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Contact: Hideo Imanaka E-mail: h.imanaka@nict.go.jp
 NICT
 Japan

Contact: Jungha Hong Tel: +82-42-860-0926
 ETRI E-mail: jhong@etri.re.kr
 Korea(Republic of)

Contact: Wook Hyun Tel: +82-42-860-1565
 ETRI E-mail: whyun@etri.re.kr
 Korea(Republic of)

Contact: MiYoung Huh Tel: +82-42-860-6118
 ETRI E-mail: myhuh@etri.re.kr
 Korea(Republic of)

Contact: Xiaojun Mu Tel: + 86 13292090213
 China Unicom E-mail: muxj@chinaunicom.cn
 China

Abstract: This document contains the updated draft of FGMV-D5.1-uriop “Service scenarios and high-level requirements for metaverse cross-platform interoperability” developed in WG5/FG-MV meeting (Geneva, 3-5 October 2023).

This document is the updated draft of FGMV-D5.1-uriop “Service scenarios and high-level requirements for metaverse cross-platform interoperability” developed in WG5/FG-MV meeting (Geneva, 3-5 October 2023). This output document has been developed based on the following input document. The discussion result about the input document is as follows.

No.	Source	Title	Discussion
FGMV-I-250-R1	NICT	D5.1: Proposals of editorial modifications of draft deliverable FGMV-D5.1-uriop	This contribution proposed several editorial modifications for the whole draft deliverable FG-MV-D5.1-uriop. WG5/FG-MV agreed to move some of the terms to the main body, and agreed to change the title to “Service scenarios and high-level requirements for

			metaverse cross-platform interoperability”. It is also agreed to remain high-level requirements only, and the detailed ones will be moved to the future work items.
FGMV-I-251	NICT	D5.1: Proposals of appending the summary table of interoperability cases into Clause 7 of FG-MV-D5.1-uriop.	This contribution proposed to append the summary table of interoperability cases into Clause 7 of the draft deliverable FGMV-D5.1-uriop, and WG5/FG-MV agreed to it.
FGMV-I-252-R1	ETRI	FGMV-D5.1-uriop: Proposed updates to metaverse search scenario in clause 7.1	This contribution proposed to update a use case for seamless discovery and mashup of content across distributed metaverse platforms to resolve editor’s note. WG5/FG-MV agreed to it with minor modifications in the Figure.
FGMV-I-264	ETRI	Proposal text for a service scenario of metaverse tour in clause 7.7 of FGMV-D5.1-uriop	This contribution proposed texts on a service scenario of metaverse tour in clause 7.7 of FGMV-D5.1-uriop. There was a comment to use ‘User’ rather than ‘Friends’, and agreed that each user comes from different platforms. WG5/FG-MV agreed this with revision.
FGMV-I-279-R1	ETRI	Proposed updates of FGMV-D5.1-uriop	This input document proposed the updates of FGMV-D5.1-uriop as well as a use case in Appendix I. There was a comment that it needs to modify the title of clause 7.3 to “Meatverse exhibitions” to accommodate similar services such as zoo, museum, etc. It was also comment about differentiating the avatar and content interoperability. WG5/FG-MV agreed to it with revision.

Technical Specification ITU-T FGMV-D5.1-uriop

Service scenarios and high-level requirements for metaverse cross-platform interoperability

Summary

This deliverable specifies the service scenarios and high-level requirements for metaverse cross-platform interoperability. With the increasing number of metaverse platforms being developed, there is a need to create an open and seamless metaverse ecosystem that fosters innovation and collaboration. This aims to identify the various service scenarios and high-level requirements of interoperability cases for metaverse cross-platform interoperability such as avatar interoperability, asset interoperability, content interoperability, identity interoperability, etc.

Keywords

metaverse cross-platform interoperability, service scenarios, requirements, **TBD**

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Service scenarios and high-level requirements for metaverse cross-platform interoperability

1 Scope

This Technical Specification provides service scenarios and high-level requirements for the metaverse cross-platform interoperability. The scope of this Technical Specification includes the following:

- Service scenarios of the metaverse cross-platform interoperability;
- High-level requirements for the metaverse cross-platform interoperability.

In addition, use cases of metaverse cross-platform interoperability and its standards activities are described in Appendixes.

2 References

The following ITU-T Recommendations and other references contain provisions which, through reference in this text, constitute provisions of these Technical Specifications. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision; users of these Technical Specifications are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of the currently valid ITU-T Recommendations is regularly published. The reference to a document within these Technical Specifications does not give it, as a stand-alone document, the status of a Recommendation.

TBD

[ITU-T X.yyy] Recommendation ITU-T X.yyy (date), *Title*.

3 Definitions

<Check in the ITU-T terms and definitions database at www.itu.int/go/terminology-database whether the term has already been defined in [a / another] Recommendation. It would be more consistent to refer to such a definition rather than to redefine the term>

3.1 Terms defined elsewhere

TBD

<Normally, terms defined elsewhere will simply refer to the defining document. In certain cases, it may be desirable to quote the definition to allow for a stand-alone document>

These Technical Specifications use the following terms defined elsewhere:

3.1.1 <Term 1> [Reference]: <optional quoted definition>.

3.1.2 <Term 2> [Reference]: <optional quoted definition>.

3.2 Terms defined in this Technical Specification

This Technical Specification defines the following terms:

3.2.1 Home avatar: the original avatar which exists within original metaverse platform, remaining customizable for the user. This primary version of a user's digital representation in the metaverse resides exclusively within a specific metaverse platform or avatar service.

3.2.2 Roaming avatar: the avatar transitioning across various metaverse platforms from original metaverse platform, potentially undergoing alterations or transformations aligned with the destination platform's compatibility and features.

[Editor's Note: New definitions need to be checked carefully whether the terms might be used in other documents.]

[Editor's Note: The definition of avatar will be included. The term "avatar" was not defined in ITU-T yet.]

4 Abbreviations and acronyms

TBD

This Technical Specification uses the following abbreviations and acronyms:

<abbr><expansion>

<Include all abbreviations and acronyms used in these Technical Specifications>

5 Conventions

The following conventions are used in these Technical Specifications:

- The keywords "is required to" indicate a requirement that must be strictly followed and from which no deviation is permitted if conformance to these Technical Specifications is to be claimed.
- The keywords "is recommended" indicate a requirement that is recommended but which is not absolutely required. Thus, this requirement need not be present to claim conformance.
- The keywords "can optionally" indicate an optional requirement that is permissible, without implying any sense of being recommended. This term is not intended to imply that the vendor's implementation must provide the option and that the feature can be optionally enabled by the network operator/service provider. Rather, it means the vendor may optionally provide the feature and still claim conformance with the specification.

6 Overview of metaverse cross-platform interoperability

6.1 Metaverse interoperability

In general, virtual worlds in metaverse are constructed on a single metaverse platform. Since the avatars and digital assets of users are developed in the platform, users can move from one virtual world to another with their avatars and assets (without any modifications) within the platform. In this regard, interoperability of avatars and assets on a single metaverse platform is achieved as a basic feature, as shown by the green line in Figure 6-1.

In a multi-platform environment as shown in Figure 6-1, the avatar of user Bob created on platform 2 cannot visit virtual world A on platform 1, since the avatar development mechanism and/or data format on platforms 1 and 2 may differ. User Alice has to make or set up another avatar on platform 2 when she wants to visit virtual world B on platform 2. In addition, assets and content created on metaverse platform 1 cannot move to metaverse platform 2, as shown in the blue line of Figure 6-1.

Interoperability is important in the development of the metaverse because it allows developers to create and share content across different platforms. It also allows users to have a seamless and cohesive experience, as they can move between different virtual worlds without creating new accounts or starting from scratch.

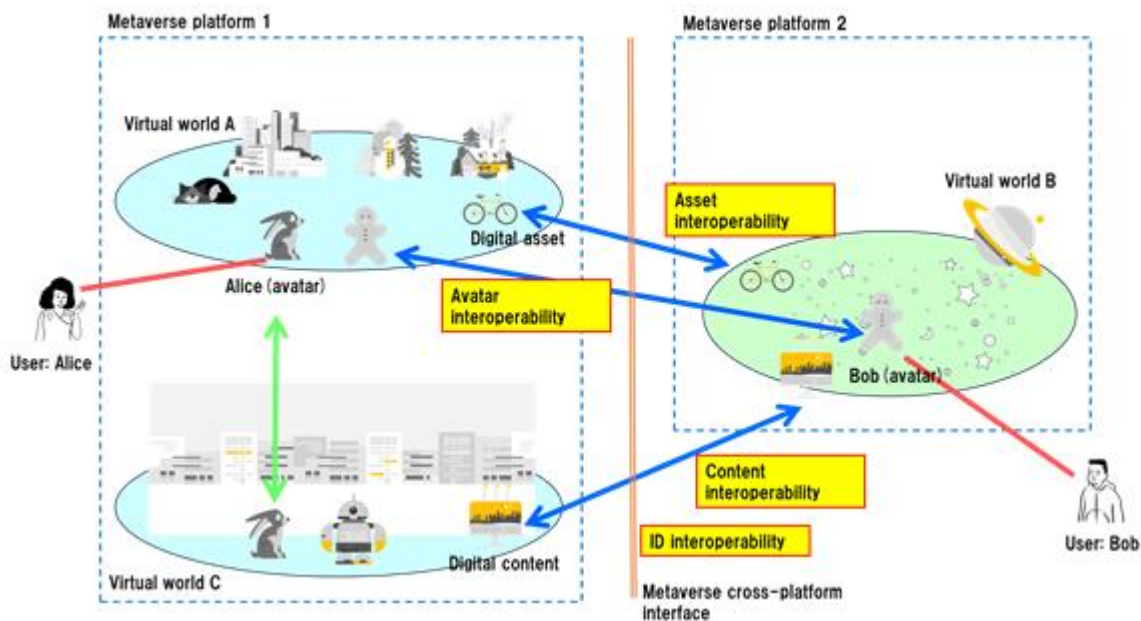


Figure 6-1 – Overview of metaverse interoperability

6.2 Aspects of metaverse cross-platform interoperability

The need for metaverse cross-platform interoperability arises from the fact that there are multiple metaverse platforms being developed by different companies, each with its own set of rules, protocols, and assets. This can create a fragmented metaverse ecosystem, making it difficult for users to move between different virtual worlds and for developers to create cross-platform applications.

