

The MPAI Metaverse Model

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Moving Picture, Audio, and Data Coding by Artificial Intelligence (MPAI) on Zoom, 2023/01/10T08 UTC



Why this presentation

Growing industry interest in the Metaverse:

- New jobs-opportunities-experiences.
- Transformational impacts on virtually all sectors of human interaction.
- MPAI plays a role in standards and AI: main drivers for the development of the Metaverse.
- Several MPAI standards address Metaverse requirements.
- Long experience of MPAI member in multi-industry standardisation projects.
- MPAI can play a positive role together with many other SDOs

The MPAI Metaverse Model (MMM): designed to facilitate the establishment of standards promoting Metaverse Interoperability.



About MPAI

Moving Picture, Audio, and Data Coding by Artificial Intelligence.

International, unaffiliated, non-profit SDO.

Developing Al-based data coding standards.

With clear Intellectual Property Rights licensing frameworks.

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MPAI's AI standardisation is "component-

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An AI application:

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

MPAI's results so far

1 foundational standard: AI Framework (MPAI-AIF)

3 application standards :

- Context-based Audio Enhancement (MPAI-CAE)
- Compression and Underst. of Financial Data (MPAI-CUI)
- Multimodal Conversation (MPAI-MMC)

1 system standard: Governance of the MPAI Ecosystem (MPAI-GME).

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Current MPAI activities

About to approve Neural Network Watermarking (MPAI-NNW).

Extending MPAI-AIF MPAI-CAE

MPAI-MMC

Developing Avatar Representation and Animation (MPAI-ARA)

Six exploratory activities

- Al Health
- Connected Autonomous Vehicles
- Server-based Predictive
- Multiplayer Gaming
- Al-based End-to-End Video Coding
- Al-Enhanced Video Coding - XR Venues

Adopted as IEEE standards

- MPAI-AIF 3301-2022
- MPAI-CAE 3302-2022
- MPAI-MMC 3300-2022
- MPAI-CUI (on its way)



About the MPAI Metaverse Model (MMM)

- The WWW has shown the power of interoperability.
 - Agreement that Metaverse Instances should be interoperable.
 - What is Metaverse Interoperability?
- The MMM is an outline of a Metaverse standards project:
 - Approach.
 - Based on proven methods adapted to the new context.
 - Roadmap.
 - First step.

2022/09/22



The proposed approach

- Metaverse standardisation is highly interdisciplinary.
- Metaverse Interoperability \neq "one size fits all".
- The approach proposed:

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- Identify and classify Metaverse Functionalities expressed by legitimate industry requirements.
- 2. Develop Common Metaverse Specifications (CMS) providing the Technologies to support the identified Functionalities.
- 3. Grouped CMS Technologies into industry-supported "Profiles".
- Retain a controlled level of Interoperability By implementing a CMS Profile.



It's not going to be easy, but let's try...



1. Definitions

Terminology: conflicting or unifying?

- **Hard** to set **terms and definitions** in any area.
- Harder when it is as multidisciplinary as the Metaverse.
- **Different** fields have **different** backgrounds, terms, and technologies.
- **Same notion** has different terms; **same terms** have different meanings.
- Conflicting terminologies please all → a Tower of Babel.
- ► Unifying terminology displeases most → shared models.
- **Consistency** of terms and definitions, regardless of what the **labels** are.



Term	Definition
Human	
- Digital	A Digitised or a Virtual Human.
- Digitised	An Object created by a computer that has a human appearance when rendered but is not a Digitised Human.
- Virtual	An Object that has the appearance of a specific human when rendered.
Object	A data structure that can be used by a Process, e.g., rendered to cause an Experience.
Persona	A manifestation of a User as a rendered Digital Human, i.e., an avatar model.
Social Graph	A representation of the interconnections between a User and other Users, groups of Users, and Components.
User	Either a Digitised Human driven by a human, or else a Virtual Human driven by a Process.
- Account	A dataset that unequivocally identifies a User. A User may have more than one Account.
- Identifier	A name uniquely associated with a Metaverse User.
- Profile	A collection of Data including Account and Identifier associated with a Metaverse User.
- Data	The Data generated by a User while in a Metaverse Environment.
	1) Community

2. Assumptions

Three basic assumptions (out of 16)

Assumption #1

MPAI develop a **set of Functionalities** required by Metaverse Instances to support legitimate industry requirements.

