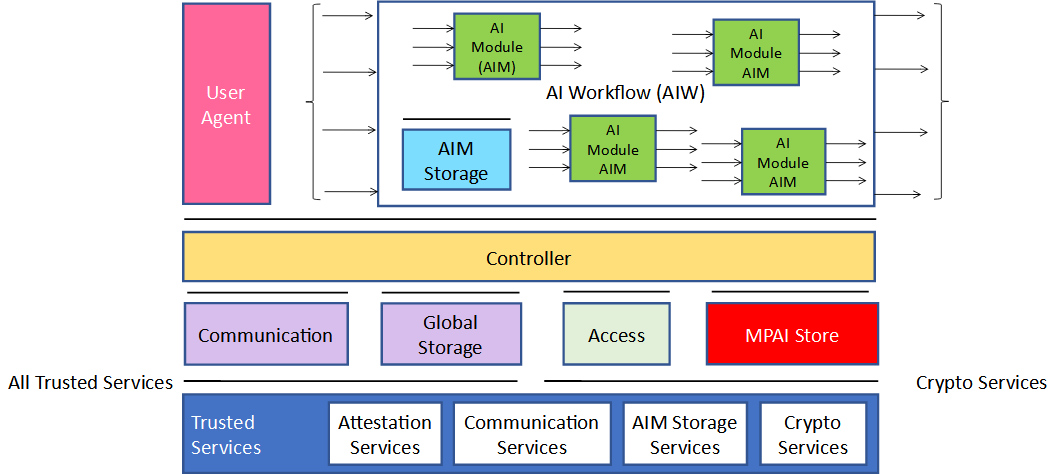
# Areas at stage 2 (FR)

## MPAI-AIF V2

AI Framework (MPAI-AIF) V2 is a project extending MPAI-AIF V1 by adding security support.

Figure 6 gives the new Reference Model.

The collection of public documents is available [here](https://mpai.community/standards/mpai-aif/).



*Figure 6 - Reference Model of MPAI-AIF V2*

## MPAI-ARA

Avatar Representation and Animation (ARA) is a project developing requirements for standards supporting the needs of MPAI-MMC, MPAI-CAV and MPAI-MCS.

The collection of public documents is available [here](https://mpai.community/standards/mpai-ara/).

## MPAI-CAV

Connected Autonomous Vehicles (CAV) is a Use Case addressing the Connected Autonomous Vehicle (CAV) domain and the 5 main operating instances of a CAV:

*Human-CAV interaction (HCI)*, i.e., the CAV subsystem that responds to humans’ com­mands and queries, senses human activities in the CAV passenger compartment and activates other subsystems as required by humans or as deemed necessary by the identified conditions.

*CAV-Environment interaction*, i.e., the subsystem that acquires information from the physical environment via a variety of sensors.

*Autonomous Motion Subsystem (AMS)*, i.e., the CAV subsystem that uses different sources of information to instructs the CAV to reach the intended destination.

*CAV-Device Interaction (CDI)*, i.e., the subsystem that communicates with sources of external information, including other CAVs, Roadside Units (RSU), other vehicles etc.

*Motion Actuation Subsystem (MAS)*, i.e., the subsystem that operates and actuates the motion instructions in the physical world.

The interaction of the 5 subsystems in depicted in Figure 7.



*Figure 7 – The CAV subsystems*

The collection of public documents is available [here](https://mpai.community/standards/mpai-cav/).

## MPAI-EEV

There is consensus in the video coding research community that the so-called End-to-End (E2E) video coding schemes can yield significantly higher performance than those target, e.g., by MPAI-EVC. AI-based End-to-End Video Coding intends to address this promising area.

The collection of public documents is available [here](https://mpai.community/standards/mpai-eev/).