There are different aspects of metaverse cross-platform interoperability to enhance the user experience. This document focuses on the following aspects:

[Editor's Note: Proposals for texts related to accessibility are invited.]

- **Avatar interoperability:** This refers to the ability of users to move avatars between different metaverse platforms while preserving their appearance, identity, and functionality. It allows users to create a single avatar that can be used across multiple virtual worlds, eliminating the need to create a new avatar for each platform. By maintaining consistency and continuity of their digital representation, users can engage themselves in various environments and situations, while also facilitating identity recognition and user tracking. Achieving avatar interoperability requires compatibility of avatar attributes such as access rights/agreements, appearance, movements, and behaviors across different platforms. Common standards and protocols for avatar creation, customization, and transfer are essential in ensuring avatar interoperability between platforms.

[Editor's Note: Avatar attributes such as ownership and their rights should be clarified.]

[Editor's Note: In terms of avatar interoperability, accessibility-related issues should be considered.]

- **Asset Interoperability:** This refers to the transfer of digital assets, such as tokenized items like NFTs (Non-Fungible Tokens), virtual real estate, and digital currencies, across metaverse platforms. It enables users to move and transact their assets across platforms, fostering cross-platform commerce. Achieving asset interoperability involves leveraging technologies like blockchain to facilitate secure and transparent asset transfers. The establishment of standards and protocols for asset formats and metadata is essential in ensuring compatibility and enabling the interoperability of these digital assets between metaverse platforms.
- **Content interoperability:** This refers to the ability of different metaverse platforms to share and exchange various elements associated with activities in the metaverse, such as user-generated content, games, experiences, and applications. This encompasses a diverse range of media formats, including 3D modeling, animation, sound, text, etc. It is crucial that such content is compatible and exchangeable across platforms, requiring the establishment of standards and protocols for content formats, metadata, and licensing, as well as for content discovery, storage, and retrieval mechanisms. It also requires the development of tools and technologies that enable creators and developers to easily create, share, and distribute content across different platforms. This eliminates the need for duplicating the content creation process for each platform, streamlining workflows and enhancing collaboration in the metaverse ecosystem, as well as for content storage, retrieval, archiving, and disposition meeting legal and regulatory requirements.
- **Identity Interoperability:** This refers to the transfer of user identities and associated data between different metaverse platforms. It enables users to maintain a unified identity across multiple virtual worlds, allowing for a smooth transition between platforms without the need to create new accounts. This encompasses not only user identities but also identity-related aspects for all entities within the metaverse, such as avatars and their associated items. To achieve identity interoperability, digital identities should be designed to be unique and consistently recognized across platforms. It is required to establish standards and protocols that ensure the privacy and protection of user information while enabling secure authentication of identities. This includes the ability for avatars to carry their associated items when moving between metaverse platforms, ensuring a smooth and consistent experience for users across different virtual worlds.

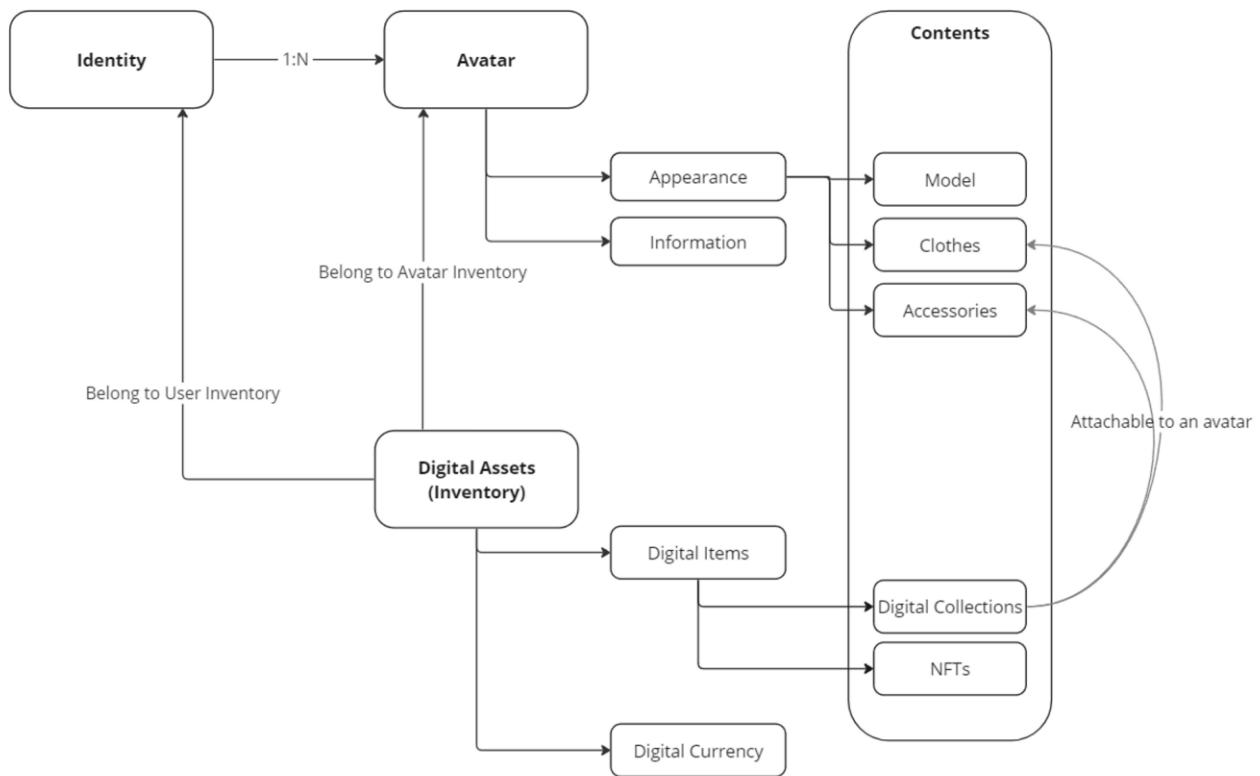


Figure 6-2 – Relationships among cross-platform interoperability aspects

[Editor Note: This figure may move to another part? Or, it needs to add some explanations for the relationships.]

Figure 6-2 illustrates the relationships among the interoperability aspects. The figure shows that a user identity can have multiple avatars, and a user has an inventory that holds items and digital currencies. It is possible to move some of these items to the inventory of any owned avatar. Digital items and avatar appearance are implemented as a type of content. By securing interoperability of these aspects, it is possible to ensure interoperability across heterogeneous metaverse platforms. The item attachable to the avatar, such as clothes, fashion items, etc., is an accessory. When an avatar moves to another metaverse platform, it needs to provide information about the avatar including its appearance, accessories, and its digital assets(inventory).

6.3 Metaverse cross-platform interoperability

Metaverse cross-platform interoperability refers to different metaverse platforms' ability to interact seamlessly, allowing users to access content, assets, and experiences across multiple virtual worlds. This interoperability is achieved through the use of standards and protocols that enable communication and data exchange between different metaverse platforms.

Two different approaches may be considered to achieve interoperability between different metaverse platforms: direct and indirect interoperability.

- **Direct interoperability** refers to the ability of two or more metaverse platforms to directly communicate and exchange data with each other, using a common set of protocols and APIs. For example, a user could enter one metaverse platform with their avatar and virtual assets and then move to another platform without having to go through transfer processes. Direct interoperability requires cooperation between the different metaverse platforms and the creation of common standards and protocols for asset and avatar transfer. These standards would need to be agreed upon and implemented by all participating platforms. This is a complex process that

requires a lot of coordination and agreement between different parties, but if successful, it would greatly enhance the user experience and create a seamless and interconnected metaverse.

- **Indirect interoperability** refers to the ability of different metaverse platforms to indirectly communicate and exchange data with each other through the 3rd party services, which are services developed and provided by a party other than the company that owns the metaverse platform. The 3rd party services could offer additional features, functionalities, or experiences to users, complementing the core services provided by the metaverse platform itself. The 3rd party services could include virtual asset exchanges, ownership and intellectual property rights management, identity verification and authentication services, etc. For example, a user could export their avatar or digital assets from one platform, and then import them into another platform using a 3rd party tool or service. While indirect interoperability is less seamless than direct interoperability, it can still provide a way for users and content creators to share and reuse content across different platforms.

