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

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Contents

1   Introduction

MPAI, Moving Picture, Audio, and Data Coding by Artificial Intelligence – the international, un-affiliated, non-profit organisation developing standards for AI-based data coding – addresses the needs for Metaverse standards by developing technical documents – Technical Reports and Specifications.

So far, MPAI has reached two milestones in its roadmap to metaverse interoperability by developing two Technical Reports:

Technical Report: MPAI Metaverse Model (MPAI-MMM) – Functionalities [1] has introduced the following elements:
1. A set of definitions.
2. A set of assumptions, the most important of which are that metaverse:
    2.1. Is a broad notion that may be used by different industries for different purposes.
    2.2. Needs technologies, some of which do not even exist with satisfactory performance.
    2.3. The notion of profile may help improve interoperability.
3. A collection of high-level use cases.
4. A collection of exemplary service providers.
5. An organised set of ~150 Functionalities.
6. A review of the main metaverse-enabling technologies.
7. An analysis of the governance needs.
8. The roadmap to metaverse standardisation.

Therefore, the Technical Report lays down the foundations of the MPAI metaverse standardisation effort: concentrate first on the identification and characterisation of the *Functionalities* that users expect the metaverse to provide.

Technical Report: MPAI Metaverse Model (MPAI-MMM) – Functionality Profiles [2] has introduced the following elements:
1. A revised and extended list of definitions.
2. A functional operation model of the metaverse based on the notion of Processes performing or requesting other Processes to perform Actions on Items.
3. A specification of a first set of Actions, Items, and Data Types to enable:
3.1. The fine description of Use Cases using Actions, Items, and Data Types.
3.2. The definition of Functionality Profiles, i.e., subsets of Actions, Items, and Data Types that satisfy a selected subset of identified Functionalities.
4. A collection of representative use cases tested against the functional operation model.
5. Four initial Functionality Profiles.

The third milestone of the MPAI roadmap is intends now to develop **Technical Specification: MPAI Metaverse Model (MPAI-MMM) – Architecture.** To reach that milestone, MPAI has developed this document **Use Cases and Functional Requirements: MPAI Metaverse Model – Architecture**, one of the attachments to the MPAI-MMM Architecture Call for Technologies [3]. It contains the following Chapters:
- Chapter 2 – Use Cases referencing Chapter 4 Use Cases of [1] and Chapter 8 of [2].
- Chapter 3 – Functionalities of the MPAI-MMM Architecture.
- Chapter 4 – Functional Requirements of the MPAI-MMM Architecture elements.
- Chapter 5 – Summary of the items addressed by the Call for Technologies [3].

In this document, word beginning with a capital letter have the meaning defined in Annex 1 - Terms and Definitions and words beginning with a small letter have the prevalent meaning of the context.
For clarifications about this document and the MPAI-MMM Architecture Call for Technologies, please contact the [MPAI Secretariat](#).

2 Use Cases

Chapter 4 of [1] has collected Use Cases from 18 application areas:

Table 1 - Application areas of Metaverse Use Cases

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

It has also analysed in depth 11 workflows:
1. Attend a Metaverse Event.
2. Buy a personal wearable.
3. Buy the real twin of an Object.
4. Establish a Metaverse Environment.
5. Interact with a Metaverse Call Centre.
6. Navigate a 3D Object.
7. Relax in a Metaverse Environment.

8. Social gathering across Metaverse Environments.
9. Train Metaverse Hospital staff.
10. Visit a Metaverse Environment.
11. Work in a Metaverse Environment.

Chapter 8 of [2] has further described and analysed the following Use Cases:
1. Virtual Lecture
2. Virtual Meeting
3. Hybrid working
4. eSports Tournament
5. Virtual performance
6. AR Tourist Guide
7. Virtual Dance
8. Virtual Car Showroom.
9. Drive a Connected Autonomous Vehicle.

While the identified Use Cases and Workflows cannot be considered exhaustive of the potential Metaverse Use Cases, they do represent a significant range of application domains.

Respondents to the Call for Technologies [3] are invited comment on these and/or propose new Use Cases.

3 Functionalities of the MPAI Metaverse Model

This Chapter introduces the Functionalities of the MPAI Metaverse Model (MPAI-MMM) making use of the Terms defined in Table 3 (also available online).

3.1 Disclaimer

The MPAI-MMM - Architecture *does not assume*:
1. A specific *type of architecture* (the model should be applicable to centralised, decentralised, or blockchain-based architectures).
2. A specific *identification technology* (the model only assumes that identification is possible, it does not make assumptions on how identification is achieved).
3. A specific *security technology* (the model only assumes that the environment in which the operation takes place is secure, it does not make assumptions on how security is achieved).
4. A specific set of *data formats* (the model only identifies the functionalities that the data format should provide, it does not make assumptions on specific data formats).
5. A specific *network* (the model only assumes that the network has the required capabilities, it does not make assumptions on how they can be provided).

3.2 Basic Functionalities

Main definitions:
1. A *Process* is Program and Metadata that can be executed in the M-Instance to perform Actions on Items.
2. An *Action* is a supported Functionality that is performed in an M-Instance. The currently identified Actions are introduced in 4.3.
3. An *Item* is Data and Metadata supported by the M-Instance where the Item exists. The currently identified Items are introduced in 4.3.
4. *Metadata* may include Rights.
5. *Rights* define:

5.1. The ability of a Process to perform Actions on Items.

5.2. The possibility that an Item be subjected to an Action by a Process.

6. An Item may include Rights held by User and Rights that it may be possible to acquire on the Item.

7. *Data Types* are data referenced by Actions and Items and are introduced in 4.5.

An M-Instance is a set of Processes providing some or all the following functions:

1. *Senses* data from U-Location.
2. *Produces* Items autonomously or by processing the sensed data.
3. *Hosts* one or more M-Environments populated by Objects that can be either digitised or virtual, the latter with or without autonomy.
4. *Processes* Objects from the M-Instance or potentially from other M-Instances to affect U- and/or M-Environments using Objects in ways that are:
   4.1. Consistent with the goals set for the M-Instance.
   4.2. Effected within the capabilities and Rules of the M-Instance, and in accordance with applicable laws and regulations.
5. *Identifies* Processes and Items with one or more than one Identifier that uniquely refers to one Process or Item and includes an Identifier.
6. *May contain* one or more M-Environments each of which:
   6.1. Includes an Identifier.
   6.2. May include M-Locations with space and time attributes.
   6.3. May require a Registration specific to the M-Environment.
7. *May make available* information regarding its Capabilities.
8. *May require* Registration for use:
   8.1. A human can request to deploy one or more Users and one or more Personae in an M-Instance.
   8.2. An M-Instance may request a subset of the Personal Profile of the Registering human.
9. *Establishes Rules* that human's Users in the M-Instance shall comply with.
10. *May penalise* a User for lack of compliance with the Rules.

3.3   Processes

MPAI-MMM – Architecture identifies the following types of *Process* performing Actions on Items in an M-Instance (see Figure 1):

1. *User* represents a human rendered as:
   1.1. A Model (Persona) animated by a stream generated by the human or by an autonomous agent. A User may be rendered by one or more Personae.
   1.2. An Object rendering the human.
2. *Device* connects User with a human or a U-Location:
   2.1. From Universe to Metaverse: captures a scene as Media and Provides Media as Data and Metadata:
   2.2. From Metaverse to Universe: receives an Entity and renders the Entity as Media with a Spatial Attitude.
3. *Service* provides Functionalities.
4. *App* is a Program executed on a Device.
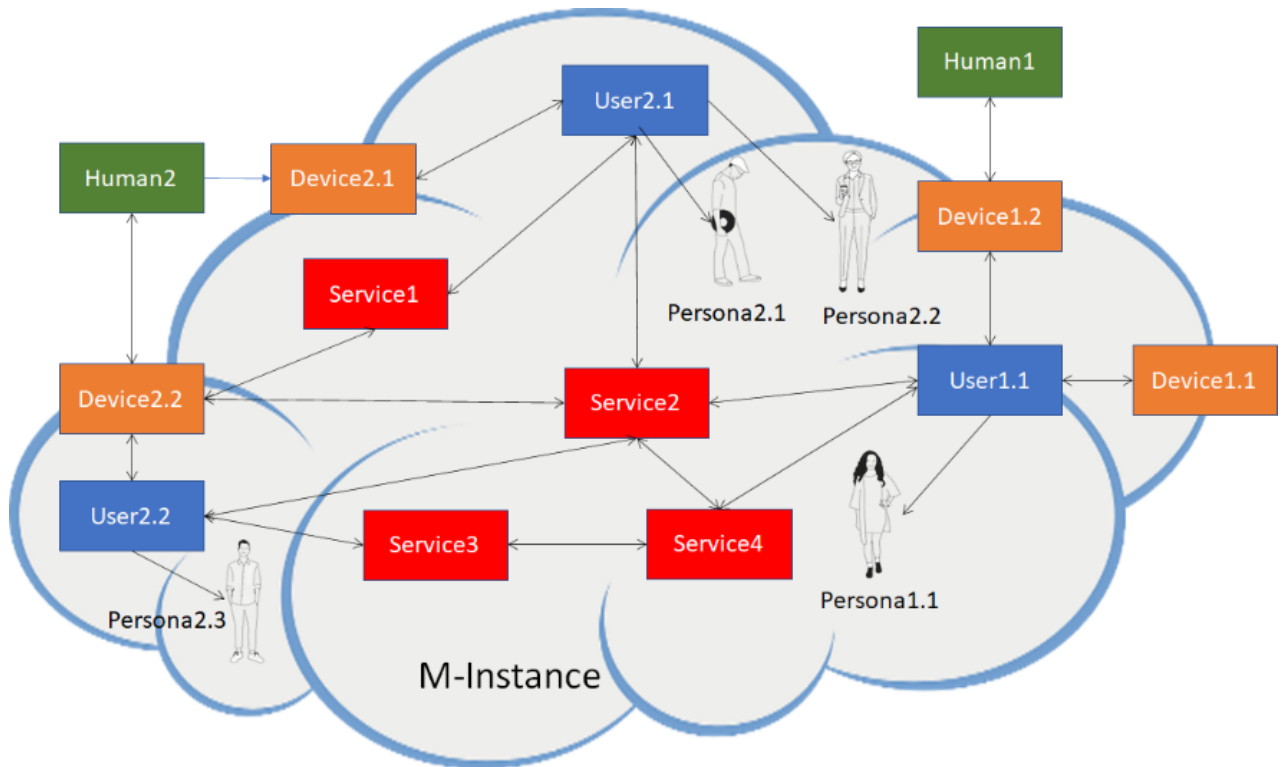
Figure 1 - Relationship of Human-Device-User-Service-Persona

A Process has the following general features:
1. *Performs* an Action on an Item if it has the Rights to do that.
2. *Can make available* information about its Capabilities.
    2.1. Items on which the Actions can be performed.
    2.2. The time during which they can be performed.
    2.3. The M-Locations where they can be performed.
3. *Can request* another Process to perform Actions on Items by transmitting to it a Request-Action Item.
4. *Can be requested* to perform an Action and it does so if:
    4.1. The requesting Process has the Rights required to perform that request.
    4.2. The requested Process has the Rights to perform the requested Action on the Item.
5. *Can respond* to another Process requesting an Action with a Response-Action Item.
6. *Uses* a supported format:
    6.1. To request another Process to perform Actions on Items (Request-Action).
    6.2. To respond to another Process that has requested an Action (Respond-Action).
7. *May perform*, or to request other Processes to perform, Actions on Items even in the absence of Rights, if the Rules so allow.
8. *May need to be certified* by the M-Instance Manager for use in an M-Instance.
9. The currently identified Processes are introduced in 4.2.
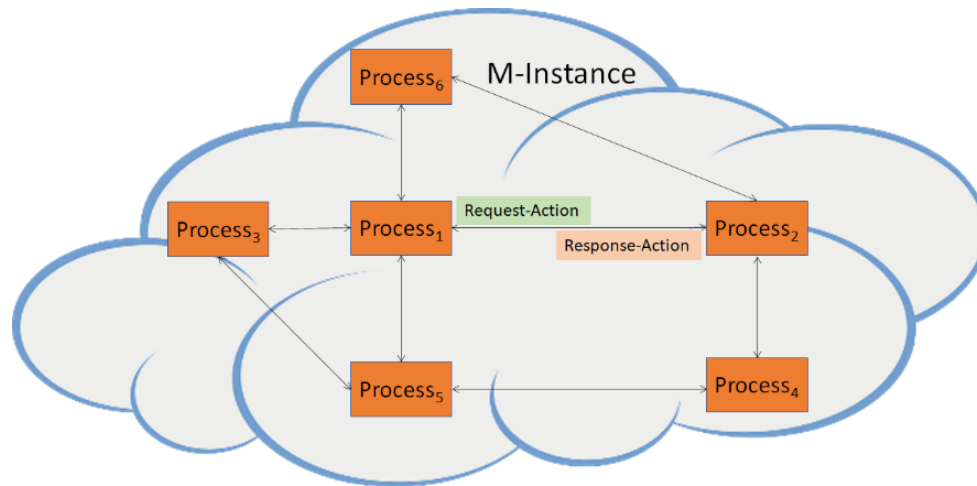
Figure 2 - Processes in an M-Instance