Assumption #2

SDOs develop **Common Metaverse Specifications** (CMS) providing technologies supporting identified Functionalities.

Assumption #3

Metaverse Governance groups CMS Technologies into **Profiles** responding to *industry* needs.



The Profile approach for the Metaverse?

The goal	Digital television	Metaverse
Industry	Homogeneous industries (kind of)	Heterogeneous industries
Functionality	People knew it (kind of)	Some ideas
Technology	Available or accessible (kind of)	Some technologies missing
Profiles	Subset of a single standard	Groups of standards
Regulation	Known (kind of)	Unknown
Scope	National/Regional	Global
Technology	Data processing	DP & AI
IP model	Decades-old CE model	Extremely complex



Full list of Assumptions

- 1. <u>Metaverse Functionalities</u>
- 2. <u>Metaverse Specifications</u>
- 3. <u>Profiling</u>
- 4. Metaverse definition
- 5. <u>Interoperability</u>
- 6. The Metaverse and AI
- 7. Organisation
- 8. Layering
- 9. The extent of the Metaverse

- 10. <u>The Metaverse is not just for</u> <u>humans</u>
- 11. <u>The Metaverse is not an asymptotic</u> <u>point</u>
- 12. The Metaverse is Digital
- 13. Who is a User
- 14. Representation and Presentation
- 15. Scene and Object hierarchy
- 16. <u>Regulation and Governance</u>



3. Use Cases

Use cases from 18 application domains

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<u>Automotive</u>	<u>Defence</u>	<u>Education</u>
<u>Enterprise</u>	<u>eSports</u>	<u>Events</u>
<u>Finance</u>	<u>Food</u>	<u>Gaming</u>
<u>Healthcare</u>	<u>Hospitality</u>	Professional training
/ <u>Real estate</u>	<u>Remote work</u>	<u>Retail</u>
<u>Social media</u>	Travel	Virtual spaces



An example – Retail

- Place furniture and gadgets in a virtual apartment (IKEA)
 Try-on makeup using an avatar (e.g., L'Oréal and Avon)
 Try-on clothing, sunglasses or fashion accessories using an avatar.
 Offer a virtual interactive experience with the object you are considering purchasing such as an automobile.
- 5. Touch, taste or smell virtual objects using haptic, gustation and olfactory interfaces.



A workflow example – Retail

- 1. User is in their preferred Metaverse Environment (e.g., a virtual sports club).
- 2. User goes to a Metaverse Environment (a shop selling sports equipment).
- 3. Uses haptic gloves to feel a few rackets.
- 4. Selects a racket.
- 5. Enters a Metaverse Environment (a virtual tennis court).
- 6. Plays tennis with an autonomous Virtual Human using the racket.
- 7. Converses with a sales clerk.
- 8. Buys the real racket.

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9. Signals intention to leave the Metaverse Environment.



4. External Services

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Why do we need to consider External Services?

A Metaverse may rely on services that are not Metaverse Instance specific.
 Independent entities provide Services also to other Metaverse Instances.

Content Creation	Content Creation Tools	<u>Marketplaces</u>
Crypto Wallets	Cryptocurrency Exchanges	Development Services
<u>Platforms</u>		

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5. Functionalities



MMM Functionalities



- A set of Functionalities some Metaverse Instances <u>may</u> support.
- No claim Functionalities are exhaustive (they will never be).
- Functionalities NOT expected to be provided by ALL Metaverse Instances.
- Metaverse Managers will select the Profiles, that respond to their needs.



1. Metaverse Instance	2. Metaverse Environment
Management	Management
<u>Organisation</u>	<u>Organisation</u>
<u>Features</u>	<u>Services</u>
<u>Storage</u>	<u>Types</u>
Process Management	Metaverse-Universe Association
Security	



4. Perception of Universe by Metaverse	5. Perception of Metaverse by Universe
<u>Audio</u>	<u>Audio</u>
<u>Visual</u>	<u>Visual</u>
<u>Tactile</u>	<u>Tactile</u>
<u>Olfaction</u>	<u>Olfaction</u>
<u>Gustation</u>	<u>Gustation</u>
<u>Other Data</u>	<u>Other Data</u>



6. Metaverse User	7. Metaverse-Human Interaction
<u>Identity</u>	<u>Interfaces</u>
<u>Profile</u>	<u>Speech</u>
<u>Data</u>	<u>Visual</u>
Perception of the Metaverse	<u>Haptic</u>
Virtual Human-oriented functionalities	<u>BCI</u>