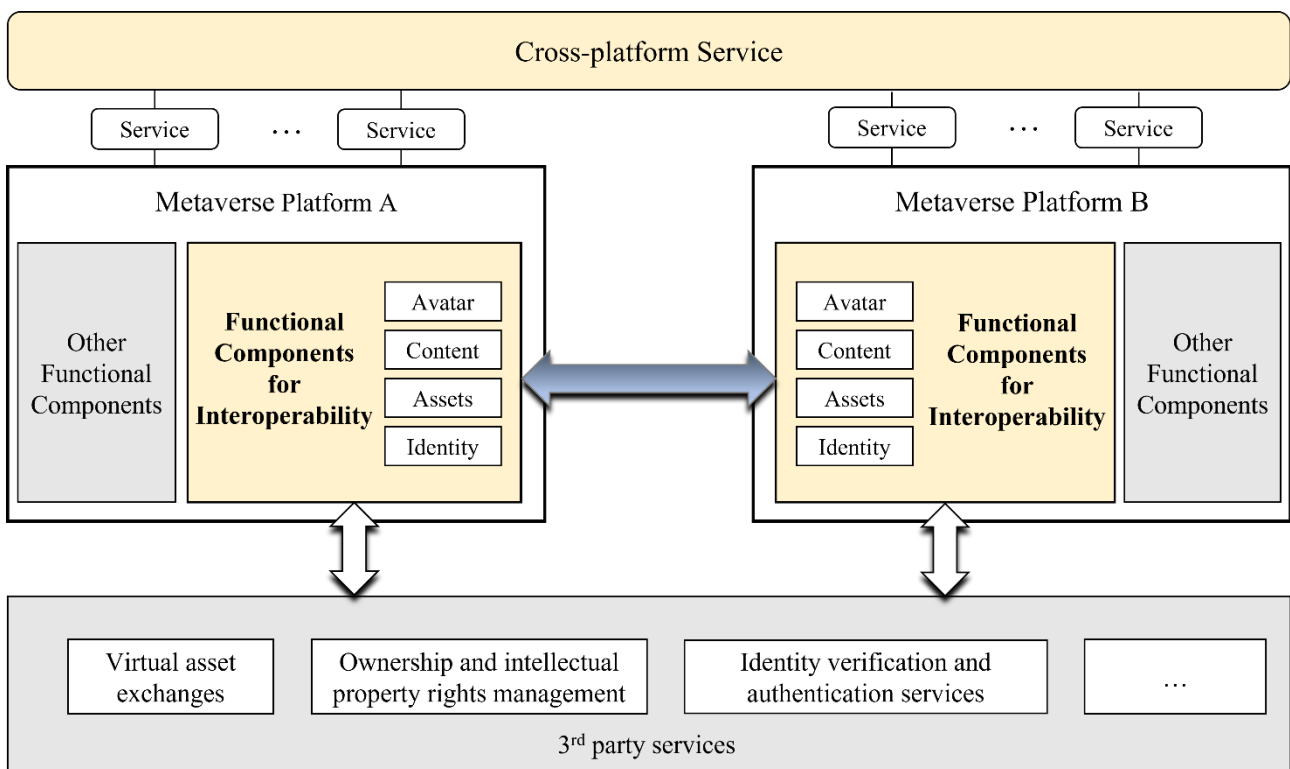


Figure 6-3 – Concept of metaverse cross-platform Interoperability

[Editor note: in the figure, direct and indirect interoperability architecture should be reconsidered. It will be updated with the removal of 'cross-platform services' and addition of legend. Also, the description about the figure will be updated.]

Figure 6-3 depicts the concept of metaverse cross-platform interoperability, where a cross-platform service is a service that allows users to interact with each other and with content across different platforms. This could include things like being able to use the same avatar and items in different metaverses, or being able to join the same virtual event from different devices.

7 Service scenarios of metaverse cross-platform interoperability

[Editor Note: all service scenarios should be used the same terminologies.]

This clause describes several considerable service scenarios realized by interoperable metaverse platforms. These service scenarios are not fully implemented because no interoperability capability between platforms is provided yet.

The table below is the summary of service scenarios and required interoperability cases, which are described in clause 6.

Table 7-1 – The relationship of service scenarios and interoperability aspects

Scenario	Description	Avatar Iop	Asset Iop	Content Iop	ID Iop	Sub-clause
Metaverse Search	This service acts as a directory or marketplace for the metaverse, showcasing various offerings from different creators, providers, or businesses.			Mash up content		7.1
Metaverse Education	Metaverse education is a virtual school where users, teachers and students, can connect remotely for education.	Avatar movement		Content retrieval Content purchase		7.2
Metaverse Zoo	Metaverse zoo is a virtual zoo that exists across multiple metaverse platforms	Avatar movement		Animal movement?		7.3
Metaverse Safety	Safety Patrol can monitor threats in the metaverse, support victims, and punish perpetrators to make the metaverse world a safer place.	Patrol			Reputation	7.4
Metaverse SNS	Metaverse can be a new area of social networking, where users can interact with each other and digital objects in real time in a virtual world.	Avatar movement	Asset movement	Photos, posts, videos		7.5
Metaverse Market	A use case for trading and transferring digital assets between metaverse platforms is when a user wants to		Asset exchange			7.6

	buy/sell virtual items or invest in a property that is only available on another platform.					
MetaTour	The Metaverse Tour service allows travel enthusiasts to create a customized tour that takes them through different metaverse platforms.	Avatar movement	Asset movement			7.7
Metaverse Signage	Metaverse signage is virtual signage that displays wayfinding information between different metaverse services offered within the platform.	Avatar movement				7.8
Metaverse Office	Metaverse office is a virtual office that allow users to collaborate and communicate remotely in a more immersive way.	Avatar movement		Content movement		7.9

[Editor’s Note: In metaverse search scenario, contributions are invited, especially for avatar and asset interoperability]

7.1 Metaverse Search: Seamless discovery and mashup of content across distributed metaverse platforms

A discovery service in the metaverse is a platform or tool that helps users find and access various virtual experiences, content, or services within the metaverse. This service acts as a directory or marketplace for the metaverse, showcasing various offerings from different creators, providers, or businesses. It is also possible to create mashup services or content by combining content from other distributed metaverse platforms.

7.1.1. Description

The contents and service discovery for the metaverse should allow users to search for specific content or services based on keywords, categories, or other criteria and filter results based on factors such as popularity, price, or creator. Furthermore, it is needed to support multimodal inputs from the users. Users can preview content or experience before purchasing it and read reviews from other users to make informed decisions. Social recommendations can also be available based on the user’s social connections, interests, or past experiences in the metaverse.

As is, a discovery service in the metaverse aims to make it easier for users to find, access, and engage with the vast array of offerings.

Users can search for services other metaverse platforms provide through the discovery service. It's essential to identify which contents are interoperable and which are not, as the distributed metaverse platform will offer independently operated services. Platform service providers can enhance competitiveness by linking with various metaverse platforms to support interoperability. In addition, users can create their content or services by combining the metaverse content that has been searched and deploying them on their metaverse platforms.

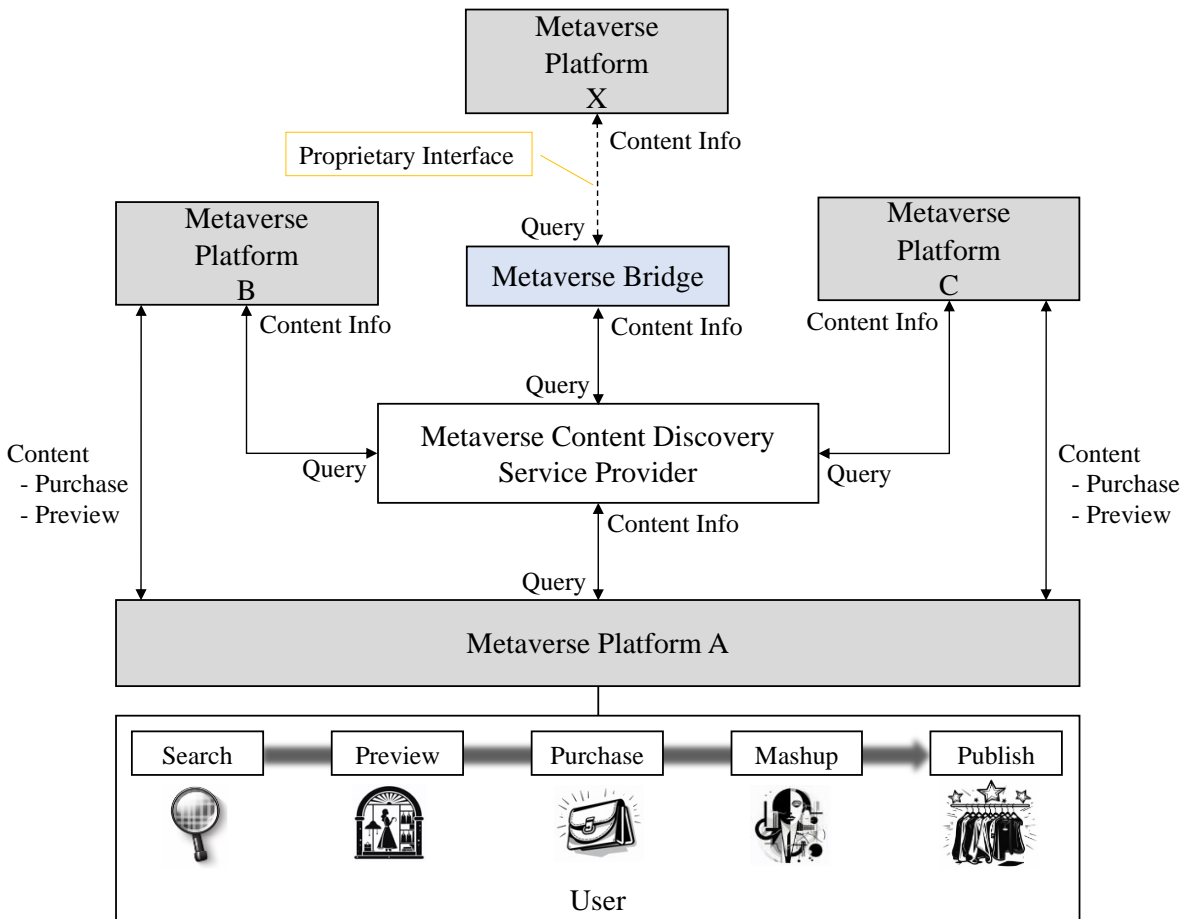


Figure 7-1 – Concept of the metaverse contents discovery use case

Nevertheless, it can become challenging for users to discover content that matches their interests in numerous dispersed and independent metaverses. In this case, it may be beneficial to have a dedicated MCDSP (Metaverse Content Discovery Service Provider) to provide an enhanced user experience. An MCDSP can help users navigate the various platforms, find the content and services that meet their needs, and be a central hub to find information about different metaverse platforms and their content. This can include information about virtual real estate, gaming experiences, social networks, virtual events, virtual education, and virtual tourist destinations. It is also possible to purchase the content on other platforms by jumping there, but this scenario gives more seamless experiences to the users since they don't need to know where the content is from.