3.4 Actions performed by Processes

A Process may request that the following Actions be performed (in bracket the initially assigned name):

1. *Modify the Rights* of a User (Change).
   Comments: A User not complying with the Rules may have its Rights diminished or additional Rights may be granted to a User.
2. *Authenticate an Item* (Authenticate).
   Comments: A Process can confirm that the speech of a human imported into an M-Instance is from a specific human.
3. *Make an Item unavailable* (Hide).
   Comments: A certain Item may be made no longer accessible. Depending on the Rights of the User, the Item may be made accessible again.
4. *Create an Item* using Data and Metadata (Identify).
   Comments: A Device may capture Media as Data subject to certain Rights for use in an M-Instance. The Data and Metadata shall be converted to an Item for them to be usable in the M-Instance.
5. *Create a new Item* by modifying an original Item with Data and Metadata (Modify).
   Comments: A User with Rights on the Item may clone and then modify the components of an existing Item.
6. *Create an Item* by providing it with Data and Metadata (Author).
   Comments: An M-Instance can provide a Service, internal or external to the M-Instance, that Users can call to create Items for use in the M-Instance.
7. *Request to find Items* by giving a description of the Items (Discover).
   Comments: An M-Instance can provide a Service, internal or external to the M-Instance, that Users can call to find Items or Processes they need.
8. *Request to provide information* about an Item (Inform).
   Comments: A User may wish to know more about an Item, starting from its Metadata.
9. *Request it to provide interpretations* of an Item (Interpret).
   Comments: A User may need to have an Item interpreted, e.g., to have the speech of a User translated.
10. *Request to display an Item* on a Service (Post).
    Comments: A User can make known its intention to surrender its Rights on an Asset by posting it to a marketplace.
11. *Request Rights* to perform Actions on Items (Transact).

The User acquiring Rights on an Item is typically required to make a Transaction to the original Rights holder of the Item.

12. *Place an Entity* at an M-Location *not perceived* by other Users/humans (MM-Add).
13. *Make an Entity perceptible* that was not (MM-Enable).
14. *Place an Entity* at an M-Location *perceived* by other Users (MM-Embed).
15. *Stop making an Entity perceptible* (MM-Disable).
    Comments: A User can place an Entity at an M-Location with different modalities:
    - By placing it but not making it perceptible by other User (MM-Add) and making it perceptible at another time (MM-Enable), or
    - By Placing and making it perceptible in one stroke (MM-Embed).
    - When the User no longer wishes to let other Users perceive the Entity it will MM-Disable it.
16. *Transmit Items* to a Process (MM-Send).
    Comments: This general function enables Right-holding Users to have available and make Actions on Items.
17. *Activate a Contract* (Execute).
    Comments: Contracts may be Executed by an underlying Blockchain.
18. *Animate a Model* (MM-Animate).
    Comments: A Process autonomously animates a Model without using Streams from a U-Location.
19. *Animate a Model using an Animation Stream* (UM-Animate)
    Comments: A Process receives a Stream from a U-Location and animates a Model.
20. *Present Media* available at a Device to a U-Location as a scene with an associated Spatial Attitude (MU-Actuate).
    Comments: A User may request that a Device present the Media is has received as an Entity via an MM-Send Action. The presentation of is made with a specified Spatial Attitude.
21. *Present an Entity* that is at an M-Location to a U-Location as a scene with an associated Spatial Attitude (MU-Render).
    Comments: A User may request that an Entity at an M-Location be presented as Media at a U-Location with a Spatial Attitude. This operation is performed in two steps: MM-Send the Entity to a Device and MU-Actuate the Media from the Device.
22. *Present a scene* that is at a U-Location to an M-Location as an Entity with an associated Spatial Attitude (UM-Render).
    Comments: The presentation of a scene captured at a U-Location as an Entity is performed by a Device using the captured Media, converting Data and Metadata to an Entity and them MM-Embedding the Entity.
23. *Capture a scene* at a U-Location as Media (UM-Capture).
    Comments: The first step of the process above is represented by the capture of a scene ay a U-Location as Media.
24. *Transmit Data and Metadata* to a Process (UM-Send).
    Comments: The second step of the process above is the transmission of Data corresponding to the Media and Metadata added by the Device to a Process.
25. *Store an Item* at an Address (MU-Send).
    Comments: Make available to a Process Data and Metadata or an Item stored at an Address (UM-Send).
26. *Place a Model* at an M-Location, *animate* it with a Stream, and *present* the animated Model at a U-Location with an associated Spatial Attitude (Track).
    Comments: With Track a two-way connection between Universe and Metaverse is established.
27. *Verify that a Process* has Rights to make an Action on an Item (Validate).
    Comments: This is a basic Functionality preserving integrity of M-Instance operation.

28. *Convert one or more Items* of a Request-Action or Response-Action to another Format (Convert).
    Comments: As for other Services, Convert can be a Service offered by the M-Instance or available outside of the M-Instance.
29. *Transmit a Request-Action* to a Resolution Service to communicate to a different M-Instance.
    Comments: As for other Services, Resolution can be a Service offered by the M-Instance or available outside of the M-Instance.
30. *Register* with an M-Instance or M-Environment.
    Comments: This Action involves a human, not a User

3.5 Items

The Metaverse requires the following Items:
1. For general use
1.1. *Contract*: Program activated by an external entity, e.g., a User or another activated Contract.
1.2. *Identifier*: An Item that uniquely references an Item. The Item can have more than one Identifier.
1.3. *Program*: Data that can be executed.
1.4. *Rights*: the ability of a Process to perform an Action on an Item at an M-Location until a Time.
2. For Environments
2.1. *M-Environment*: A portion of an M-Instance covered by an Account including an Identifier.
2.2. *M-Instance*: An identifiable portion of an M-Instance covered by an Account.
3. For Process-to-Process communication
3.1. *Message*: An Item containing application-specific Data MM-Sent by a Source to a Destination.
3.2. *Request-Action*: An Item containing the request to a Service to perform an Action.
3.3. *Response-Action*: An Item containing the response of a Service to a Request-Action.
4. For the Register Action
4.1. *Account*: An Item that uniquely references a human who has Registered. A human may have more than one Account with one or more Services.
4.2. *Activity Data*: The record of the Actions of a User.
4.3. *Personal Profile*: An Item containing the Data about the human represented by User.
4.4. *Rules*: The terms and conditions under which a User operates in an M-Instance/Environment.
4.5. *Social Graph*: A representation of a User's network of connections with Items, Processes, and Services.
4.6. *User Data*: An Item containing Activity Data, Personae, Social Graph, and Personal Profile of a User.
5. For the Transact Action
5.1. *Asset*: An Item placed at an M-Location or Posted to a Service that may be subject to a Transaction.
5.2. *Ledger*: The list of Transactions involving Assets.
5.3. *Provenance*: The Ledger associated with a specific Asset.
5.4. *Transaction*: Item representing the changed state of the Accounts and the Rights of a seller User and a buyer User on an Asset and optionally of the Service facilitating/enabling the Transaction.
5.5. *Value*: An Amount and the Currency with which the Amount is expressed.
5.6. *Wallet*: A container of Currency units. In general, a Wallet is implemented outside of the Environment.
6. For requesting Actions by Services

6.1. *AuthenticateIn*: The description of the Item to be Authenticated.
6.2. *AuthenticateOut*: The description of the Authentication of the Item.
6.3. *DiscoverIn*: The description of the Items or Processes to be Discovered.
6.4. *DiscoverOut*: The description of the Items or Processes Discovered.
6.5. *InformIn*: The description of the Items or Process about which information is sought.
6.6. *InformOut*: The information about the Item or Process.
6.7. *InterpretIn*: The description of the Item to be Interpreted.
6.8. *InterpretOut*: The Interpretation of the Item.

7. For user experience
7.1. *Entity*: An Item that can be rendered.
7.1.1. *Event*: The combination of an M-Location, its Entities and their Animations starting from Start Time until End Time.
7.1.2. *Experience*: An Event as MM-Sent to a User and the User Interactions with the Entities of the Event.
7.1.3. *Model*: An Object representing an object with its features ready to be animated.
7.1.4. *Object*: An Entity representing an object.
7.1.5. *Persona*: A Model of a human.
7.1.6. *Scene*: A possibly hierarchical Composition of Objects each having a Spatial Attitude.
7.1.7. *Stream*: A continuous flow of Data.
7.2. *Interaction*: The list of Actions made by a User on the Entities at an M-Location and the corresponding Times.
7.3. *Map*: A structure establishing a correspondence between U-Locations with M-Locations.

8. For spatial information
8.1. *M-Location*: A delimited portion of an M-Environment with an Identifier.
8.2. *U-Location*: A delimited portion of the Universe with an Identifier.

3.6 Data Types

The Metaverse requires the following Data Types:

1. For general use
1.1. *Address*: A URL.

2. For Transactions
2.1. *Currency*: A medium of exchange enabling Transactions in an M-Instance.
2.2. *Amount*: A number expressing a Value in a Currency.

3. For internal status
3.1. *Cognitive State*: A User's Personal Status that reflects the way it understands the Environment, such as "Confused", "Dubious", "Convinced".
3.2. *Emotion*: A User's Personal Status that results from its interaction with an Environment, such as "Angry", "Sad", "Determined".
3.3. *Personal Status*: The information internal to a User characterising its behaviour.
3.4. *Social Attitude*: The representation of a User's Personal Status related to the way it in-tends to position vis-à-vis an M-Environment, e.g., "Respectful", "Confrontational", "Soothing".

4. For spatial information
4.1. *Coordinates*: A set of numbers representing a Position in a Metaverse Environment using a coordinate system.
4.2. *Orientation*: The set of the 3 roll, pitch, yaw angles indicating the rotation around the principal axis (x) of an Object, its y axis having an angle of 90° counterclockwise (right-to-left) with the x axis and its z axis (pointing up toward a viewer from above).
4.3. *Point of View*: The Spatial Attitude of a User watching the Environment.
4.4. *Position*: The coordinates of an Object with respect to a coordinate set in a Metaverse Environment.

4.5. *Spatial Attitude*: The Position and Orientation of an Entity, and their velocities and accelerations.

5. For time information

5.1. *Time*: A measure of time.

3.7 Interoperability support

When $Process_A$ in $Metaverse_A$ requests $Process_B$ in $Metaverse_B$ to perform Action on an $Item_{A.1}$, the following workflow enables interoperability between $Metaverse_A$ and $Metaverse_B$ (RS=Resolution Service, CS=Conversion Service).