## MPAI-EVC

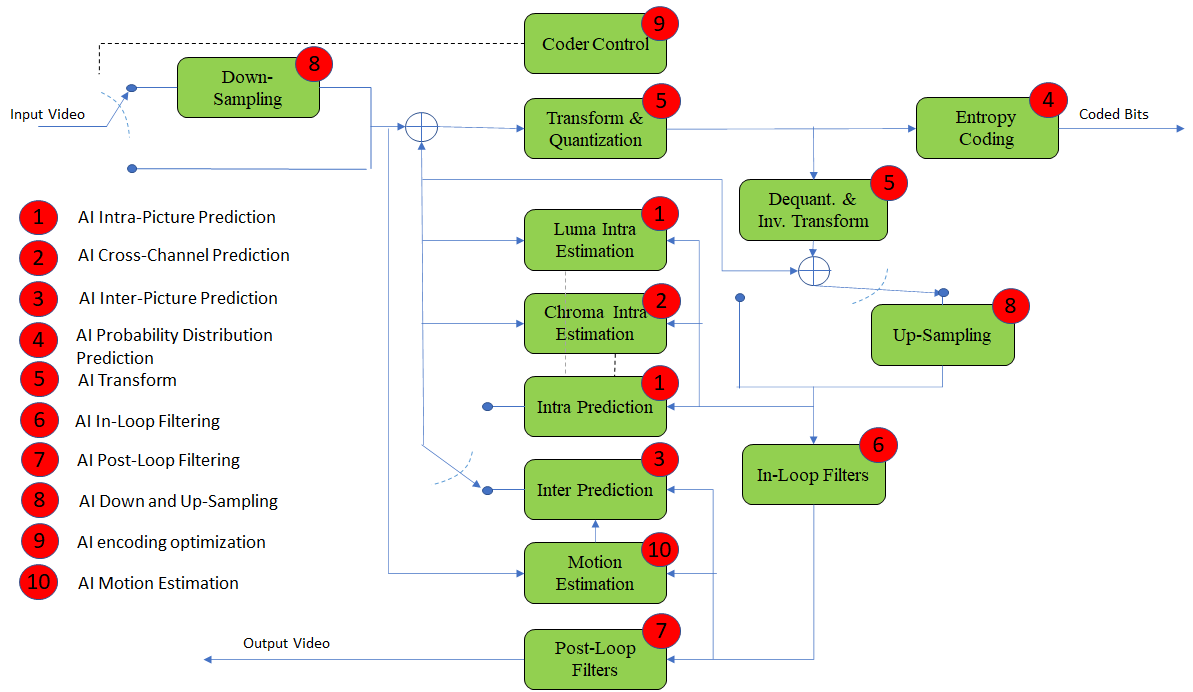
AI-Enhanced Video Coding (MPAI-EVC) is a video compression stan­dard that substantially en­hances the performance of a traditional video codec by improving or replacing traditional tools with AI-based tools. Two approaches – Horizontal Hybrid and Vertical Hybrid – are envisaged. The **Vertical Hybrid** approach envigaes an AVC/HEVC/EVC/VVC base layer plus an enhanced machine learning-based layer. This case can be represented by Figure 8.

Diagram

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*Figure* 8 – *A reference diagram for the Vertical Hybrid approach*

The **Horizontal Hybrid** approach introduces AI based algorithms combined with trad­itional image/video codec, trying to replace one block of the traditional schema with a machine learn­ing-based one. This case can be described by Figure 9 where green circles represent tools that can be replaced or enhanced with their AI-based equivalent.



*Figure* 9 – *A reference diagram for the Horizontal Hybrid approach*

MPAI is engaged in the MPAI-EVC Evidence Project seeking to find evidence that AI-based technologies provide sufficient improvement to the Horizontal Hybrid approach. A second project on the Vertical Hybrid approach is being considered.

The collection of public documents is available [here](https://mpai.community/standards/mpai-evc/).

## MPAI-GSA

Integrative Genomic/Sensor Analysis (MPAI-GSA) uses AI to understand and compress the res­ult of high-throughput experiments combining genomic/proteomic and other data, e.g., from video, motion, location, weather, medical sensors.