The MCDSP can also provide users with relevant information about the platforms, such as the types of experiences and activities available, the number of users, and the quality of the user experience.

7.1.2. Assumptions

The assumptions related to this use case include the following;

- It is assumed that metaverse platforms A, B, and C provide a standardized interface for searching and exchanging their contents, and metaverse platform X uses a metaverse bridge to interact with other metaverse using their interface.
- It is assumed that a user is connected to the metaverse platform A.
- It is assumed that users can create their mashup content using multiple distributed content and publish it onto a specific metaverse platform.

7.1.3. Service flow

This clause describes the typical service flow for metaverse contents and service discovery service.

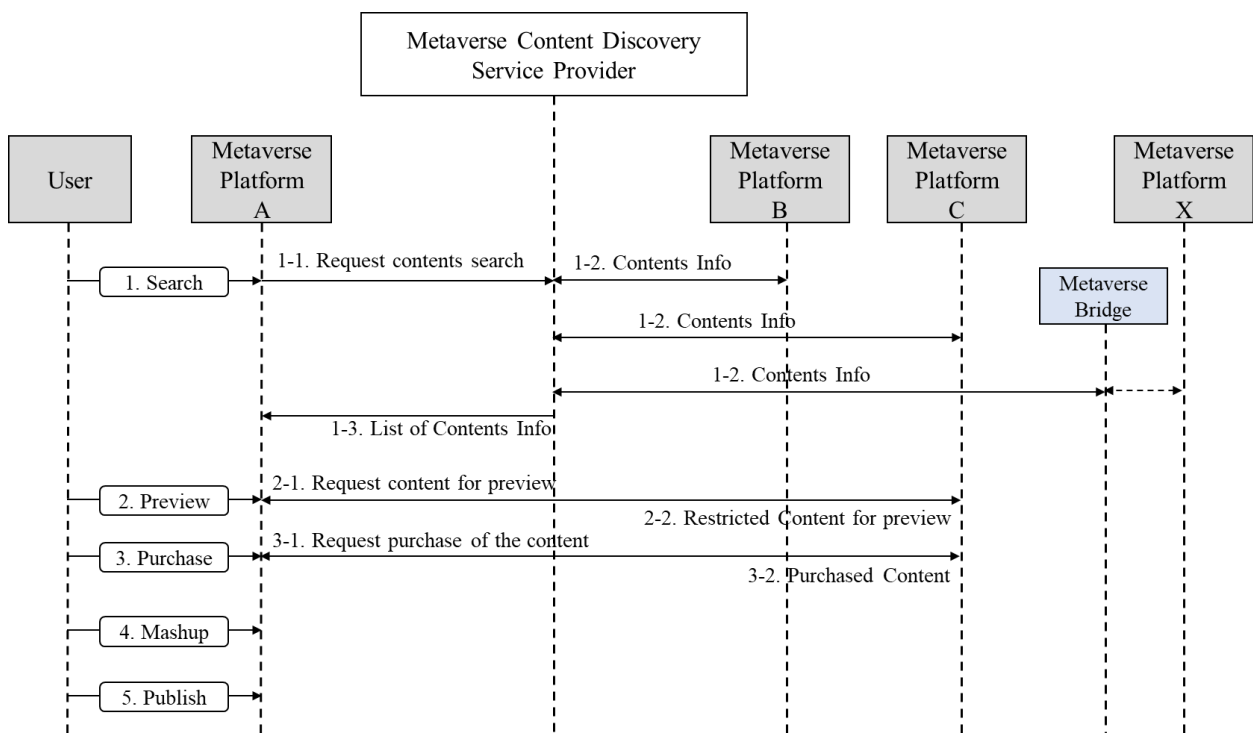


Figure 7-2 – Service flows for the metaverse contents and service discovery use case

1. The user searches for metaverse content using the discovery service. Using the discovery service's user-friendly intuitive interface, the user searches for specific content based on keywords, categories, or other criteria including multimodal inputs from the user.
 - The metaverse platform A sends the user's intention to the MCDSP to request content information through several distributed metaverse platforms.
 - Each metaverse platform gives content information that matches the query request. It includes the metaverse platform address, hardware requirements, billing information, etc.
 - The MCDSP gathers and provides the information to the metaverse platform A.
2. The user requests to preview the content or experience before purchasing it and read reviews from other users to help them make informed decisions. During the preview, users can try the content using their immersive devices.

- The metaverse platform A interacts with platform C to get content for preview.
 - The metaverse platform C gives content restricted to only preview to platform A. When the user requests metaverse platform A to purchase the content of platform C, and the platform interacts with platform C to buy it on behalf of the user.
 - The metaverse platform A interacts with platform C to purchase the content.
 - The metaverse platform C gives content to platform A, and platform A will make the user own it.
3. The user creates content in its metaverse platforms A.
 4. The user publishes and locates the mash-up contents into the metaverse platform A. This user metaverse content can also be searched through the discovery service and used for creating a new service by other users.

7.2 Metaverse Education: Content exploration and learning through transcending space

A use case for metaverse education is a virtual school where users, teachers and students, can connect remotely for education.

7.2.1 Description

In the use case of metaverse education, a virtual school known as the metaverse school is created, enabling teachers and students to connect through avatars. This approach enables an immersive learning environment and facilitates interactive and collaborative experiences within a virtual classroom. Teachers have the flexibility to create instructional materials by accessing a diverse range of content available from numerous content servers within the metaverse. Similarly, students are not limited to solely utilizing the materials provided by their teachers. they can also learn relevant content from various content servers, enriching their learning experience.

By creating a metaverse school in virtual space, students and teachers from around the world can seamlessly connect and learn together, regardless of the platform they use. Teachers have the advantage of accessing a wide array of content from various platforms, including 3D models, interactive visualizations, virtual libraries, and more. Students, in turn, can access and explore diverse learning materials that cater to their unique learning styles and preferences, without any limitations posed by geography or physical boundaries. This opens up exciting opportunities for remote and distance learning, ensuring that everyone has equal access to quality education and the ability to maximize their learning potential.

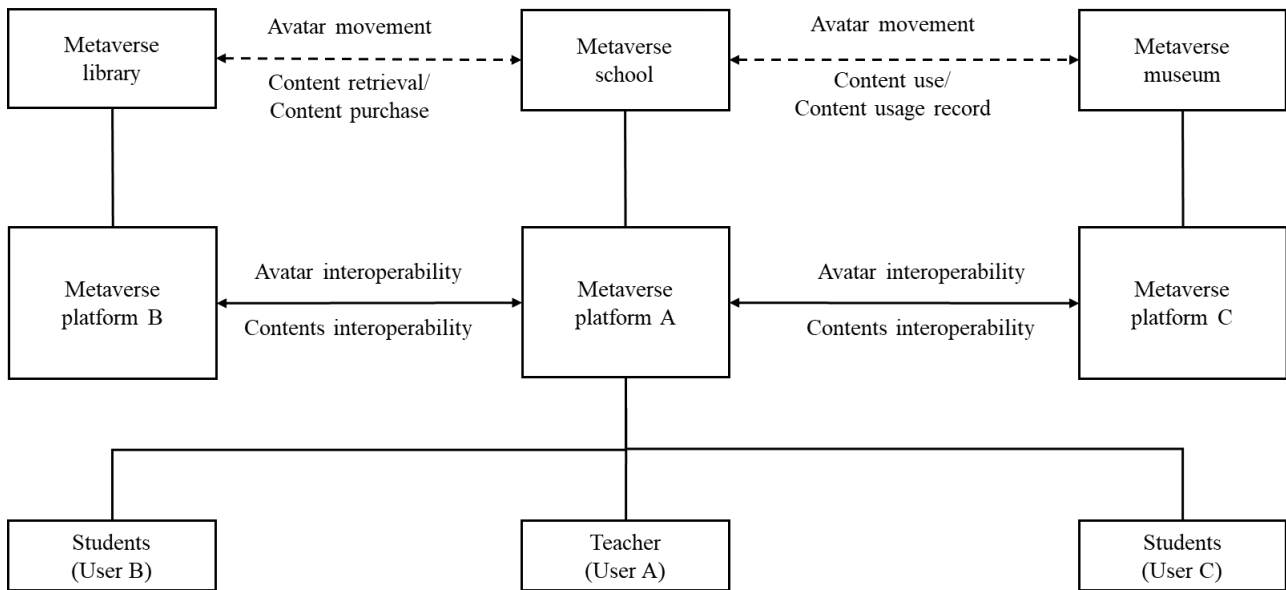


Figure 7-3 – Concept of metaverse education over cross-platform

7.2.2 Assumptions

- It is assumed that the metaverse school, the metaverse library, and the metaverse museum exist on a metaverse platform, with each being provided on different metaverse platforms A, B, and C. It is assumed that teachers and students are the users of the metaverse school.
- It is assumed that the metaverse library offers a variety of content, including educational materials, and provides diverse search functionalities, such as topic, media type, running environment, and required device type, to facilitate easy content discovery for users. This allows users to find content aligned with their interests or specific needs to create educational materials or engage in learning.
- It is assumed that the metaverse museum, in addition to its unique functions as a museum, is responsible for providing supplementary content related to students' lessons in the education area. It is assumed that there is a contractual agreement between the metaverse museum and the metaverse school, specifying designated lists of allowable users and content list.
- It is assumed that the metaverse museum manages the records of content utilization, including the list of contents accessed by users, timestamps of usage, learning outcomes, and provides certification marks to users who have studied the content.