1. $Process_A$ transmits Request-$Action_{A.1}$ to RS_A.
2. RS_A transmits Request-$Action_{A.1}$ to RS_B.
3. RS_B transmits $Item_{A.1}$ to CS.
4. CS produces and transmit $Item_{A.2}$ containing Converted Data to RS_B.
5. RS_B transmits the new Request-$Action_{A.2}$ to $Process_B$.
6. $Process_B$
    6.1. Performs the Action specified in Request-$Action_{A.2}$ using $Item_{A.2}$.
    6.2. Produces Response-$Action_{A.2}$.
    6.3. Requests RS_B to transmit to RS_A Response-$Action_{A.2}$ containing $Item_{A.3}$ (result of performing Request-$Action_{A.2}$).
    6.4. RS_B transmits Response-$Action_{A.2}$ to RS_A.
    6.5. RS_A transmits $Item_{A.3}$ to CS.
    6.6. CS produces and transmits to RS_A $Item_{A.4}$, corresponding to $Item_{A.3}$ with converted Data.
    6.7. RS_A produces and transmits to $Process_A$ a new Response-$Action_{A.4}$ that references $Item_{A.4}$.

An M-Instance may allow Processes to communicate directly with Processes in other M-Instances without calling $ResolutionService_A$.

The Call for Technologies requests comments on, proposed revisions of, or justified proposals for MPAI-MMM Functional Requirements.
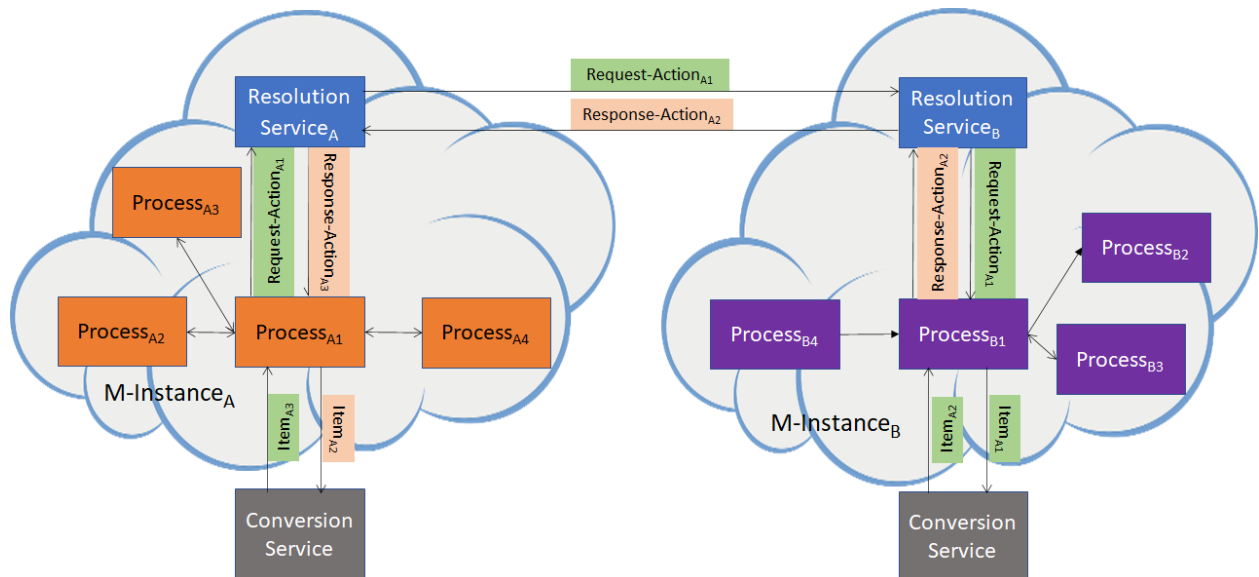

Figure 3 - Processes communicating across M-Instances

4 Functional Requirements

4.1 General

The Metaverse Architecture Technical Specification specifies the components of an M-Instance that enable its Processes to interoperate with the Processes of the same or a different M-Instance. These components shall satisfy the Functional Requirements identified in this document. To develop a Metaverse Architecture, MPAI is issuing a Call for Technologies [3] referencing this MPAI-MMM – Architecture – Functional Requirements document requesting **comments on currently specified elements and/or proposals for modified or new elements**:

1. Processes
2. Actions
3. Items
4. Data Types

4.2 Processes

4.2.1 General

Process is the basic building block of the MMM-Architecture and the Call for Technologies requests:

1. Comments on or proposed revisions of Purpose, Functional Requirements, and Metadata of the currently identified Processes.
2. Justified proposals for new Processes with a specification of Purpose, Functional Requirements, and Metadata having a level of detail comparable to the one provided by this document.
3. In particular, comments are requested on the *Functional Requirements* of Processes.

4.2.2 App

Purpose	An application-specific Program executed on a Device.		
Functional Requirements	The Manager of the M-Instance in which an App will be deployed may request that the Device be subject to certification.		
Metadata	AppID	The ID of the App.	
	UserID	The ID of the User having Rights to Act on the App.	
	InRightsID	The ID of the User's Rights to Act granted to the App.	
	OutRightsID	The ID of the Rights a User may acquire on the App.	
	DescrMdata	Any description of the App.	

4.2.3 Device

Purpose	A Process able to: 1. UM-Capture Data from a U-Location 2. UM-Send Data and Metadata to a User. and/or 1. MM-Send an Entity from an M-Location to the Device. 2. MU-Render an Entity at a U-Location.		
Functional Requirements	The Manager of the M-Instance in which a Device will be deployed may request that the Device be subject to certification.		
Metadata	DeviceID	The ID of the Device.	
	UserID	The ID of the User having Rights to Act on the Device.	
	InRightsID	The ID of the User's Rights to Act granted to the Device.	

		OutRightsID	The ID of the Rights a User may acquire on the Device.	
		DescrMdata	Any description of Device.	

4.2.4 Service

Purpose	A Process that can be called to provide specific Functionalities.	
Func-tional Require-ments	A Service may be: 1. One of the Services natively supported by an M-Instance, or 2. Subject to certification by the Manager of the M-Instance in which the Device will be deployed, or an entity delegated by them.	
Metadata	ServiceID	The ID of the Service.
	UserID	The ID of the User having Rights to Act on the Service.
	InRightsID	The ID of the User's Rights to Act granted to the Service.
	OutRightsID	The ID of the Rights to Act on the Service a User may acquire.
	DescrMdata	Any description of the Rights.

4.2.5 User

Purpose	A Process representing a human that is UM-Animated by a Stream or MM-Animated by an autonomous agent.	
Functional Require-ments	The Manager of the M-Instance in which a User will be deployed may request that the User be subject to certification.	
Metadata	UserID	ID of User.
	RightsID	ID of Rights held by User
	AccountIDs	IDs of Accounts where the User can operate.
	WalletIDs	IDs of Wallets held by User.
	UserDataID	ID of User Data.
	DescrMdata	Any description of the User.

4.3 Items

4.3.1 General

Items are Data and Metadata, possibly including Rights that are supported by an M-Instance. The Call for Technologies requests:
1. Comments on or proposed revisions of Purpose, Functional Requirements, and Metadata of the currently specified Items.
2. Justified proposals for new Items with a specification of Purpose, Functional Requirements, and Metadata provided with a level of detail comparable to that provided by this document.

In particular, comments are requested on the *Functional Requirements* of Items.

4.3.2 Account

Purpose	An Item that uniquely references a human who has Registered. A User may have more than one Account with one or more Services.	
Functional Require-ments	An Account shall include: 1. An M-Instance-specific subset of the Registered human's User Data. 2. The Rights held by the human's Users. 3. The duration of the Rights. 4. The duration of validity of the Account.	
Metadata	AccountID	The ID of the Account.
	humanID	The ID of the Account holder.

	RightsIDs	The ID of the Users' Rights in the M-Instance.
	M-InstanceID	The ID of the M-Instance the Account refers to.
	DescrMdata	Any description of the Account.

4.3.3 Activity Data

Purpose	An Item containing the record of all the Actions made by a User.	
Functional Require-ments	Activity Data shall include: 1. The M-Instance ID. 2. The duration the Activity Data refer to. 3. The list of Interactions.	
Metadata	ActivityDataID	The ID of the Activity Data.
	UserID	The ID of the User "having Rights to Act on the Activity Data".
	InRightsID	The ID of the User's Rights to Act on the Activity Data.
	OutRightsID	The ID of the Rights a User may acquire on the Activity Data.
	M-InstanceID	The ID of the M-Instance the Account refers to.
	DescrMdata	Any description of the Activity Data.

4.3.4 Asset

Purpose	An Item that may be the object of a Transaction. It may be MM-Embedded at an M-Location or Posted to a Service.		
Functional Require-ments	An Asset shall preserve the Data Formats of the Item that has spawned it.		
Metadata	AssetID	The ID of the Asset.	
	UserID	The ID of the User "having Rights to Act on the Asset".	
	InRightsID	The ID of the User's Rights to Act on the Asset.	
	OutRightsID	The ID of the Rights a User may acquire on the Asset.	
	DescrMdata	Any description of the Asset.	

4.3.5 AuthenticateIn

Purpose	An Item containing: 1. The Entity or the ID of the Entity to be Authenticated. 2. Information related to the rendering of AuthenticateOut.	
Functional Require-ments	The Entity to be Authenticated can be: 1. Speech produced by a User. 2. The visual appearance of a User Information on the Rendering of InterpretOut may be provided by: 1. Media type used for rendering. 2. Spatial Attitude of InterpretOut rendered Object.	
Metadata	AuthenticateInID	The ID of the AuthenticateIn Item.
	UserID	The ID of the User generating the AuthenticateIn Item.
	ServiceID	The ID of the Service providing Authentication Services.
	RightsID	The ID of the Rights "to Act on the AuthenticateIn Item" granted to the Authentication Service.
	DescrMdata	Any description of the AuthenticateIn Item.

4.3.6 AuthenticateOut

Purpose	An Item containing the result of processing the Request-Authenticate Action and its rendering.	
Functional Require-ments	AuthenticateOut shall be: 1. Made available to the User as Item, or 1. Rendered to the User as a perceptible Object as specified in AuthenticateIn.	
Metadata	Autheti-cateOutID	The ID of the Request-Authenticate Item.
	ServiceID	The ID of the Service providing the AuthenticateOut Item.
	UserID	The ID of the User having requested the AuthenticateOut Item.
	RightsID	The ID of the Rights "to Act on the AuthenticateOut Item" granted to UserID.
	De-scrMdata	Any description of the AuthenticateOut Item.

4.3.7 Contract

Purpose	A Program and its Metadata stored on a Device. It is activated by an external entity, e.g., a User, or another activated Contract.	
Functional Require-ments	A Contract may be subject to a certification carried out by or on behalf of the M-Instance Manager before it can be imported into an M-Instance. The Data of a Contract shall be in a form that allows its execution in the M-Instance.	
Metadata	AssetID	The ID of the Contract.
	UserID	The ID of the User "having Rights to Act on the Contract".
	InRightsID	The ID of the User's Rights to Act on the Contract.
	OutRightsID	The ID of the Rights a User may acquire on the Contract.
	DescrMdata	Any description of the Contract.

4.3.8 DiscoverIn

Purpose	An Item containing: 1. A description of the Items to be Discovered. 2. Information related to the rendering of DiscoverOut.	
Functional Require-ments	Items candidate for Discovery may be described by: 1. Verbal/text description 2. Similar Items 3. Belonging to specific M-Instances/M-Environments/M-Locations 4. Belonging to specific sections of Activity Data. Information on DiscoverOut Rendering may be provided by: 1. Media type used for rendering. 2. Spatial Attitude of DiscoverOut rendered Object.	
Metadata	DiscoverInID	The ID of the DiscoverIn Item.
	UserID	The ID of the User generating the DiscoverIn Item.
	ServiceID	The ID of the Service providing Discovery Services.
	RightsID	The ID of the Rights "to Act on the DiscoverIn Item" granted to the Discovery Service.
	DescrMdata	Any description of the DiscoverIn Item.

4.3.9 DiscoverOut

Purpose	An Item containing the description of the Items Discovered and information related to its rendering.	
Functional Require-ments	Discovered Items shall be: 1. Described by the IDs of the Items Discovered. 2. Rendered to the User as a perceptible Object.	
Metadata	DiscoverOutID	The ID of the Request-Discover Item.
	ServiceID	The ID of the Service providing the DiscoverOut Item.
	UserID	The ID of the User having requested the DiscoverOut Item.
	RightsID	The ID of the Rights "to Act on the DiscoverOut Item" granted to UserID.
	DescrMdata	Any description of the DiscoverOut Item.