3. Content Representation	9. Economy support
Scene Description	<u>Activities</u>
Object Representation	<u>Assets</u>
Content Metadata	<u>Agreements</u>
	<u>Transactions</u>
8. Information search	
<u>Discovery</u>	
Recommendation	



Methodology/1

Area	1. Instance
Subarea	1.2 Organisation
Title	1.2.1 Centralised Functionalities
Description	A Metaverse Instance supports centralised Functionalities.
Comment	The Metaverse Manager collects, stores, and manages the Data generated in their Instance.
Dependencies	1.1.2



Methodology/2

Area	1. Instance
Subarea	1.2 Organisation
Title	1.2.2 Terms of Services - Ethical
Description	The Terms of Service of an Instance include the ethical requirements that Users shall conform to.
Comment	The Terms of Service may extend beyond the requirements set by the laws of the jurisdiction under which the Instance operates.
Dependencies	1.2.1



6. Technologies

Technologies for a challenging job

Who	Does what	_	
Human	Makes an action.		
User device	Senses and processes action.	•	
Network	Transmits data to Metaverse Instance.		
Metaverse Instance	Processes and sends data back to user device.	• >	
User device	Processes data and presents information to human.		ίŢŢ

Are we sure we have the technologies we need?



Technologies – what we need

- **1. Perfect signal representation:** Audio-Visual-Tactile-Gustation-Olfaction-Brain...
- 2. Efficient data processing overcoming processing device capabilities
- **3. Distributed processing elements** (cloud-edge-device) to move data between human and Metaverse Instance.
- 4. Blameless performance of mobile and fixed networks.
- 5. High-performance energy storage for demanding data processing.
- **4.** High-level energy consumption by thousands of Metaverse Instances and millions of devices against energy saved (transportation etc.).



7. Governance

Governance of the Metaverse System

The ensemble of entities and rules ensuring that Metaverse Instances operate in the interest of Metaverse Stakeholders.

1. Management of the life cycle of a Technology, e.g.:

- 1. Identification of a Functionality.
- 2, Proposal-acceptance-update-removal of a Technology from the CMS.
- 2. / Management of the life cycle of a CMS Profile, e.g.:
 - 1. Identification-Proposal-Acceptance-Update-Removal of a Profile.
- B. Identification of a Metaverse Instance.
- 4. Metadata for a Metaverse Instance.
 - Interactions between Metaverse Instances.



Metaverse and the law

Can the Metaverse flourish without giving a meaning to some common words in the Metaverse?

- Authorship
 Contract
 Defamation
- 4. Privacy

- 5. Property
- 6. Taxation
- 7. Tort
- 8. Trademark

The MMM does not resolve, only identifies issues, stimulates research, and reports results.





MMM posted for community comments

1st **step** to **Profile-based** Metaverse standardisation. Open process to collectharmonise-classify Functionalities.

Contributions to <u>MPAI</u> <u>Secretariat</u> until 23 January. MMM V1 published as a Technical Report on 25 Jan.

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MMM V1 TR not an end point, but the starting point.

Profile work plan (for 2023)

- Functionality Profiles for existing Metaverse Instances
- Metaverse Architecture including:
 - Main functional blocks.
 - Data types exchanged.
- Functional Requirements of data types.
- Table of Content of Common Metaverse Specifications.
- Initial CMS version including relevant MPAI standard Technologies.
- Goal: to demonstrate that the proposed process to develop Metaverse standards can be practically implemented.





9. Functionality Profiles

First ideas about Functionality Profiles

- An MMM Functionality Profile (MFP) is a specification of a Metaverse Profile that only references Functionalities included in MMM, as opposed to Technologies.
- An MFP shall enable an implementer to develop a Metaverse Instance (MI) MI1 able to interoperate with another MI (MI2) that
 - 1. Is based on the same MFP used by MI2, and
 - 2. Utilises the same technologies that implement the Functionalities.



Beyond 2023

- 1. Metaverse Governance Mission, to manage the subsequent process.
- 2. Common Metaverse Specifications, integrating technologies from SDOs.
- **3. Technology Profile Specifications**, from industry requirements.

This is a good time to join MPAI – international unaffiliated non-profit SDO developing standards with clear licensing frameworks

Until the next GA (25 Jan) non-members contributing to the MMM may attend the (online) meetings of the MMM group

Join the fun Build the future!