7.2.3 Service scenario

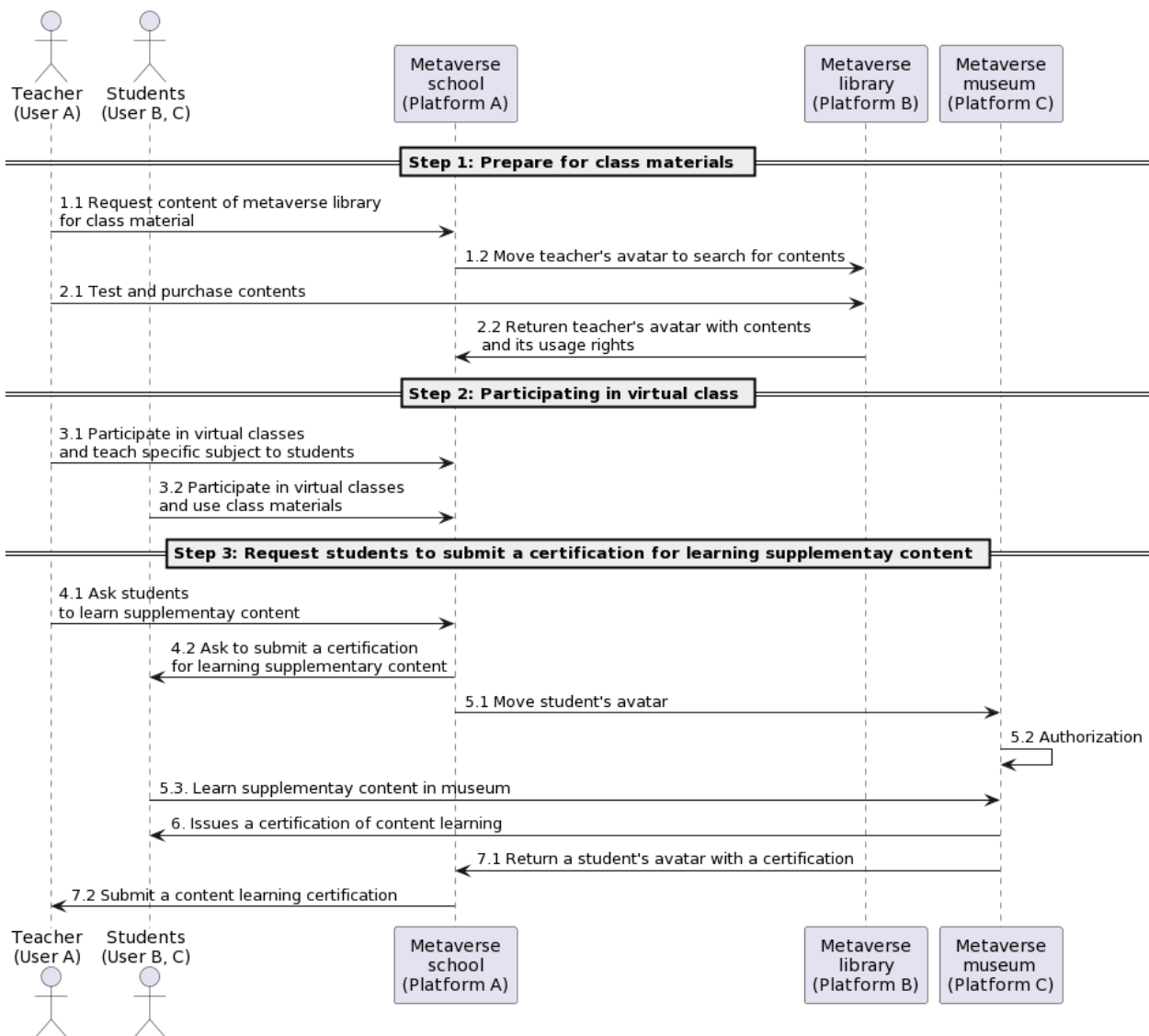


Figure 7-4 – Service flows for metaverse education use case

1. The teacher enters the metaverse school as their avatar to prepare educational materials for the class. To find the content required for lesson preparation, the teacher navigates to the metaverse library and performs searches using various keywords such as subject, media type, execution environment, and device requirements.
2. When the desired content is found, the teacher checks if there are any issues accessing the content using the devices utilized in the class. The teacher decides to purchase the content to make it available for all users of the metaverse school. The purchased content and content usage rights are transferred from the metaverse library to the metaverse school. The teacher completes the lesson materials by combining the content available at the metaverse school with the content obtained from the metaverse library.
3. The teacher and students participate in virtual classes by entering the metaverse school with their avatars. Students engage in the shared use of content prepared by the teacher.
4. After the class is over, the teacher requests the students to learn supplement content available at the metaverse museum in order to enhance their understanding of the lesson, and then submit a learning certification.
5. Students enter the metaverse museum with their avatars from the metaverse school. At the museum, their status as authorized users and their access to specific content are verified. If

granted permission, students can engage in learning the relevant content available at the metaverse museum.

6. The metaverse museum generates and manages records of content utilization, including lists of content used, usage history, and user learning outcomes. The museum also provides students with learning certification for the content they have studied. These certifications may include information such as the user who completed the learning, the content studied, and the learning outcomes.
7. Students return to the metaverse school with their content learning certification and submit them to the teacher.

7.3 Metaverse Exhibitions : Seamless metaverse exhibitions over cross-platforms

[Editor's Note: It is necessary to modify this whole sub-clause according to the change of the title.]

Metaverse zoo is a virtual zoo that exists across multiple metaverse platforms, providing an immersive and educational experience for visitors. Using advanced technologies such as augmented and virtual reality, visitors can explore different animal exhibits and habitats, and interact with some of the animals. The seamless integration across platforms allows visitors to continue their visit on a different platform without losing progress. This offers a new way to appreciate and learn about different species, regardless of physical location.

7.3.1 Description

This use case describes a seamless metaverse zoo that provides an immersive and educational experience for visitors using advanced technologies such as AR and VR. The seamless metaverse zoo spans multiple metaverse platforms, allowing visitors to explore different animal exhibits and habitats, and interact with some of the animals in a way that feels real.

Visitors can learn about different species through interactive experiences, including feeding animals, watching them in their natural habitats, and learning about their unique behaviors. The seamless metaverse zoo's integration across platforms enables visitors to seamlessly switch between platforms and continue their visit without losing progress.

This seamless metaverse zoo provides a unique opportunity to appreciate and learn about different species from anywhere in the world, regardless of physical location. It allows visitors to gain a deeper understanding of animals and their natural habitats through an immersive and interactive experience that can't be replicated in traditional zoos. The use of advanced technologies like AR and VR makes this seamless metaverse zoo an innovative and exciting way to learn about and appreciate the natural world.

[Editor's Note: animals could be moved to other metaverse zoos. This situation could be added.]

[Editor's Note: the specific use case about metaverse zoo might be useful for better understanding, so it might be moved to Appendix I.] This was addressed.

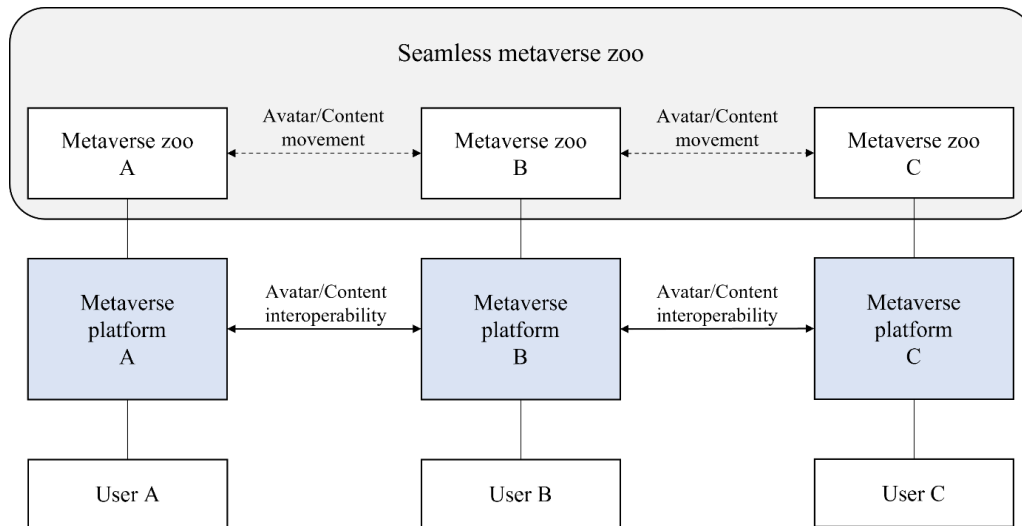


Figure 7-5 – Concept of seamless metaverse zoo over cross-platforms

[Editor’s Note: The figure will be updated in a way to indicate the avatar interoperability and content interoperability, respectively.]

7.3.2 Assumptions

The assumptions related to this use case include the following;

- It is assumed that the seamless metaverse zoo has animal and habitat exhibits hosted on multiple metaverse platforms, including A, B, and C.
- It is assumed that the seamless metaverse zoo has partnerships with different metaverse platform providers to host the exhibits.
- It is assumed that the seamless metaverse zoo has access to advanced technologies such as AR and VR to provide an immersive and interactive experience for visitors.
- It is assumed that the seamless metaverse zoo has a system in place to seamlessly integrate visitors' progress across different platforms.
- It is assumed that visitors have access to the necessary technology and equipment to access the virtual zoo on different platforms.

7.3.3 Service scenario

This clause describes the typical service flow for the use case of the seamless metaverse zoo over cross-platforms.