4.3.10 Entity

Purpose	Any of the following Items that can be MU-Rendered: Object, Model, Scene, Event, and Experience.
Functional Require-ments	It shall be possible to render an Entity.

4.3.11 Event

Purpose	An Entity that includes selected Entities at an M-Location and their Animations during a period.	
Functional Require-ments	An Event shall include: 1. Start Time and End Time. 2. M-LocationID. 3. List of selected Entities, their Animations, and Interactions.	
Metadata	EventID	The ID of the Event.
	UserID	The ID of the User "having Rights to Act on the Event".
	InRightsID	The ID of the Rights "to Act on the Event".
	OutRightsID	The ID of the Rights a User may acquire on the Event.
	ParentItemID	The ID of the Entity "from which the Event is derived".
	DescrMdata	Any description of the Event.

4.3.12 Experience

Purpose	An Entity comprising User-selected Entities of an Event and the User Interac-tions with the Entities of the Event.	
Functional Require-ments	An Experience shall include: 1. Start Time and End Time 2. EventID 3. List of selected Entities, their Animations, and User Interactions.	
Metadata	ExperienceID	The ID of the Experience.
	UserID	The ID of the User "having Rights to the Experience".
	InRightsID	The ID of the Rights "to Act on the Experience".
	OutRightsID	The ID of the Rights a User may acquire on the Experience.
	ParentEntityID	The ID of the Event spawning the Experience.
	DescrMdata	Any description of the Experience.

4.3.13 Identifier

Purpose	An Item that uniquely references an Item in an M-Instance.
Functional Requirements	An Item can have more than one Identifier. An Identifier of an Item may have a hierarchical structure: 1. M-InstanceID 2. M-EnvironmentID 3. M-LocationID 4. ItemID. An Identifier of an Item may have a hierarchical structure: 1. M-InstanceID 2. M-EnvironmentID 3. ProcessID 4. ItemID.
Metadata	No Metadata

4.3.14 InformIn

Purpose	An Item containing: 1. A description of the Item about which information is requested. 2. Information related to the rendering of InformOut.
Functional Requirements	InformIn may refer to: 1. Item Metadata 2. Any other information that a Service may have on the Item. Information on rendering of InformOut may be provided by: 1. Media type used for rendering. 2. Spatial Attitude of InformOut rendered Object.
Metadata	<table><tr><td>InformInID</td><td>The ID of the InformIn Item.</td></tr><tr><td>UserID</td><td>The ID of the User generating the InformIn Item.</td></tr><tr><td>ServiceID</td><td>The ID of the Service providing Inform Services.</td></tr><tr><td>RightsID</td><td>The ID of the Rights "to Act on the InformIn Item" granted to the Inform Service.</td></tr><tr><td>DescrMdata</td><td>Any description of the InformIn Item.</td></tr></table>

4.3.15 InformOut

Purpose	An Item containing the description of the Item object of an InformIn.
Functional Requirements	InformOut shall be: 1. Made available to the User as an Item, or 2. Rendered to the User as a perceptible Object.
Metadata	<table><tr><td>InformOutID</td><td>The ID of the InformOut Item.</td></tr><tr><td>ServiceID</td><td>The ID of the Service providing the InformOut Item.</td></tr><tr><td>UserID</td><td>The ID of the User having requested the InformIn Item.</td></tr><tr><td>RightsID</td><td>The ID of the Rights "to Act on the InformOut Item" granted to UserID.</td></tr><tr><td>DescrMdata</td><td>Any description of the InformOut Item.</td></tr></table>

4.3.16 Interaction

Purpose	An Item containing the Request-Action issued by a User on an Entity at an M-Locations and the corresponding Times.

Functional Requirements	Interaction shall include the Request-Action.		
Metadata	InteractionID	The ID of the Interaction.	
	UserID	The ID of the User "having Rights to Act on the Interaction".	
	InRightsID	The ID of the Rights "to Act on the Interaction".	
	OutRights	The ID of the Rights a User may acquire on the Interaction.	
	EntityID	The ID of Entity "User Interacted with".	
	DescrMdata	Any description of the Interaction.	

4.3.17 InterpretIn

Purpose	An Item containing: 1. The ID or the Item to be Interpreted. 2. Information related to the rendering of InterpretOut.
Functional Requirements	Items candidate for Discovery may be described by: Item or ItemID. Information on InterpretOut Rendering may be provided by: 1. Media type used for rendering. 2. Spatial Attitude of InterpretOut rendered Object.

Metadata	DiscoverInID	The ID of the DiscoverIn Item.
	UserID	The ID of the User generating the DiscoverIn Item.
	ServiceID	The ID of the Service providing Discovery Services.
	RightsID	The ID of the Rights "to Act on the DiscoverIn Item" granted to the Discovery Service.
	DescrMdata	Any description of the DiscoverIn Item.

4.3.18 InterpretOut

Purpose	An Item containing the description of the Item object of an InterpretIn Item.
Functional Requirements	Interpreted Items shall be: 1. Described by the IDs of the Interpreted Item. 2. Rendered to the User as a perceptible Object.

Metadata	DiscoverOutID	The ID of the Request-Discover Item.
	ServiceID	The ID of the Service providing the DiscoverOut Item.
	UserID	The ID of the User having requested the DiscoverOut Item.
	RightsID	The ID of the Rights "to Act on the DiscoverOut Item" granted to UserID.
	DescrMdata	Any description of the DiscoverOut Item.

4.3.19 Ledger

Purpose	An Item containing a list of Transactions involving Assets.
Functional Requirements	The list of entries of a Ledger shall depend on: 1. The types of Item included in the Ledger. 2. The Items at an M-Location. 3. The Users to which a Ledger refers. 4. The duration in time to which a Ledger refers. 5. The Items in a DiscoverOut Item.

Metadata	LedgerID	The ID of the Ledger.
	UserID	The ID of the User who "has Rights on the Ledger".
	InRightsID	The ID of the Rights "to Act on the Ledger".

	OutRightsID	The ID of the Rights "to Act on the Ledger" a User may acquire.
	DescrMdata	Any descriptive Metadata.

4.3.20 Map

Purpose	An Item containing a structure establishing a correspondence between U-Locations with M-Locations.	

Functional Requirements	A Map shall include:
	1. The M-Location it refers to.
	2. A list containing for each U-LocationID having one correspondence with an Entity at the M-Location:
	   2.1. The IDs of the M-Location corresponding to the U-LocationID.
	   2.2. Metadata related to the U-LocationID.
	   2.3. Metadata related to the M-LocationID.	

Metadata	MapID	The ID of the Map.
	UserID	The ID of the User "having Rights to Act on the Map".
	InRightsID	The ID of the User Rights "to Act on the Map".
	OutRightsID	The ID of the Rights of a User may acquire on the Map.
	AuthorID	The ID of the User "who Authored the Map".

4.3.21 M-Environment

Purpose	An Identified subset of an M-Instance.	
Functional Requirements	It shall be possible to carve out M-Locations from an M-Instance.	
Metadata	M-Environ-mentID	The ID of the Map.
	UserID	The ID of the User "having Rights to Act on the M-Environment".
	InRightsID	The ID of the User Rights "to Act on the M-Environment".
	OutRightsID	The ID of the Rights a User may acquire on the M-Environment.

4.3.22 Message

Purpose	An Item containing application-specific Data MM-Sent by a Source Process to a Destination Process.	
Functional Requirements	A Message may carry: 1. An Item, or 2. Data and Metadata	
Metadata	MessageID	The ID of the Map.
	Descriptive Metadata	Any description of the Message.

4.3.23 M-Location

Purpose	An Identified delimited space of an M-Environment.	
Functional Requirements	An M-Location shall: 1. Define the space of the M-Instance belonging to the M-Location. 2. Enable the creation of sub-spaces defining sub-M-Locations	
Metadata	M-LocationID	The ID of the M-Location Item.

	UserID	The ID of the User "having Rights to Act on the M-Location".
	InRightsID	The ID of the Rights "to Act on the M-Location.
	OutRightsID	The ID of the Rights a User may acquire on the M-Location.
	DescrMdata	Any description of the M-Location.

4.3.24 Model

Purpose	An Object representing an object with its features ready to be MM-Animated or UM-Animated.	

Functional Requirements	A Model shall include:
	 1. The type(s) of Media (Audio-Visual-Haptic) composing the Model.
	 2. The type of Model
	     2.1. An inanimate Object (e.g., a table)
	     2.2. An autonomous Object (e.g., a robot)
	     2.3. An animal, possibly with high accuracy
	     2.4. A human, possibly with high accuracy	

Metadata	ModelID	The ID of the Object Model.
	UserID	The ID of the User "having Rights to Act on Object Model".
	InRightsID	The ID of the Rights "to Act on the Object Model".
	OutRightsID	The ID of the Rights a User may acquire on the Object Model.
	AuthorID	The ID of the User "who Authored the Object Model".
	AuthoringToolID	The ID of the Service "who provided the Authoring tool".
	DescrMdata	Any description of the Model.

4.3.25 Object

Purpose	An Entity representing an object.

Functional Requirements	A Model shall include:
	 1. The type(s) of Media (Audio-Visual-Haptic) composing the Model.
	 2. The Data representation
	     2.1. Audio Data representation
	         2.1.1. Mono (e.g., speech)
	         2.1.2. Stereo
	         2.1.3. Multichannel
	         2.1.4. Microphone array
	         2.1.5. Spatial Audio
	     2.2. Image Data representation
	     2.3. Visual Data representation
	         2.3.1. Mono
	         2.3.2. Camera array
	         2.3.3. Light field
	         2.3.4. Holography
	     2.4. Haptic Data representation
	 3. The type of Object
	     3.1. An inanimate Object (e.g., a table)
	     3.2. An autonomous Object (e.g., a robot)
	     3.3. An animal, possibly with high accuracy

	3.4. A human, possibly with high accuracy	
Metadata	Object ID	The ID of the Object Identified by ObjectID.
	UserID	The ID of the User "having Rights to Act on the Object".
	InRightsID	The ID of the Rights "to Act on the Object".
	OutRightsID	The ID of the Rights a User may acquire on the Object.
	AuthorID	The ID of the User "who Authored the Object".
	Authoring-ToolID	The ID of the Service "who provided the Authoring tool"
	DescrMdata	Any description of the Object.

4.3.26 Persona

Purpose	A Model representing a human.
Functional Require-ments	As for the Model.
Metadata	PersonaID	The ID of the Object Model.

Metadata	PersonaID	The ID of the Object Model.
	UserID	The ID of the User "having Rights to Act on Persona".
	InRightsID	The ID of the Rights "to Act on the Persona".
	OutRightsID	The ID of the Rights a User may acquire on the Persona.
	AuthorID	The ID of the User "who Authored the Persona".
	Author-ingToolID	The ID of the Service "who provided the Authoring tool".
	DescrMdata	Any description of the Persona.

4.3.27 Personal Profile

Purpose	An Item containing the Data about the human represented by a User.	
Functional Require-ments	The Personal Profile may include: 1. First Name 2. Last Name 3. Address 4. Country 5. Age 6. Biometric data 7. …	
Metadata	PersonalDa-taID	The ID of the Personal Data.
	humanID	The ID of the User "Having Rights on the Personal Data".
	InRightsID	The ID of the Rights "to Act on the Personal Data".
	OutRightsID	The ID of the Rights a User may acquire on the Personal Data.
	DescrMdata	Any description of the Personal Data.

4.3.28 Program

Purpose	Data that can be executed	
Functional Require-ments	The code: 1. Shall be executable in the M-Instance. 2. May be subject to certification before being admitted to the M-Instance.	
Metadata	ProgramID	The ID of the Program.

	UserID	The ID of the User who "has Rights to Execute the Program".
	InRightsID	The ID of the Rights "to Act on the Program".
	OutRightsID	The ID of the Rights "to Act on the Program" a User may acquire.
	DescrMdata	Any descriptive Metadata.