Figure 10 addresses the Smart Farming Use Case.

Diagram

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*Figure* 10 – *An MPAI-GSA Use Case: Smart Framing*

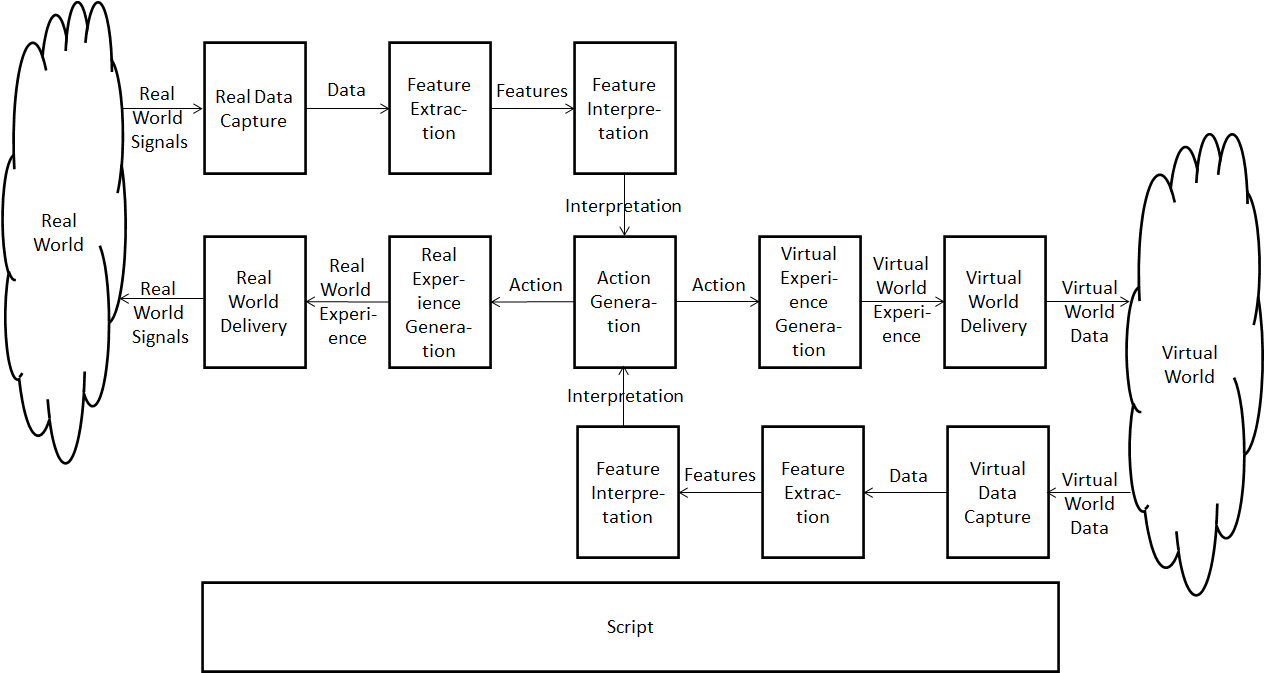
The collection of public documents is available [here](https://mpai.community/standards/mpai-gsa/).

## MPAI-MCS

Mixed-Reality Collaborative (MPAI-MCS) Spaces is a project riding on the opportunities offered by emerging technologies enabling developers to deliver mixed-reality collaborative space (MCS) applications where biomedical, scientific, and industrial sensor streams and recordings are to be viewed. MCS systems use AI ro achieveimmersive presence, spatial maps (e.g. Lidar scans, inside-out tracking) rendering, and multiuser synchronis­ation etc.

The requirements of the Avatar-Based Videoconference Use Case, originally developed in the MCS Requirements subgroup, are currently being finalised by MMC-DC with the goal of issuing a Call for Technologies.

The MCS Requirements subgroup is now working on the XR Theatre Use Case and has specifically developed a reference model that describes the components of Real-to-Virtual-to-Real scenario depicted in Figure 11.