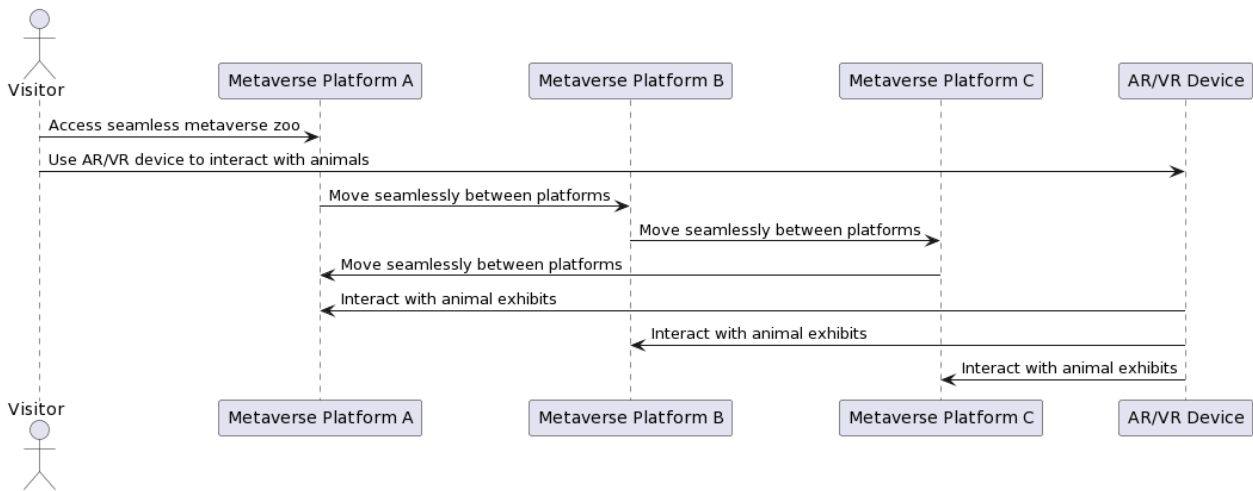


Figure 7-6 – Service flows for the seamless metaverse zoo over cross-platforms

Visitors may start to visit through platform A, exploring the habitat of a particular animal. They can then seamlessly switch to platform B, where they can learn about the animal's behavior and diet through interactive exhibits. The visitor can then move to platform C, where they can use AR technology to interact with the animal and feed it virtually.

1. Visitors access the seamless metaverse zoo on any of these platforms using their AR/VR devices.
2. Advanced technologies such as AR and VR enable visitors to interact with animals virtually and gain a deeper understanding of their behavior and natural habitat.
3. Visitors can seamlessly move between platforms, maintaining their progress and interaction with the exhibits using their AR/VR devices.
4. The seamless integration across platforms provides a comprehensive and immersive experience of the zoo, allowing visitors to engage with different exhibits on different platforms using their AR/VR devices.
5. Visitors can use their AR/VR devices to interact with the animals virtually, feed them, and learn about their natural habitat.

7.4 Metaverse Safety: Safety patrol service

Safety issues in virtual worlds are not a new phenomenon, and users of the metaverse have expressed concerns about safety issues. To protect user safety, metaverse platforms can operate organizations or services such as Safety Patrol to protect users. Safety Patrol can monitor threats in the metaverse, support victims, and punish perpetrators to make the metaverse world a safer place.

[Editor's Note: it is better to exchange information with WG6 regarding COP.]

7.4.1 Description

In virtual reality games, there have been instances of harassment, physical assault, bullying, hate speech, and more. As the metaverse provides users with an increased sensory experience, bad behavior within the metaverse can be even more serious than current online harassment. Problematic behaviours in virtual reality generally occur in real-time and are difficult to track as they are not typically recorded. Therefore, a safety patrol is necessary to prevent immediate user harm and online harassment. However, it may be difficult for every metaverse to operate its own independent safety patrol. Therefore, a separate provider of Metaverse Patrol as a Service can take

on this role, and each metaverse platform can ensure safety through an agreement with this service provider. In this use case, when the Metaverse platform receives a request for help from an online user, it accompanies the user with a Safety Patrol to monitor the situation nearby and immediately warn users who engage in problematic behaviours. This can be especially useful for protecting children in the Metaverse environment. This patrol ensures it can be distinguished from regular users through consistent uniforms or marks. In addition, it warns users who engage in problematic behaviours in advance or reports them to the Metaverse platform administrator for future reference. The Metaverse platform administrator will impose sanctions on the user based on the report and record it in the reputation management system of the platform to ensure accountability.

[Editor’s Note: the relation with patrol service provided by each metaverse platform should be clarified.]

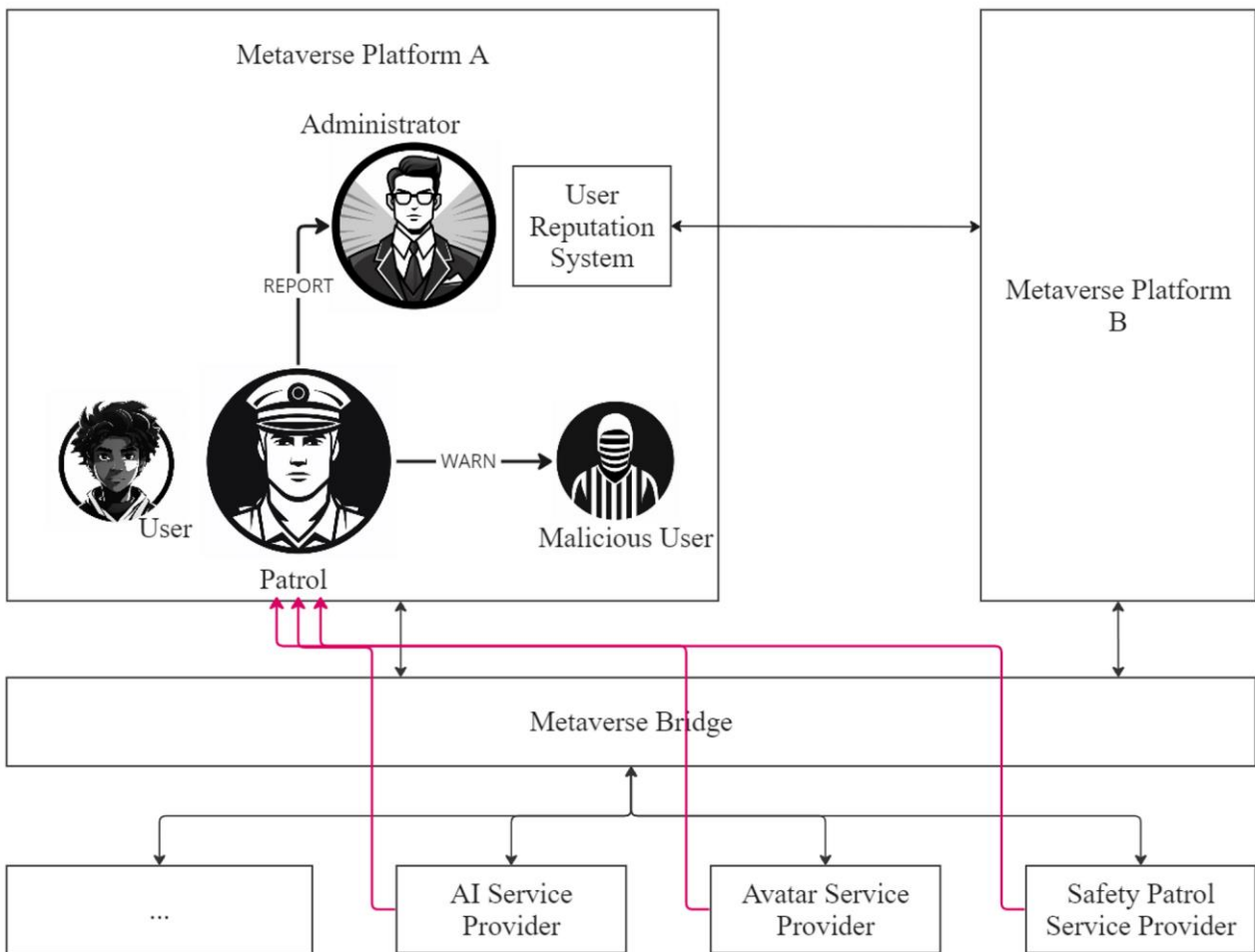


Figure 7-7 – Concept of a safety patrol service over metaverses

Figure 7-7 shows a concept of a safety patrol service over metaverses. As shown in this Figure, the patrol is visible and operated through a combination of the AI service provider, avatar service provider, and safety patrol service provider.

7.4.2 Assumptions

The assumptions related to this use case include the following;

- It is assumed that metaverse platform A has entered into an agreement with a metaverse patrol as a service provider.

- It is assumed that metaverse platform A has shared its platform's rules and policies with the patrol service provider in advance.
- It is assumed that metaverse platform A has granted the patrol's avatar the necessary level of authority within the platform.
- It is assumed that the patrol operates as an AI patrol avatar through collaboration with an avatar service provider and an AI service provider.

7.4.3 Service scenario

This clause describes the typical service flow for metaverse safety patrol service.