4.3.29 Provenance

Purpose	The Ledger associated with a specific Asset.	
Functional Requirements	The Provenance Item shall include the list of all Transactions executed: 1. On an Asset. 2. Starting from the first Transaction and including the last. 3. The Marketplace on which a Transaction was performed.	
Metadata	ProvenanceID	The ID of the Provenance.
	UserID	The ID of the User who "has Rights on the Provenance".
	InRightsID	The ID of the Rights "to Act on the Provenance".
	OutRightsID	The ID of the Rights "to Act on the Provenance" a User may acquire.
	AssetID	The ID of the Asset the Provenance refers to.
	DescrMdata	Any descriptive Metadata.

4.3.30 Request-Action

Purpose	An Item of the request to a Process to perform an Action as defined in this document.	
Functional Requirements	A Request-Action shall include: 1. Time the Request-Action was issued. 2. The Source ProcessID. 3. The Destination ProcessID. 4. The Action requested. 5. The ItemIDs relevant to the Action. 6. The Location of the Items. 7. The Location of the output Items produced by the Request-Action. 8. The requested Rights on the output Items.	
Metadata	Request-ActionID	The ID of the Request-Action.
	DescrMdata	Any descriptive Metadata.

4.3.31 Response-Action

Purpose	An Item containing the response of a Process to a Request-Action as defined in this document.	
Functional Requirements	The Response-Item shall include: 1. Time the Response-Action was issued. 2. The Source ProcessID (Source refers to the Process that issued the request). 3. The Destination ProcessID. 4. The output Items produced by the Request-Action. 5. Error messages.	
Metadata	Request-ActionID	The ID of the Response-Action.
	DescrMdata	Any descriptive Metadata.

4.3.32 Rights

Purpose	An Item expressing the ability of a Process to perform an Action on an Item.		
Functional Require-ments	A Rights Item shall express the Actions that can be performed on Items, the Time interval, and the Locations in which the Actions can be performed.		
Metadata	RightsID	The ID of the Rights.	
	UserID	The IDs of the Process "having Rights".	
	OutRightsID	The ID of the Rights a User may acquire.	
	DescrMdata	Any description of the Rights.	

4.3.33 Rules

Purpose	An Item expressing the terms and conditions under which a User operates in an M-Instance or M-Environment.	
Functional Require-ments	The Rules may express: 1. The ability of a User to perform Actions on Items for which it has Rights. 2. The inability of a User to perform Actions on Items for which it has no Rights. 3. The duty of a User to perform Actions on Items. 4. The ability of a User to make Transactions.	
Metadata	RulesID	The ID of the Rules.
	UserID	The ID of the User having Rights on the Rules.
	InRightsID	The ID of the Rights "to Act on the Rules".
	M-InstanceID	The ID of the M-Instance "where the Rules hold".
	DescrMdata	Any descriptive Metadata.

4.3.34 Scene

Purpose	A possibly hierarchical Composition of Objects having Spatial Attitudes.	

Functional Require-ments	It should be possible to:
	1. MM-Embed a Scene at a specified M-Location.
	2. Represent Objects:
	   2.1. With their Spatial Attitude.
	   2.2. Animated by a stream or an autonomous agent.	

Metadata	SceneID	The ID of the Scene Identified by SceneID
	UserID	The ID of the User "having Rights to Act on the Scene".
	InRightsID	The ID of the Rights "to Act on the Scene".
	OutRightsID	The ID of the Rights "to Act on the Scene" a User may acquire.
	AuthorID	The ID of the User "who created the Scene".
	Auth.ToolID	The ID of the Service "who provided the Creation tool".
	DescrMdata	Any description of the Scene.

4.3.35 Social Graph

Purpose	A representation of a User's network of connections with Items and Processes.
Functional Require-ments	The Social Graph should represent the following: 1. The types and the connections with Items and their M-Locations. 2. The types and the connections with Devices (frequency of use, etc.). 3. The types and the connections with Services (frequency of use, etc.). 4. The types and the connections with Users, groups of Users in terms of: 4.1. Time

Metadata		
	SocialGraphID	The ID of the Social Graph.
	UserID	The ID of the User "having Rights on the Social Graph".
	inRightsID	The ID of the Rights "to Act on the Social Graph".
	OutRightsID	The ID of the Rights "to Act on the Social Graph" a User may acquire.
	DescrMdata	Any description of the Social Graph.

4.2. M-Locations.
4.3. Declared purpose.

4.3.36 Stream

Purpose	An Item made by a continuous flow of Data.	
Functional Require-ments	Streams may be scalable in space and time. Streams may be used for: 1. Animating a Model. 2. Represent a Digitised Object in an M-Instance.	
Metadata	StreamID	The ID of the Stream.
	UserID	The ID of the User "having Rights to Act on the Stream".
	InRightsID	The ID of Rights "to Act on the Stream".
	OutRightsID	The ID of the Rights "to Act on the Stream" a User may acquire.
	DescrMdata	Any description of the Stream.

4.3.37 Transaction

Purpose	Item representing the changed state of the Accounts and the Rights of a seller User and a buyer User on an Asset and optionally of the Service facilitating/enabling the Transaction	
Functional Require-ments	The Transaction shall represent: 1. The Time the Transaction is performed. 2. The Value moving into the Wallet of User 1 (seller). 3. The Value moved from the Wallet of User2 (buyer). 4. The Value moved into the Wallet of User 3 (service) - optional. 5. The Time the Values were moved. 6. The Rights to Act owned by User1 after Time. 7. The Rights to Act owned by User2 after Time.	
Metadata	TransactionID	The ID of the Transaction.
	AssetID	The ID of the Asset the Transaction refers to.
	UserID	The ID of User1 "who grants the Rights".
	InRightsID	The ID of the Rights of User1.
	WalletID1	The ID of the Wallet of UserID1.
	TargetUserID	The ID of the User2 "who is granted the Rights".
	OutRightsID	The ID of the Rights "granted to User2".
	TargetWalletID	The ID of the Wallet of UserID2.
	ServiceID	The ID of the Marketplace.
	ServiceWalletID	The ID of the Wallet of the Marketplace.
	DescrMdata	Any description of the Transaction.

4.3.38 U-Location

Purpose	An identifiable delimited portion of the Universe.

Functional Requirements	A U-Location shall:
	1. Define the space in the Universe belonging to the U-Location.
	2. Enable the definition of sub-spaces (sub-U-Locations) comprised in the U-Location.
	The enforcement of Rights to a U-Location is not part of this document.

Metadata	U-LocationID	The ID of the U-Location.
	UserID	The ID of the User "having Rights to Act on the U-Location".
	RightsID	The ID of the Rights "to perform Actions on the U-Location".
	OutRightsID	The ID of the Rights "to perform Actions on the U-Location" a User may acquire.
	DescrMdata	Any description of the U-Location.

4.3.39 User Data

Purpose	An Item containing Activity Data, Personae, Social Graph, and User Profile of a User.
Functional Requirements	User Data may include the following Data:
	1. Rights held by the human.
	2. The Personal Profile of the human.
	3. The Personae that the Users of the human may assume.
	4. The Activity Data of the Users of the human.
	5. The Social Graphs of the Users of the human.
	User Data should have a representation that allow extraction and sharing of a User Data subset.

Metadata	UserDataID	ID of UserData.
	UserID	ID of User having Rights on UserData
	RightsID	ID of Rights held by User
	PersonalProfileID	ID of Personal Profile.
	PersonaIDs	IDs of Personae held User.
	ActivityDataID	ID of Activity Data
	SocialGraphID	ID of SocialGraph
	DescrMdata	Any description of the User.

4.3.40 Value

Purpose	An Amount and the Currency with which the Amount is expressed.
Functional Requirements	Value shall have a representation that enables the expression of the Amount and the Currency used to represent the Amount.

Metadata	ValueID	The ID of the Value.
	UserID	The ID of the User who has used the Value for a Transaction.
	DescrMdata	Any description of the User.

4.3.41 Wallet

Purpose	A container of Currency units. In general, a Wallet is implemented outside of the Environment.
Functional Requirements	A Wallet shall enable the representation of:
	1. The Amounts in each Currency.
	2. The Transactions performed.

Metadata	WalletID	The ID of the Wallet.	
	UserID	The ID of the User "having Rights to the Wallet".	
	InRightsID	The ID of the Rights "User has on the Wallet".	
	DescrMdata	Any description of the User.	

4.4 Actions

4.4.1 General

Actions are Functionalities provided by Processes. The Call for Technologies requests:

1. Comments on or proposed revisions of Purpose, Request-Action, and Response-Action of the currently identified Actions.
2. Justified proposals for new Actions with a specification of Purpose, Request-Action, and Response-Action having a level of detail comparable to that provided by this document.

In particular, comments are requested on the *Purpose* of Actions.

4.4.2 Authenticate

Purpose	The Action of requesting that a Service confirm that an Entity is what it claims to be.			
Request-Action	Time			
	Source	UserID		
	Destination	ServiceID		
	Action	*Authenticate*		
	InItems	AuthenticateIn ∨ AuthenticateInID		
	InLocation	M-LocationID ∨ UserID		
	OutLocation	UserID		
	OutRights	Rights ∨ RightsID		
Response-Action	Success	OutItem	AuthenticateOut ∨ AuthenticateOutID	
	Error	FaultyReq	The Request is Faulty	
		IDs	Incorrect	
		Rights	Missing or incomplete	
		M-Location	Out of range	
		U-Location	Out of range	

4.4.3 Author

Purpose	The Action of Calling a Service to obtain an Entity with associated OutRights to Act on the Entity.			
Request-Action	Time			
	Source	UserID		
	Destination	ServiceID		
	Action	*Author*		
	InItems	Item ∨ ItemID ∨ DataMdata		
	InLocation	UserID ∨ Address		
	OutLocation	UserID ∨ ServiceID		
	OutRights	Rights ∨ RightsID		
Response-Action	Success	OutItem	Entity ∨ EntityID	
	Error	FaultyReq	The Request is Faulty	
		IDs	Incorrect	
		Rights	Missing or incomplete	

		Wallet error	Insufficient Value	

4.4.4   Change

Purpose	The Action of requesting that a Service modify the Rights of a User and provide OutRights, e.g., to further Change the Rights.			
Request-Action	Time			
	Source	UserID		
	Destination	ServiceID		
	Action	*Change*		
	InItems	UserID ∧ (Rights ∨ RightsID)		
	OutRights	Rights ∨ RightsID		
Response-Action	Success	OutItem		
	Error	FaultyReq	The Request is Faulty	
		IDs	Incorrect	
		Rights	Missing or incomplete	
		M-Location	Out of range	

4.4.5   Convert

Purpose	The Action of requesting that a Service change the Format of the Data of an Item into a Format specified by a FormatID.			
Request-Action	Time			
	Source	UserID		
	Destination	ServiceID		
	Action	*Convert*		
	InItem	(Item ∨ ItemID) ∧ FormatID		
	InLocation	ServiceID ∨ M-LocationID		
	OutLocation	ServiceID		
	OutRights	Rights ∨ RightsID		
Response-Action	Success	OutItem	Item ∨ ItemID	
	Error	FaultyReq	The Request is Faulty	
		IDs	Incorrect	
		Rights	Missing or incomplete	

4.4.6   Discover

Purpose	The Action of requesting that a Service provide a DiscoveryOut Item containing: 1. The IDs of the Items relevant to the User's request to Discover expressed in the DiscoverIn Item 2. The OutRights to Act on the DiscoverOut Item.		
Request-Action	Time		
	Source	UserID	
	Destination	ServiceID	
	Action	*Discover*	
	InItem	DiscoveryIn ∨ DiscoveryInID	
	InLocation	UserID ∨ ServiceID	
	OutLocation	UserID	
	OutRights	Rights ∨ RightsID	

Response-Action	Success	OutItem	DiscoveryOut ∨ DiscoveryOutID	
	Error	FaultyReq	The Request is Faulty	
		IDs	Incorrect	
		Rights	Missing or incomplete	

4.4.7 Execute

Purpose	The Action of requesting that a Process execute a Contract.			
Request-Action	Time			
	Source	UserID		
	Destination	ProcessID		
	Action	*Execute*		
	InItem	Item ∨ ItemID ∨ DataMdata		
	OutRights	Rights ∨ RightsID		
Response-Action	Success	OutItem	Item ∨ ItemID	
	Error	FaultyReq	The Request is Faulty	
		IDs	Incorrect	
		Rights	Missing or incomplete	