MPAI. Community

https://mpai.community/



http://mmm.mpai.community/





Details of MMM Assumptions



1. Metaverse Functionalities

- MPAI defines an initial set of Functionalities required by Metaverse Instances to support legitimate industry requirements.
 - A Functionality in the set does not mean that all Metaverse Instances shall support that Functionality, but that the Functionality is a candidate to be included in one or more Metaverse Profiles.
 - The absence of a Functionality means that you should propose it.



2. Metaverse Specifications

- Eventually, the Metaverse Industry will have access to a collection of Interoperability specifications called Common Metaverse Specifications (CMS).
- t is expected that the CMS will be developed based on an agreed Functionality master plan using contributions made by different SDOs.

 The CMS should adopt the "one Functionality-one Tool" principle followed by successful standards, but it can be unavoidable – although not welcome for the eventual success of Metaverse Interoperability – that more than one tool be specified for the same Functionality.



3. Profiling

- A Profile is a particular subset of the technologies used in a standard.
- In the Metaverse, Profile means a collection of many Technologies (Tools) probably coming from different SDOs.
- Appropriate entities will group the CMS Technologies into Profiles responding to industry needs, to enable implementers of Metaverse Instances to select the Profiles that best serve *their* needs, while retaining a level of Interoperability with other Metaverse Instances.



#4 Metaverse definition

- MMM assumes that a Metaverse Instance will be developed and deployed based on a Profile selected by the Metaverse Manager.
- The MPAI definition of Metaverse cannot contradict this assumption.
 Minimalist definition of Metaverse:
 - Metaverse is a collection of Digital Environments that are implementations of Profiles built from Common Metaverse Specification Tools; it is populated by Digital Objects that are representations of either real Objects – called Digitized – or computer-generated Objects – called Virtual – or both.



#5 Interoperability



#6 Metaverse and AI

Al is likely to permeate Metaverse Instances. Here is an example of how MPAI sees the interaction between two "verses".



#7 Organisation

- A Metaverse Manager owns, operates, and maintains a Metaverse Instance.
- A Metaverse Operator runs a Metaverse Environment under Metaverse Manager's licence.
- A Metaverse Partner acts in a Metaverse Environment under licence of a Metaverse Operator.
- End **Users**.



#8 Layering



#9 The extent of a Metaverse





#10 The Metaverse is not just for humans

- The Metaverse notion is applicable to cases where the Environment is not intended for human consumption.
 - E.g., a Connected Autonomous Vehicle (CAV) produces/contributes data to a Metaverse Instance that is intended to be an accurate
 Representation of the Universe Environment where a CAV happens to be.
- The layered architecture of a CAV may very well not include an Experience Layer.



#11 The Metaverse is not an asymptotic point

- Some of the most emblematic functionalities of the Metaverse will become available only after many years of research and development.
- We should not wait for and celebrate the magic moment in which the first Metaverse Instance will be "turned on".
- Metaverse Instances exist today offering subsets of MMM Functionalities.
- They do not use CMS Technologies (they do not exist) but should be considered as Metaverse Instances.



#12 The Metaverse is Digital

An Object can be:

- *"Digitised"* if it refers to a data structure generated by the digital representation of an object.
- *Virtual* if it refers to a data structure created by a computer, as opposed to a data structure entirely originated from an object.
- "Digital" if it refers a data structure that is either "Digitised" and "Virtual".



#13 Who is a User

► A Metaverse User is:

Either a Digitised Human driven by a human.

Ør else, a Virtual Human driven by a Process.

A Metaverse User can be rendered and perceived as an avatar.



#14 Representation and Presentation

Distinction between the way information is digitally represented and the way information is rendered.

For instance:

A Digital Human is a Digital Object suitably represented as bits in a Metaverse Instance.

An Avatar is a rendered Digital Human and is perceived as physical stimuli.



#15 Scene and Object hierarchy

We perceive a Universe Environment as one or more scenes containing objects.

When mapping it to a Metaverse Environment, a scene and its objects have a digital representation.

It is desirable that the format of the Digital Scene Representation be shared by all Digital Scenes, whether they are Digitised or Virtual.



#16 Regulation and Governance

- The operation of a Metaverse Instance is typically regulated and governed based on applicable law.
 - The Functionalities provided are intended for use in conformity with applicable law.
 - An MMM Section identifies some regulatory and governance issues that will likely have to be addressed if Metaverse Instances offering seamless and rewarding Experiences to Users are to become possible.





Details of MMM Functionalities