*Figure 11 – The Client Based Ambient Reference Model (Client TX)*

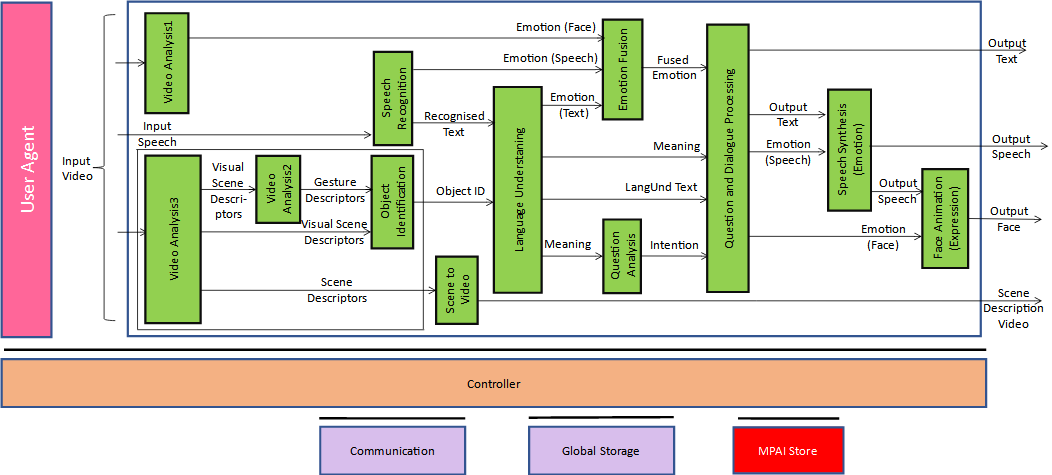
The collection of public documents is available [here](https://mpai.community/standards/mpai-mcs/).

## MPAI-MMC V2

Multi-modal conversation V2 (MPAI-MMC V2) uses AI to enable human-machine conversation that emul­ates human-human conversation in completeness and intensity.

So far, 3 new Use Cases have been identified: Conversation About a Scene (CAS), Human-CAV Interaction (HCI) and Avatar-Based Videoconference (ABV).

Figure 12 is the reference model of the Conversation About a Scene (CAS) Use Case.



*Figure* 12 – *An MPAI-MMC V2 Use Case: Conversation About a Scene*

## MPAI-NNW

Neural Network Watermarking is a project developing require­ments for a standard enabling the measure, for a given size of the watermarking payload, of:

1. The impact, e.g., the degradation of the user experience caused by the watermark applied to a neural network.
2. The resistance to attacks, e.g., transfer learning, pruning.
3. The processing cost of watermarking injection, e.g., time, processing cost.

## MPAI-SPG

Server-based Predictive Multiplayer Gaming (MPAI-SPG) aims to minimise the audio-visual and gameplay discontinuities caused by high latency or packet losses during an online real-time game. In case information from a client is missing, the data collected from the clients involved in a particular game are fed to an AI-based system that predicts the moves of the client whose data are missing. The same technologies provide a response to the need to detect who amongst the players is cheating.

Figure 13 depicts the MPAI-SPG reference model including the cloud gaming model.

Graphical user interface

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*Figure* 13 – *The MPAI-SPG Use Case*

The collection of public documents is available [here](https://mpai.community/standards/mpai-spg/).

# Areas at stage 1 (UC)

## MPAI-OSD

Visual object and scene description is a collection of Use Cases sharing the goal of describe visual object and locate them in the space. Scene description includes the usual des­cription of objects and their attributes in a scene and the semantic description of the objects.

Unlike proprietary solutions that address the needs of the use cases but lack interoperability or force all users to adopt a single technology or application, a standard representation of the ob­jects in a scene allows for better satisfaction of the requirements.

The collection of public documents is available [here](https://mpai.community/standards/mpai-osd/).

# Areas at stage 0 (IC)