4.4.8 Hide

Purpose	The Action of requesting that a Service make the ID of an Item unavailable and provide OutRights, e.g., to make the ID available again.			
Request-Action	Time			
	Source	UserID		
	Destination	ServiceID		
	Requested Action	*Hide*		
	InItem	Item ∨ ItemID		
	OutRights	Rights ∨ RightsID		
Response-Action	Success	OutItem		
	Error	FaultyReq	The Request is Faulty	
		IDs	Incorrect	
		Rights	Missing or incomplete	

4.4.9 Identify

Purpose	The Action of requesting that a Service produce an Item from Data & Metadata.			
Request-Action	Time			
	Source	Process ID		
	Destination	ServiceID		
	Action	*Identify*		
	InItems	DataMdata		
	InLocation	UserID		
	OutLocation	ServiceID		
Response-Action	Success	OutItem	Item ∨ ItemID	
	Error	FaultyReq	The Request is Faulty	
		IDs	Incorrect	
		Rights	Missing or incomplete	

4.4.10 Inform

Purpose	The Action of requesting that a Service provide an InformOut Item containing information about an InItem, such as the Metadata of the InItem, with the OutRights to Act on the InformOut Item.		
Request-Action	Time		
	Source	UserID	
	Destination	ServiceID	
	Action	*Inform*	
	InItem	InformIn ∨ InformInID	
	InLocation	M-LocationID	
	OutLocation	UserID	
	OutRights	Rights ∨ RightsID	
Response-Action	Success	OutItem	InformOut ∨ InformOutID
	Error	FaultyReq	The Request is Faulty
		IDs	Incorrect
		Rights	Missing or incomplete

4.4.11 Interpret

Purpose	The Action of requesting that a Service provide an InterpretOut Item containing interpretation of an InItem, such as translation or extraction of Personal Status, with the OutRights to Act on the InterpretOut Item.		
Request-Action	Time		
	Source	UserID	
	Destination	ServiceID	
	Action	*Interpret*	
	InItem	InterpretIn ∨ InterpretInID	
	InLocation	M-LocationID	
	OutLocation	UserID	
	OutRights	Rights ∨ RightsID	
Response-Action	Success	OutItem	InterpretOut ∨ InterpretOutID
	Error	FaultyReq	The Request is Faulty
		IDs	Incorrect
		Rights	Missing or incomplete

4.4.12 MM-Add

Purpose	The Action of requesting that a Service add an Entity at an M-Location with a Spatial Attitude and provide OutRights to Act on the MM-Added Entity.		
Request-Action	Time		
	Source	UserID	
	Destination	ServiceID	
	Action	*MM-Add*	
	InItem	(Entity ∨ EntityID) ∧ Spatial Attitude	
	InLocation	UserID ∨ ServiceID ∨ M-LocationID	
	OutLocation	M-LocationID	
	OutRights	Rights ∨ RightsID	
Response-Action	Success	OutItem	Entity ∨ EntityID
	Error	FaultyReq	The Request is Faulty
		IDs	Incorrect

		Rights	Missing or incomplete
		Clash	Entity clashes with another Entity
		M-Location	Out of range

4.4.13 MM-Animate

Purpose	The Action of requesting that a Service change the features of a Model MM-Embedded at an M-Location with a Stream and provide the OutRights to Act on the MM-Added Entity.		
Request-Action	Time		
	Source	UserID	
	Destination	ProcessID	
	Action	*MM-Animate*	
	InItem	(Model ∨ ModelID) ∧ Spatial Attitude	
	InLocation	ServiceID	
	OutLocation	M-LocationID	
	OutRights	Rights ∨ RightsID	
Response-Action	Success	OutItem	
	Error	FaultyReq	The Request is Faulty
		IDs	Incorrect
		Rights	Missing or incomplete
		Item mismatch	Entity Data Type and Animation Stream Data Type.

4.4.14 MM-Disable

Purpose	The Action of requesting that a Service stop MM-Enabling selected Entities Embedded at an M-Location and provide OutRights to Act on the MM-Disabled Entities.		
Request-Action	Time		
	Source	UserID	
	Destination	ServiceID	
	Action	*MM-Disable*	
	InItem	List of EntityIDs	
	InLocation	M-LocationID	
	OutLocation	M-LocationID	
	OutRights	Rights ∨ RightsID	
Response-Action	Success	OutItem	
	Error	FaultyReq	The Request is Faulty
		IDs	Incorrect
		Rights	Missing or incomplete
		M-Location	Out of range

4.4.15 MM-Embed

Purpose	The Composite Action of requesting that a Service MM-Add and MM-Enable an Entity either located at a Service or at an M-Location at a destination M-Location with a Spatial Attitude and provide OutRights to Act on the MM-Embedded Entity.	
Request-Action	Time	
	Source	UserID
	Destination	ServiceID

	Action		*MM-Embed*	
	InItem		(Entity ∨ EntityID) ∧ Spatial Attitude	
	InLocation		ServiceID ∨ M-LocationID	
	OutLocation		M-LocationID	
	OutRights		Rights ∨ RightsID	
Re-sponse-Action	Success	OutItem		
	Error	FaultyReq	The Request is Faulty	
		IDs	Incorrect	
		Rights	Missing or incomplete	
		Clash	Entity clashes with another Entity	
		M-Location	Out of range	

4.4.16 MM-Enable

Purpose	The Action of requesting that a Service accept requests to MM-Send selected Entities MM-Added at an M-Location or to MM-Embed those selected Entities at a destination M-Location and provide OutRights to act on the M-Entities.			
Request-Action	Time			
	Source	UserID		
	Destination	ServiceID		
	Action	*MM-Enable*		
	InItem	Entity ∨ EntityID		
	InLocation	M-LocationID		
	OutLocation	M-LocationID		
	OutRights	Rights ∨ RightsID		
Re-sponse-Action	Success	OutItem		
	Error	FaultyReq	The Request is Faulty	
		IDs	Incorrect	
		Rights	Missing or incomplete	
		M-Location	Out of range	

4.4.17 MM-Send

Purpose	The Action of requesting that a Service forward to a Process an Item with OutRights to Act on the Item, or Data/Metadata.			
Request-Action	Time			
	Source	ProcessID		
	Destination	ServiceID		
	Action	*Send*		
	InItem	Item ∨ ItemID ∨ DataMdata		
	InLocation	ProcessID ∨ M-Location		
	OutLocation	ProcessID ∨ M-Location		
	OutRights	Rights ∨ RightsID		
Response-Action	Success	OutItem	Item ∨ ItemID ∨ DataMdata	
	Error	Request	Faulty	
		IDs	Incorrect	
		Rights	Missing or incomplete	

4.4.18 Modify

Purpose	The Action of requesting that a Service produce a new Item from an existing Item by providing new Data and Metadata with the OutRights to further Act on the new Item.			
Request-Action	Time			
	Source	Process ID		
	Destination	ServiceID		
	Action	*Modify*		
	InItems	DataMdata ∧ Item		
	InLocation	UserID		
	OutLocation	ServiceID		
Response-Action	Success	OutItem	Item ∨ ItemID	
	Error	FaultyReq	The Request is Faulty	
		IDs	Incorrect	
		Rights	Missing or incomplete	

4.4.19 MU-Actuate

Purpose	The Action of requesting that a Device present an Entity available at a Device to a U-Location as Media with a Spatial Attitude.			
Request-Action	Time			
	Source	UserID		
	Destination	DeviceID		
	Action	*MU-Actuate*		
	InItem	(Entity ∨ EntityID) ∧ Spatial Attitude		
	InLocation	DeviceID		
	OutLocation	U-LocationID		
	OutRights	Metadata		
Response-Action	Success	OutItem	Media	
	Error	FaultyReq	The Request is Faulty	
		IDs	Incorrect	
		Rights	Missing or incomplete	
		U-Location	Out of range	

4.4.20 MU-Render

Purpose	The Composite Action of requesting that: 1. A Service MM-Send selected Entities Embedded at an M-Location to a Device. 2. The Device MU-Actuate at a U-Location with a Spatial Attitude the Entity received.		
Request-Action	Time		
	Source	UserID	
	Destination	ServiceID	
	Action	*MM-Render*	
	InItem	List of Entities ∧ Spatial Attitude	
	InLocation	M-LocationID	
	OutLocation	U-Location	
	OutRights	Rights ∨ RightsID	

Response-Ac-tion	Success	Action result	Media	
	Error	FaultyReq	The Request is Faulty	
		IDs	Incorrect	
		Rights	Missing or incomplete	
		M-Location	Out of range	

4.4.21 MU-Send

Purpose	c		
Request-Action	Time		
	Source	ProcessID	
	Destination	ServiceID	
	Action	*MU-Send*	
	InItem	Item ∨ ItemID	
	InLocation	M-LocationID ∨ ProcessID	
	OutLocation	Address	
	OutRights	Rights ∨ RightsID	
Response-Action	Success	OutItem	
	Error	FaultyReq	The Request is Faulty
		IDs	Incorrect
		Rights	Missing or incomplete
		Address	Incorrect

4.4.22 Post

Purpose	The Action of requesting that a Marketplace include an Asset to its repertory of Assets.		
Request-Ac-tion	Time		
	Source	UserID	
	Destination	ServiceID	
	Action	*Post*	
	InItem	Asset ∨ AssetID	
	InLocation	UserID ∨ ServiceID	
	OutLocation	ServiceID	
	OutRights	Rights ∨ RightsID	
Response-Ac-tion	Success	OutItem	
	Error	FaultyReq	The Request is Faulty
		IDs	Incorrect
		Rights	Missing or incomplete
		Wallet	Insufficient Value

4.4.23 Register

Purpose	The Action of a human requesting that an M-Instance grant their Users the Rights to perform Actions in the M-Instance.	
Request-Ac-tion	Time	
	Source	humanID
	Destination	ServiceID
	Requested Action	*Register*
	InItem	UserData ∨ UserDataID
	InLocation	Address

	OutLocation	ServiceID	
	OutRights	Rights ∨ RightsID	
Response-Action	Success	OutItem	Account ∨ AccountID
	Error	FaultyReq	The Request is Faulty
		Wallet	Insufficient Value

4.4.24 Resolve

Purpose	The Action of requesting that a Service forward a Request-Action or a Response-Action to a Resolution Service in another M-Instance.		
Request-Action	Time		
	Source	ProcessID	
	Destination	ServiceID	
	Requested Action	*Resolve*	
	InItem	Request-Action ∨ Response-Action ∨ Request-ActionID ∨ Response-ActionID ∨ Item ∨ ItemID	
	InLocation	ProcessID	
	OutLocation	ProcessID	
	OutRights	Rights ∨ RightsID	
Response-Action	Success	OutItem	Request-Action ∨ Response-Action ∨ Item ∨ ItemID
	Error	FaultyReq	The Request is Faulty
		IDs	Incorrect
		Rights	Missing or incomplete

4.4.25 Track

Purpose	The Composite Action of requesting that a Service: 1. MM-Embed a Model at an M-Location with a Spatial Attitude. 2. MU-Animate the Model MM-Embedded at an M-Location. 3. MU-Render specified Entities at the M-Location to a U-Location.		
Request-Action	Time		
	Source	UserID	
	Destination	ServiceID	
	Action	Track	
	InItem	(Model ∨ ModelID) ∧ Spatial Attitude ∧ M-LocationID	
	InLocation	ServiceID	
	OutLocation	U-LocationID	
	OutRights	Rights ∨ RightsID	
Response-Action	Success	OutItem	Media
	Error	FaultyReq	The Request is Faulty
		IDs	Incorrect
		Rights	Missing or incomplete
		M-LocationID	Out of range
		U-LocationID	Out of range

4.4.26 Transact

Purpose	The Action of a User$_1$ requesting that a Service: 1. Assign Rights on an Asset to User$_2$ ("buyer"). 2. Cause: 2.1. Wallet$_1$ of User$_1$ ("seller") to be increased by Value$_1$.

	2.2. Wallet$_2$ of User$_2$ to be decreased by Value$_2$.		
	2.3. Wallet$_3$ of the Service enabling/facilitating the Transaction to be increased by Value$_3$ (optionally).		