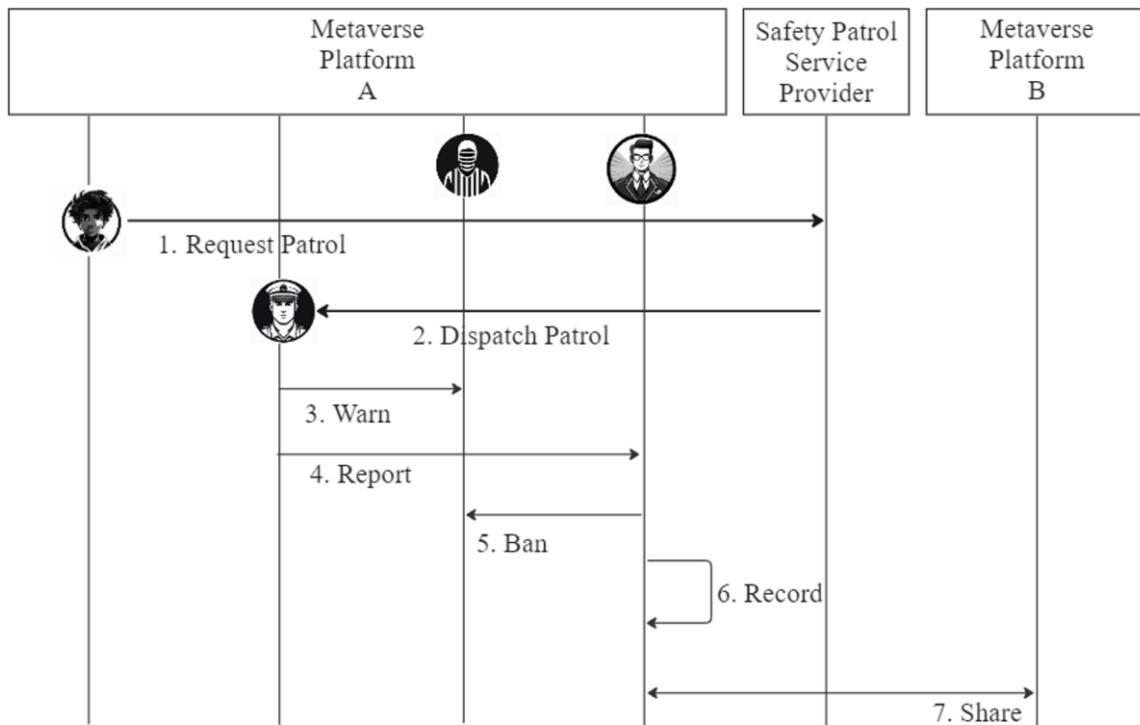


Figure 7-8 – Service flows for a safety patrol service over metaverses

1. When a user experiences harassment or problematic behavior, the user requests patrol services through the metaverse platform A.
2. When a request for help comes in, the platform requests patrol services from a provider to have a safety patrol accompany the user and monitor the situation.
 - The patrol prevents problematic situations by being distinguished from regular users through consistent uniforms or marks. Alternatively, an item indicating that the user avatar is protected by the patrol and only revealing the patrol's avatar when necessary may be attached to avoid rendering performance issues due to additional avatars.
 - The patrol uses artificial intelligence provided by an AI service provider to determine if other users' real-time conversations and actions are problematic.
3. Safety patrol monitors users exhibiting potential problematic behavior and immediately issues warnings if necessary.
 - The platform requests an AI service provider to make judgments based on the rules and policies of the metaverse platform and user behavioral data.

- If necessary, appropriate sanctions can be immediately enforced according to the permissions granted by the platform.
- 4. Patrols create reports on detected issues and send them to the metaverse platform administrators.
- 5. The administrator reviews the reports and decides on sanctions for the problematic user.
- 6. If sanctions are imposed, the reputation management system for that user is recorded, and additional measures are reviewed and implemented for the prevention of recurrence.
 - Users subject to sanctions may be blocked from accessing the metaverse.
- 7. Depending on the situation, other metaverse platforms B that have entered into an agreement may share reputation management information.

7.5 Metaverse SNS: Social Networking Services on metaverse

This use case is about social networking services in the metaverse. Users can display content such as NFT assets and user-created content in their personal metaverse social space, and visitors can access and interact with the user's content. Additionally, users can delegate their avatars to artificial intelligence to greet visitors. Compared to existing SNS services composed of text, images, and 2D videos, social networking services in the metaverse can provide immersive content through interactive 3D content.

[Editor's Note: some explanation texts of the difference of ordinal SNS need to be added.]

7.5.1. Description

Metaverse can be a new area of social networking, where users can interact with each other and digital objects in real time in a virtual world. In this context, a Metaverse SNS (Social Networking Service) provides users with a space to organize NFT assets, upload personal photos and videos, record daily activities, post photos and text, and communicate with friends through comments and various activities. Users can customize the appearance of their avatars, including clothing, accessories, and animations, and interact with others in virtual environments, games, and events. This use case also considers platform interoperability between different Metaverse SNS platforms, including the transfer of avatars and accessories between platforms. Users can expand their social network and participate in various communities and events by promoting interoperability and collaboration between platforms.

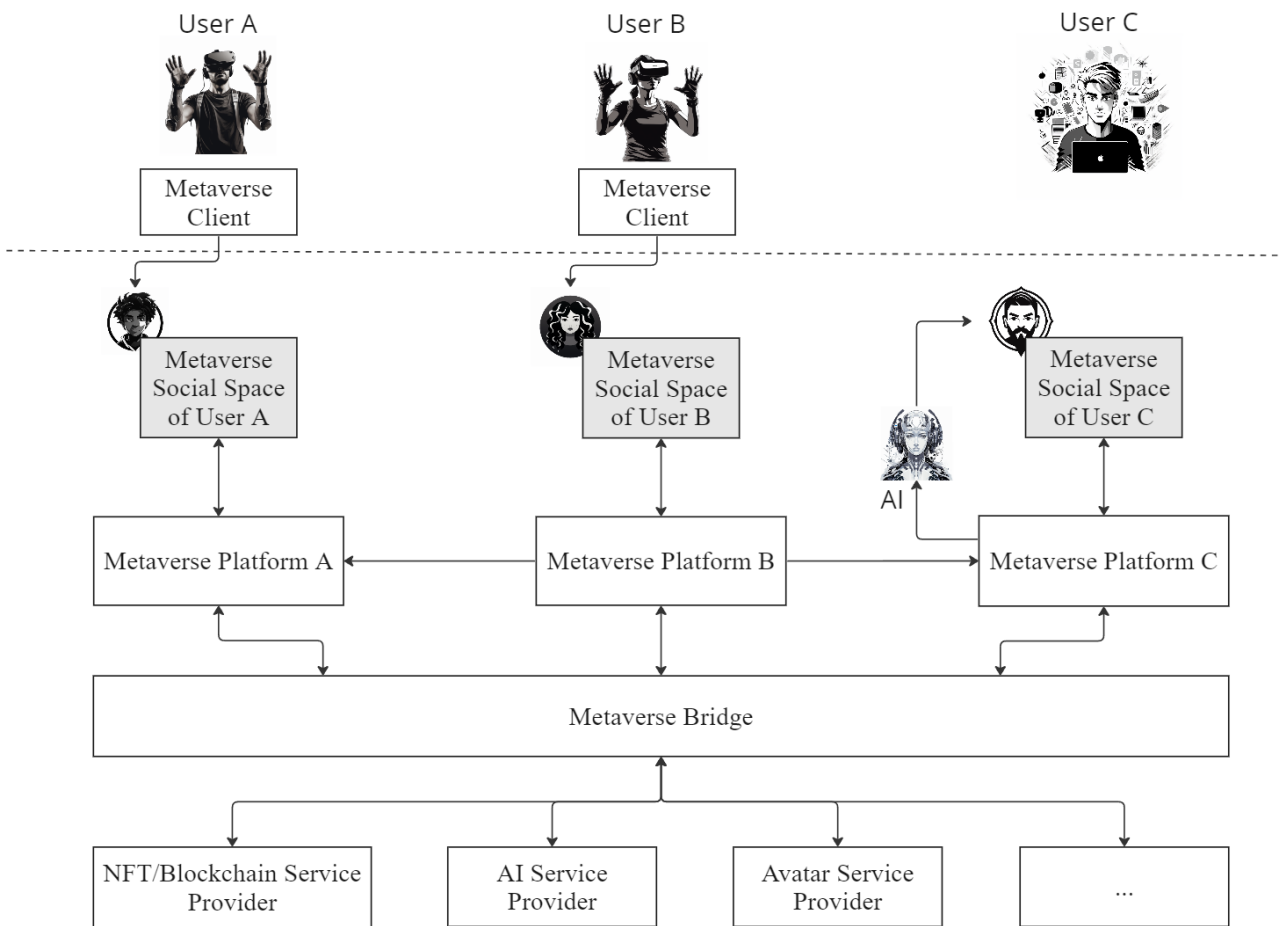


Figure 7-9 – Concept of the metaverse social networking use case

Figure 7-9 shows a concept of the metaverse social network use case. In the concept, a metaverse social space resides on top of metaverse platforms. That is, a metaverse platform can hold multiple metaverse, and those platforms can interact with each other directly or via a metaverse bridge. It is also possible to interact with 3rd party services such as NFT/Blockchain service provider, AI service provider, avatar service provider, etc. In this use case, a user's avatar can either be affiliated with the metaverse platform or a separate avatar service provider.

7.5.2. Assumptions

The assumptions related to this use case include the following;

- It is assumed that the user's SNS space in the metaverse is called "Metaverse Social Space".
- It is assumed that Users A, B, and C each own a Metaverse Social Space and, being in a mutual friendship, can freely visit each other's spaces. User C is assumed to have connected artificial intelligence to the avatar to cater to visitors on behalf.

7.5.3. Service scenario

This clause describes the typical service flow for metaverse social networking service.