Request-Action	Time		
	Source	UserID	
	Destination	ServiceID	
	Action	*Transact*	
	InItem	Transaction ∨ TransactionID	
	InLocation	M-LocationID ∨ ServiceID	
	OutLocation	UserID ∨ ServiceID	
	OutRights	Rights ∨ RightsID	

Response-Action	Success	OutItems	AssetID ∧ WalletID$_1$ ∧ WalletID$_2$ ∧ WalletID$_3$
	Error	FaultyReq	The Request is Faulty
		IDs	Incorrect
		Rights	Missing or incomplete
		Wallet	Wallet$_2$ has insufficient Value

4.4.27 UM-Animate

Purpose	The Composite Action of a User requesting:
	1. A Device to
	1.1. UM-Capture an animation stream extracted from a scene at a U-Location.
	1.2. UM-Send the animation stream and Metadata to a User.
	2. A Service to Identify the Animation Stream.
	3. A Service to MM-Animate the Model MM-Embedded at the M-Location using the Animation Stream.

Request-Action	Time	
	Source	UserID
	Destination	DeviceID
	Action	*UM-Animate*
	InItem	scene ∧ (Model ∨ ModelID)
	InLocation	U-LocationID
	OutLocation	M-LocationID
	OutRights	Metadata

Response-Action	Success	OutItem	Entity ∨ EntityID
	Error	FaultyReq	The Request is Faulty
		IDs	Incorrect
		Rights	Missing or incomplete
		U-Location	Out of range
		M-Location	Out of range

4.4.28 UM-Capture

Purpose	The Action of requesting that a Device capture Media from a scene at a U-Location.

Request-Action	Time	
	Source	UserID
	Destination	DeviceID
	Action	*UM-Capture*

	InItem	scene		
	InLocation	U-LocationID		
	OutLocation	DeviceID		
Response-Action	Success	OutItem	Media	
	Error	FaultyReq	The Request is Faulty	
		IDs	Incorrect	
		Rights	Missing or incomplete	
		U-Location	Out of range	

4.4.29 UM-Render

Purpose	The Composite Action of a User requesting:
	 1. A Device to:
	   1.1. UM-Capture a scene at U-Location.
	   1.2. MM-Send Data and Device-provided Metadata to a User.
	 2. A Service to:
	   2.1. Identify an Entity from UM-Sent Data and Metadata.
	   2.2. MM-Embed the Entity at an M-Location with a Spatial Attitude.			

Request-Action	Time			
	Source	UserID		
	Destination	DeviceID		
	Action	*UM-Render*		
	InItem	scene ∧ Spatial Attitude		
	InLocation	U-LocationID		
	OutLocation	M-LocationID		
	OutRights	Rights ∨ RightsID		
Response-Action	Success	OutItem	Entity ∨ EntityID	
	Error	FaultyReq	The Request is Faulty	
		IDs	Incorrect	
		Rights	Missing or incomplete	
		Clash	Entity clashes with another Entity	
		M-Location	Out of range	
		U-Location	Out of range	

4.4.30 UM-Send

Purpose	The Action of a Device transmitting Item or Data & Metadata to a Process.			
Request-Action	Time			
	Source	DeviceID		
	Destination	ProcessID		
	Action	*UM-Send*		
	InItem	Item ∨ ItemID ∨ DataMdata		
	InLocation	DeviceID ∨ Address		
	OutLocation	ProcessID		
	OutRights	Metadata		
Response-Action	Success	OutItem	DataMdata	
	Error	Request	Faulty	
		IDs	Incorrect	
		Rights	Missing or incomplete	
		U-Location	Out of range	

4.4.31 Validate

Purpose	The Action of requesting that a Service verify that a Process has the Rights to perform or request a Process to perform an Action on an Item.			
Request-Action	Time			
	Source	ProcessID		
	Destination	ProcessID		
	Action	*Validate*		
	InItem	Request-Action ∨ Request-ActionID		
	InLocation	ProcessID		
	OutLocation	ProcessID		
	OutRights	Rights ∨ RightsID		
Response-Action	Success	OutItem	Item ∨ ItemID	
	Error	Request	Faulty	
		IDs	Incorrect	
		Rights	Missing or incomplete	
		U-Location	Out of range	

4.5 Data Types

4.5.1 General

Data Types are Data referenced by Processes, Actions, and Items. The Call for Technologies requests:
1. Comments on the proposed Purpose and Functional Requirements of the identified Items.
2. Justified proposals for new Data Types with a specification of Purpose and Functional Requirements of new Items having a level of detail comparable to that provided by this document.

4.5.2 Address

Purpose	The URL of a storage facility.
Functional Requirements	A URL

4.5.3 Amount

Purpose	A number expressing a Value in a Currency.
Functional Requirements	The ability to express an Amount, e.g., a decimal number.

4.5.4 Cognitive State

Purpose	The representation of a User's Personal Status that reflects the way they understand the Environment, such as "Confused", "Dubious", "Convinced".
Functional Requirements	The ability to express a particular Cognitive State, e.g., with a label from a dictionary of Cognitive States.

4.5.5 Coordinates

Purpose	A set of numbers representing a Position in a Metaverse Environment using a co-ordinate system.
Functional Requirements	Coordinates shall be able to uniquely indicate a position in the coordinate system.

4.5.6 Currency

Purpose	A medium of exchange enabling Transactions in a Metaverse Environment.
Functional Requirements	Currency shall express an entry in a standard list of Currencies.

4.5.7 Emotion

Purpose	The representation of a User's Personal Status that results from their interaction with an Environment, such as "Angry", "Sad", "Determined".
Functional Requirements	The ability to express a particular Emotion, e.g., with a label from a dictionary of Emotions.

4.5.8 Orientation

Purpose	The set of the 3 roll, pitch, yaw angles indicating the rotation around the principal axis (x) of an Object, its y axis having an angle of 90˚ counterclockwise (right-to-left) with the x axis and its z axis (pointing up toward a viewer viewing from above).
Functional Requirements	Orientation may be expressed as an array of 3 rows and 3 columns: α,β,γ (roll, pitch, and yaw) 1st order time derivatives of α,β,γ 2nd order time derivatives of α,β,γ

4.5.9 Personal Status

Purpose	The representation of the information internal to a User characterising their behaviour.
Functional Requirements	Personal Status shall at least include Cognitive State, Emotion, and Social Attitude.

4.5.10 Point of View

Purpose	The Spatial Attitude of a Persona watching an Environment.
Functional Requirements	Point of View shall express the Position of a Persona with the Orientation of the Persona watching an Environment.

4.5.11 Position

Purpose	The Coordinates of a point in a Metaverse Environment using a Coordinate system.

Func-tional Require-ments	Position may be expressed as an array of 3 rows and 3 columns: x,y,z 1st order time derivatives of x,y,z 2nd order time derivatives of x,y,z

4.5.12 Social Attitude

Purpose	The representation of a User's Personal Status representing the way User intends to position vis-à-vis other Users, e.g., "Respectful", "Confrontational", "Soothing".
Func-tional Require-ments	A particular Social Attitude is expressed by a label from a dictionary of Social Attitudes.

4.5.13 Spatial Attitude

Purpose	The Position and Orientation of an Entity, and their velocities and accelerations.
Func-tional Require-ments	Spatial Attitude may be expressed as an array of 6 rows and 3 columns: x,y,z 1st order time derivatives of x,y,z 2nd order time derivatives of x,y,z α,β,γ (roll, pitch, and roll) 1st order time derivatives of α,β,γ 2nd order time derivatives of α,β,γ

4.5.14 Time

Purpose	The representation of the measure of time.
Func-tional Require-ments	Time shall be able to express a value on a the time axis.

4.6 Summary

Table 2 provides an overview of the InItem, InLocation, OutLocation, and OutRights involved in all Actions. The prefixes In and Out refer to Items, Locations and Rights provided as input or as output, respectively.

Table 2 – Actions and InItem, InLocation, OutLocation, and OutRights involved.

Legend: Mdata= Metadata

	InItem			InLocation		OutLocation		OutRights
Actions	#1	#2	#3	#1	#2	#1	#2	#1
Register	UserData							Rights
Identify		Data	Mdata	User				Rights
Modify	Item	Data	Mdata	User				Rights
Validate	Request-Action			Process		Process		Rights
Change	User	Rights						Rights
Execute	Contract	Data	Mdata					Rights
Hide	Item							Rights
Authenticate	AuthenticateIn			User	MLoc	User		Rights
Author	Entity	Data	Mdata	User	Address	User	Service	Rights
Discover	DiscoverIn			User	Service	User		Rights

Inform	InformIn				MLoc	User		Rights
Interpret	InterpretIn				MLoc	User		Rights
Post	Asset			Process		Service		Rights
Transact	Transaction			Service	M-Loc	Process		Rights
MM-Add	Entity	SA		Process	MLoc		MLoc	Rights
MM-Animate	Model	SA	Stream		MLoc		MLoc	Rights
MM-Embed	Entity	SA		Process	MLoc		MLoc	Rights
MM-Enable	Entity				MLoc		MLoc	Rights
MM-Disable	Entity				MLoc		MLoc	Rights
MM-Capture	Entity				MLoc	Process		Rights
MM-Send	Item			Process	MLoc	Process	MLoc	Rights
MU-Actuate	Entity	SA		Process			ULoc	Mdata
MU-Render	Entity	SA			MLoc	Device	ULoc	Mdata
MU-Send	Item			Process	M-Loc		Address	x
UM-Animate	scene	SA	Model		ULoc		MLoc	Rights
UM-Capture	scene				ULoc	Device		x
UM-Render	scene	SA			ULoc		MLoc	Rights
UM-Send	Item	Data	Mdata	Process	Address	Process		Mdata
Track	Model	SA	Stream	Service	MLoc	ULoc		Rights

5 Summary of the items requested by the Call for Technologies

The Call for Technologies – MPAI Metaverse Model (MPAI-MMM) – Architecture specifically requests comments on, modification of and additions to the following:

1. **Use Cases** of the MPAI Metaverse Model.
2. **Functionalities** of the MPAI Metaverse Model derived from the Use Cases.
3. **Processes:**
   3.1. *Comments on or proposed revisions* of Purpose, Functional Requirements, and Metadata of the currently identified Processes.
   3.2. *Justified proposals* for new Processes with a specification of Purpose, Functional Requirements, and Metadata having a level of detail comparable to the one provided by this document.
   In particular, comments are requested on Functional Requirements of Items.
4. **Items**
   4.1. *Comments on or proposed revisions* of Purpose, Functional Requirements, and Metadata of the currently specified Items.
   4.2. *Justified proposals* for new Items with a specification of Purpose, Functional Requirements, and Metadata provided with a level of detail comparable to the one Provided by this document.
   In particular, comments are requested on Functional Requirements of Items.
5. **Actions**
   5.1. *Comments on or proposed revisions of* Purpose, Request-Action, and Response-Action of the currently identified Action.
   5.2. Justified proposals for new Actions with a specification of Purpose, Request-Action, and Response-Action having a level of detail comparable to the one Provided by this document.
   In particular, comments are requested on Functional Requirements of Items.
6. **Data Types**
   6.1. *Comments on or proposed revisions of* Purpose, Functional Requirements, and Metadata of the identified Items.

6.2. *Justified proposals* for new Data Types with a specification of Purpose, Functional Requirements, and Metadata of new Items having a level of detail comparable to the one provided by this document.

In particular, comments are requested on Functional Requirements of Data Types.

6 References

1. Technical Report – MPAI Metaverse Model (MPAI-MMM) – Functionalities; January 2023; https://mpai.community/wp-content/uploads/2023/04/Technical-Report-MPAI-Metaverse-Model-MPAI-MMM-Functionalities-V1.pdf
2. Technical Report – MPAI Metaverse Model (MPAI-MMM) – Functionality Profiles; May 2023; https://mpai.community/standards/mpai-mmm/mpai-metaverse-model/
3. MPAI; Call for Technologies: MPAI Metaverse Model (MPAI-MMM) – Architecture; N1249; https://mpai.community/standards/mpai-mmm/call-for-technologies-mpai-mmm-architecture/
4. MPAI; Framework Licence: MPAI Metaverse Model (MPAI-MMM) – Architecture; N1251; https://mpai.community/standards/mpai-mmm/framework-licence-mpai-metaverse-model-mpai-mmm-architecture/
5. MPAI: Template for responses: MPAI Metaverse Model (MPAI-MMM) – Architecture; N1251; https://mpai.community/standards/mpai-mmm/template-for-responses-mpai-mmm-call-for-technologies/

Annex 1 - Terms and definition

Table 3 gives the subset of MMM terms and definitions that are referenced in this document.

Table 3 - Basic terms and definition applicable to this document

	Term	
General	Action	An operation affecting an Item.
	Capability	The ability of a Process to perform Actions of Items.
	Data	Information represented in digital form.
	DataMdata	The combination of Data and Metadata that is not (yet) an Item.
	Data Format	The syntax and semantics of Data.
	Data Type	Data used in Actions and Items.
	Functionality	A standard feature provided by an M-Instance to be enabled by Common Metaverse Specifications Tools.
	Functional Requirement	A Functionality that is expected to be provided by an entity.
	Item	Data and Metadata supported and identified by an M-Instance.
	Manager	The entity overseeing the operation of an M-Instance.
	Media	Data in a Device that can be: 1. MU-Actuated 2. Identified as an Entity.
	Metadata	An attribute of Data, e.g., of a User, an Object, or a Service.
	Metaverse	A set of Processes providing some or all the following functions: 1. To sense data from U-Locations. 2. To process the sensed data and produce Data. 3. To produce one or more M-Environments populated by Objects that can be either digitised or virtual, the latter with or without autonomy. 4. To process Objects from the M-Instance or potentially from other M-Instances to affect U- and/or M-Environments using Object in ways that are: 4.1. Consistent with the goals set for the M-Instance. 4.2. Effected within: 4.2.1. The capabilities of the M-Instance 4.2.2. The Rules set for the M-Instance.
	Profile	A set of base standards and/or their subsets.
	Use Case	An example of how an application domain can be supported by the Functionalities of an M-Instance/Environment.
	Universe	The physical world.
Process	App	An application-specific Program executed on a Device.
	Device	A Process able to: 1. UM-Capture Data from a U-Location 2. UM-Send Data and Metadata to a User. and/or 1. MM-Send an Entity from an M-Location to the Device.

		2. MU-Render an Entity at a U-Location.
	Service	A Process that can be called to provide specific Functionalities.
	User	A Process representing a human that is UM-Animated by a Stream or MM-Animated by an autonomous agent.
Item	Account	An Item that uniquely references a human who has Registered. A User may have more than one Account with one or more Services.
	Activity Data	An Item containing the record of all the Actions made by a User.
	Asset	An Item that may be the object of a Transaction. It may be MM-Embedded at an M-Location or Posted to a Service.
	Authenti-cateIn	An Item containing: 1. The Entity or the ID of the Entity to be Authenticated. 2. Information related to the rendering of AuthenticateOut.
	Authenti-cateOut	An Item containing the result of processing the Request-Authenticate Action and its rendering.
	Contract	A Program and its Metadata stored on a Device. It is activated by an external entity, e.g., a User, or another activated Contract.
	DiscoverIn	An Item containing: 1. A description of the Items to be Discovered. 2. Information related to the rendering of DiscoverOut.
	DiscoverOut	An Item containing the description of the Items Discovered and information related to its rendering.
	Entity	Any of the following Items that can be MU-Rendered: Object, Model, Scene, Event, and Experience.
	Event	An Entity that includes selected Entities at an M-Location and their Animations during a period.
	Experience	An Entity comprising User-selected Entities of an Event and the User Interactions with the Entities of the Event.
	Identifier	An Item that uniquely references an Item in an M-Instance.
	InformIn	An Item containing: 1. A description of the Item about which information is requested. 2. Information related to the rendering of InformOut.
	InformOut	An Item containing the description of the Item object of an InformIn.
	Interaction	An Item containing the Request-Action issued by a User on an Entity at an M-Locations and the corresponding Times.
	InterpretIn	An Item containing: 1. The ID or the Item to be Interpreted. 2. Information related to the rendering of InterpretOut.
	InterpretOut	An Item containing the description of the Item object of an InterpretIn Item.
	Ledger	An Item containing a list of Transactions involving Assets.
	Map	An Item containing a structure establishing a correspondence between U-Locations with M-Locations.
	M-Environ-ment	An Identified subset of an M-Instance.
	Message	An Item containing application-specific Data MM-Sent by a Source Process to a Destination Process.
	M-Instance	An Identified delimited space of an M-Environment.
	M-Location	An Identified delimited space of an M-Environment.

	Model	An Object representing an object with its features ready to be MM-Animated or UM-Animated.
	Object	An Entity representing an object.
	Persona	A Model representing a human.
	Personal Profile	An Item containing the Data about the human represented by a User.
	Program	Data that can be executed
	Provenance	The Ledger associated with a specific Asset.
	Request-Action	An Item of the request to a Process to perform an Action as defined in this document.
	Response-Action	An Item containing the response of a Process to a Request-Action as defined in this document.
	Rights	An Item expressing the ability of a Process to perform an Action on an Item.
	Rules	An Item expressing the terms and conditions under which a User operates in an M-Instance or M-Environment.
	Scene	A possibly hierarchical Composition of Objects having Spatial Attitudes.
	Social Graph	A representation of a User's network of connections with Items and Processes.
	Stream	An Item made by a continuous flow of Data.
	Transaction	Item representing the changed state of the Accounts and the Rights of a seller User and a buyer User on an Asset and optionally of the Service facilitating/enabling the Transaction
	U-Location	An identifiable delimited portion of the Universe.
	User Data	An Item containing Activity Data, Personae, Social Graph, and User Profile of a User.
	Value	An Amount and the Currency with which the Amount is expressed.
	Wallet	A container of Currency units. In general, a Wallet is implemented outside of the Environment.
Action	Authenticate	The Action of requesting that a Service confirm that an Entity is what it claims to be.
	Author	The Action of Calling a Service to obtain an Entity with associated OutRights to Act on the Entity.
	Change	The Action of requesting that a Service modify the Rights of a User and provide OutRights, e.g., to further Change the Rights.
	Convert	The Action of requesting that a Service change the Format of the Data of an Item into a Format specified by a FormatID.
	Discover	The Action of requesting that a Service provide a DiscoveryOut Item containing: 1. The IDs of the Items relevant to the User's request to Discover expressed in the DiscoverIn Item 2. The OutRights to Act on the DiscoverOut Item.
	Execute	The Action of requesting that a Process execute a Contract.
	Hide	The Action of requesting that a Service make the ID of an Item unavailable and provide OutRights, e.g., to make the ID available again.
	Identify	The Action of requesting that a Service produce an Item from Data & Metadata.

	UM-Import	The Action of a User requesting that a Service read Data & Metadata stored at an Address.
	Inform	The Action of requesting that a Service provide an InformOut Item containing information about an InItem, such as the Metadata of the InItem, with the OutRights to Act on the InformOut Item.
	Interpret	The Action of requesting that a Service provide an InterpretOut Item containing interpretation of an InItem, such as translation or extraction of Personal Status, with the OutRights to Act on the InterpretOut Item.
	MM-Add	The Action of requesting that a Service add an Entity at an M-Location with a Spatial Attitude and provide OutRights to Act on the MM-Added Entity.
	MM-Animate	The Action of requesting that a Service change the features of a Model MM-Embedded at an M-Location with a Stream and provide the Out-Rights to Act on the MM-Added Entity.
	MM-Disable	The Action of requesting that a Service stop MM-Enabling selected Entities Embedded at an M-Location and provide OutRights to Act on the MM-Disabled Entities.
	MM-Embed	The Composite Action of requesting that a Service MM-Add and MM-Enable an Entity either located at a Service or at an M-Location at a destination M-Location with a Spatial Attitude and provide OutRights to Act on the MM-Embedded Entity.
	MM-Enable	The Action of requesting that a Service accept requests to MM-Send selected Entities MM-Added at an M-Location or to MM-Embed those selected Entities at a destination M-Location and provide OutRights to act on the M-Entities.
	MM-Send	The Action of requesting that a Service forward to a Process an Item with OutRights to Act on the Item, or Data/Metadata.
	Modify	The Action of requesting that a Service produce a new Item from an existing Item by providing new Data and Metadata with the OutRights to further Act on the new Item.
	MU-Actuate	The Action of requesting that a Device present an Entity available at a Device to a U-Location as Media with a Spatial Attitude.
	MU-Render	The Composite Action of requesting that: 1. A Service MM-Send selected Entities Embedded at an M-Location to a Device. 2. The Device MU-Actuate at a U-Location with a Spatial Attitude the Entity received.
	MU-Send	The Action of requesting that a Process transmit an Item to a Device or store an Item at an Address.
	Post	The Action of requesting that a Marketplace include an Asset to its repertory of Assets.
	Register	The Action of a human requesting that an M-Instance grant their Users the Rights to perform Actions in the M-Instance.
	Resolve	The Action of requesting that a Service forward a Request-Action or a Response-Action to a Resolution Service in another M-Instance.
	Track	The Composite Action of requesting that a Service: 1. MM-Embed a Model at an M-Location with a Spatial Attitude. 2. MU-Animate the Model MM-Embedded at an M-Location. MU-Render specified Entities at the M-Location to a U-Location.

	Transact	The Action of a User$_1$ requesting that a Service:
		1. Assign Rights on an Asset to User$_2$ ("buyer").
		2. Cause:
		   2.1. Wallet$_1$ of User$_1$ ("seller") to be increased by Value$_1$.
		   2.2. Wallet$_2$ of User$_2$ to be decreased by Value$_2$.
		Wallet$_3$ of the Service enabling/facilitating the Transaction to be increased by Value$_3$ (optionally).	

	UM-Animate	The Composite Action of a User requesting:
		1. A Device to
		   1.1. UM-Capture an animation stream extracted from a scene at a U-Location.
		   1.2. UM-Send the animation stream and Metadata to a User.
		2. A Service to Identify the Animation Stream.
		3. A Service to MM-Animate the Model MM-Embedded at the M-Location using the Animation Stream.	

	UM-Capture	The Action of requesting that a Device capture Media from a scene at a U-Location.	

	UM-Render	The Composite Action of a User requesting:
		1. A Device to:
		   1.1. UM-Capture a scene at U-Location.
		   1.2. MM-Send Data and Device-provided Metadata to a User.
		2. A Service to:
		   2.1. Identify an Entity from UM-Sent Data and Metadata.
		   2.2. MM-Embed the Entity at an M-Location with a Spatial Attitude.	

	UM-Send	The Action of a Device transmitting Item or Data & Metadata to a Process.	
	Validate	The Action of requesting that a Service verify that a Process has the Rights to perform or request a Process to perform an Action on an Item.	
Data Type	Address	The URL of a storage facility.	
	Amount	A number expressing a Value in a Currency.	
	Cognitive State	The representation of a User's Personal Status that reflects the way they understand the Environment, such as "Confused", "Dubious", "Convinced".	
	Coordinates	A set of numbers representing a Position in a Metaverse Environment using a coordinate system.	
	Currency	A medium of exchange enabling Transactions in a Metaverse Environment.	
	Emotion	The representation of a User's Personal Status that results from their interaction with an Environment, such as "Angry", "Sad", "Determined".	
	Orientation	The set of the 3 roll, pitch, yaw angles indicating the rotation around the principal axis (x) of an Object, its y axis having an angle of 90° counterclockwise (right-to-left) with the x axis and its z axis (pointing up toward a viewer viewing from above).	
	Personal Status	The representation of the information internal to a User characterising their behaviour.	
	Point	A point in an M-Environment identified by the set of local Coordinates.	
	Point of View	The Spatial Attitude of a Persona watching an Environment.	

	Position	The Coordinates of a point in a Metaverse Environment using a Coordinate system.
	Social Attitude	The representation of a User's Personal Status related to the way it intends to position vis-à-vis an M-Environment, e.g., "Respectful", "Confrontational", "Soothing".
	Spatial Attitude	The Position and Orientation of an Entity, and their velocities and accelerations.
	Time	The representation of the measure of time.