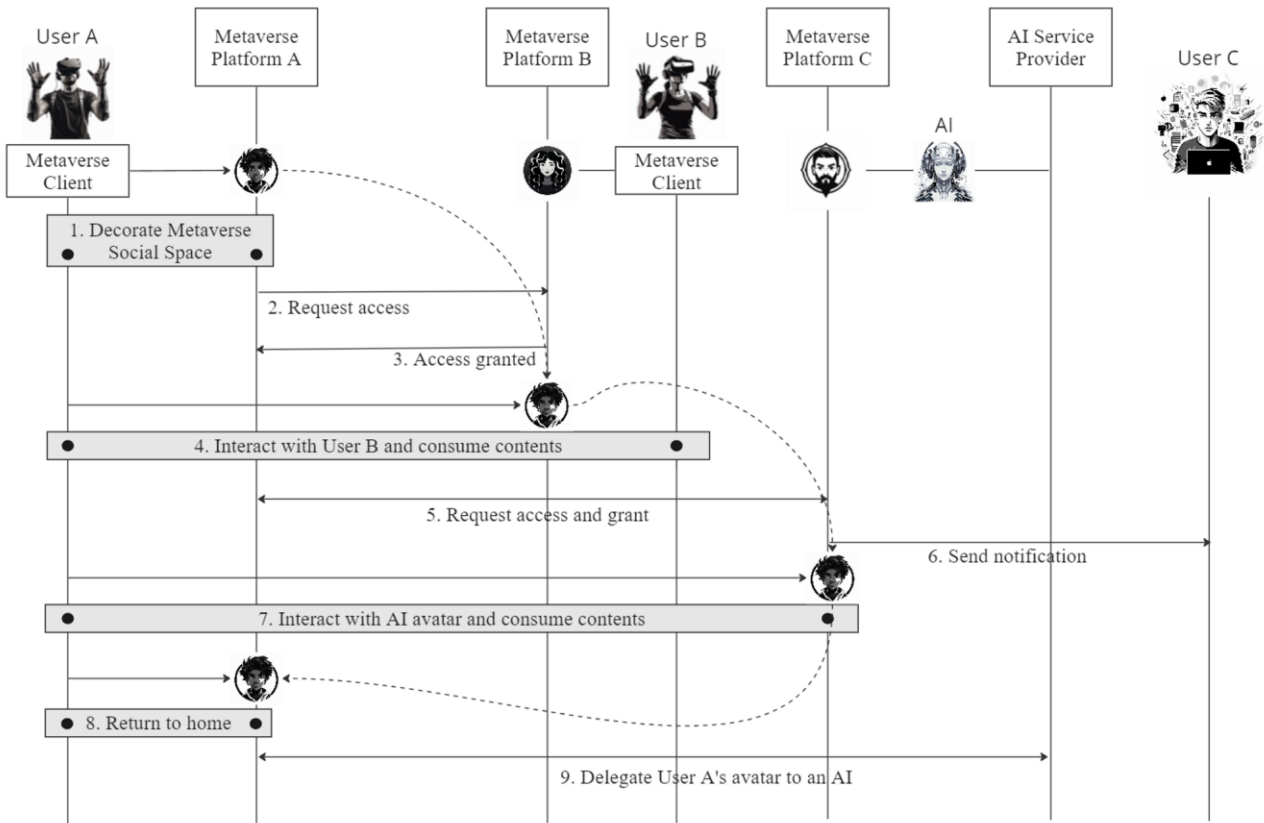


Figure 7-10 – Service flows for the metaverse contents and service discovery use case

1. Users create their own metaverse social spaces using the tools provided by each metaverse platform. In this step, users can do the following;
 - Place their digital assets, items, photos, posts, videos, party rooms, and playable games that they have purchased as NFTs in their metaverse social space.
 - Invite friends to their space and make content accessible to other users even when the user is not online.
 - Grant differentiated access rights to their spaces and content.
 - Set content display and access conditions when decorating their spaces.
 - Create multiple metaverse social spaces and specify them as public or private. For private spaces, access can be limited to invited users for a certain period of time.
 - Place their avatars in their metaverse spaces. These avatars can mimic the user's appearance and behavior or be set to a different appearance as desired. When the user is offline, an AI-powered avatar greets visiting friends. The avatar only provides information the user has allowed and engages in conversations that align with the user's intentions.
 - Place portals linked to their friends' metaverse spaces on their own metaverse social space. The connection of these portals is only possible if it is allowed by the bilateral agreement between the user and the friend. These portals only allow movement for people who are friends with the user, and users who are not friends can only see information that the portal owner has allowed. It is also possible to send friend requests to other users connected to them through portals placed in visited metaverse social spaces.

2. User A sends a request to move to User B's metaverse platform through a portal. The user retains the avatar, identity, and accessories they were using and can either maintain their avatar as it is or change it to fit the other platform.
 - User can use their avatar as it is without any modification if each platform supports it;
 - The appearance of the avatar may be altered during the compliance checks to follow the rule or policy of the target metaverse platform;
 - Items not allowed are disabled if it does not fit the target platform.
3. The metaverse platform checks the user's identity to confirm whether the user has permission to access the metaverse space.
4. User A shares their experience of the content in the metaverse space and engages in conversation or enjoys content such as movies and games together with User B in their metaverse social space using their avatar. Multiple users can participate online at the same time.
 - Users collaboratively create content and issue NFTs on the metaverse space with other users;
 - Users exchange their items with each other, and the avatars can bring the items to their metaverse social space when they return.
5. User A moves to User C's metaverse social space through User B's portal. User information and avatar model files are received from User A's metaverse platform since that information is maintained in the metaverse platform A.
6. When User A's entry is permitted, notifications such as email, messenger, phone, or text messages may be sent to the user.
7. User C's AI-powered avatar communicates with User A in natural language to leave a message for their friend or request their friend's content. In addition, users can communicate with friends through their avatars. Various contact methods such as mobile phones, VoIP, email, and messenger can be used.
8. User A returns to their metaverse SNS space.
9. When logging out of metaverse SNS space, User A delegates its avatar to an AI by requesting to the AI service provider.
 - The user can indicate their preferences regarding whether the avatar can contact the owner or what information can be provided to visiting friends.
 - Users can check messages or notifications left by visitors to their personal space later when they log in again.

7.6 Metaverse Market: Trade of digital assets between metaverse platforms

A use case for trading and transferring digital assets between metaverse platforms is when a user wants to buy/sell virtual items or invest in a property that is only available on another platform. This allows users to take advantage of opportunities and transactions that would not be possible on a single platform.

7.6.1 Description

Metaverse platforms offer users access to virtual worlds and economies where they can participate in various activities and acquire digital assets such as virtual currencies, real estate in virtual worlds, and other virtual goods. However, due to the decentralized and fragmented nature of these platforms, some digital assets may be exclusively available on specific platforms.

In such cases, trading and transferring digital assets between metaverse platforms can enable users to buy or sell virtual items or invest in exclusive properties that are not available on their current platform. For example, a user who plays a game on one metaverse platform may find a rare virtual item or exclusive virtual property that is only available on another platform. Without the ability to transfer digital assets, this user would not be able to acquire these items or invest in the property.

By enabling trading and transferring of digital assets between metaverse platforms, users can access a wider range of opportunities and transactions that would not be possible on a single platform. This functionality allows users to diversify their virtual asset portfolios, take advantage of exclusive opportunities, and maximize the potential value of their virtual assets. Additionally, digital asset exchange services that support multiple metaverse platforms can facilitate these transactions, making it easier for users to transfer and trade their digital assets across various platforms.

[Editor's Note: Avatar interoperability and ID interoperability could also realize metaverse market.]

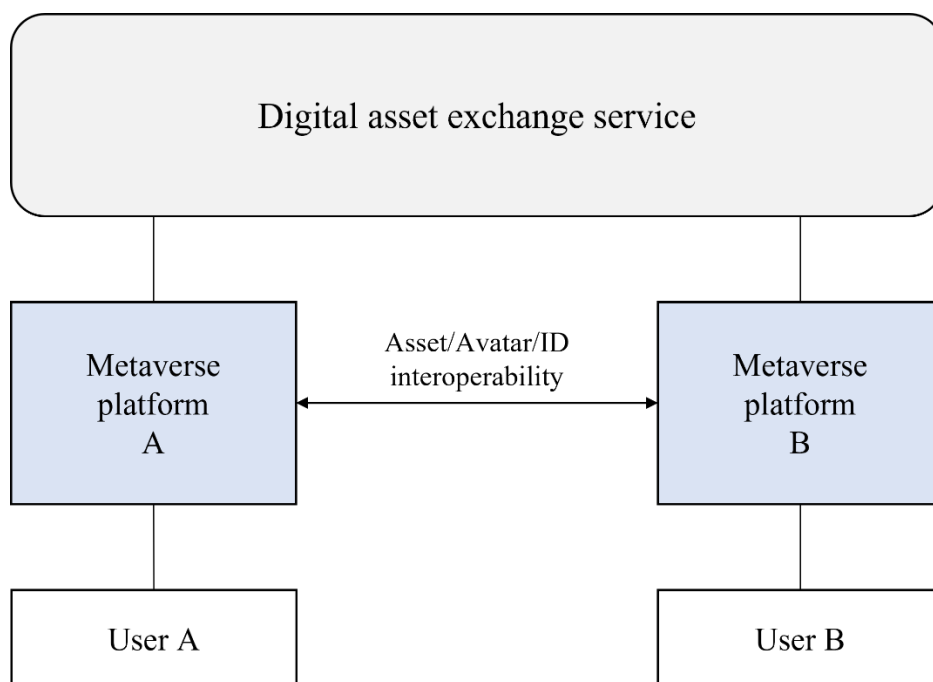


Figure 7-11 – Concept of digital asset exchange over metaverse cross-platforms

7.6.2. Assumptions

The assumptions related to this use case include the following;

- It is assumed that the user has accounts on both the source and target metaverse platforms.
- It is assumed that the user possesses digital assets on the source metaverse platform that they wish to transfer to the target platform.
- It is assumed that the user has access to a digital asset exchange service that supports both the source and target metaverse platforms.
- It is assumed that the target metaverse platform allows for the purchase or investment in virtual items or properties using the transferred digital assets.

7.6.3. Service scenario

This clause describes the typical service flow for the use case of the digital asset exchange service.

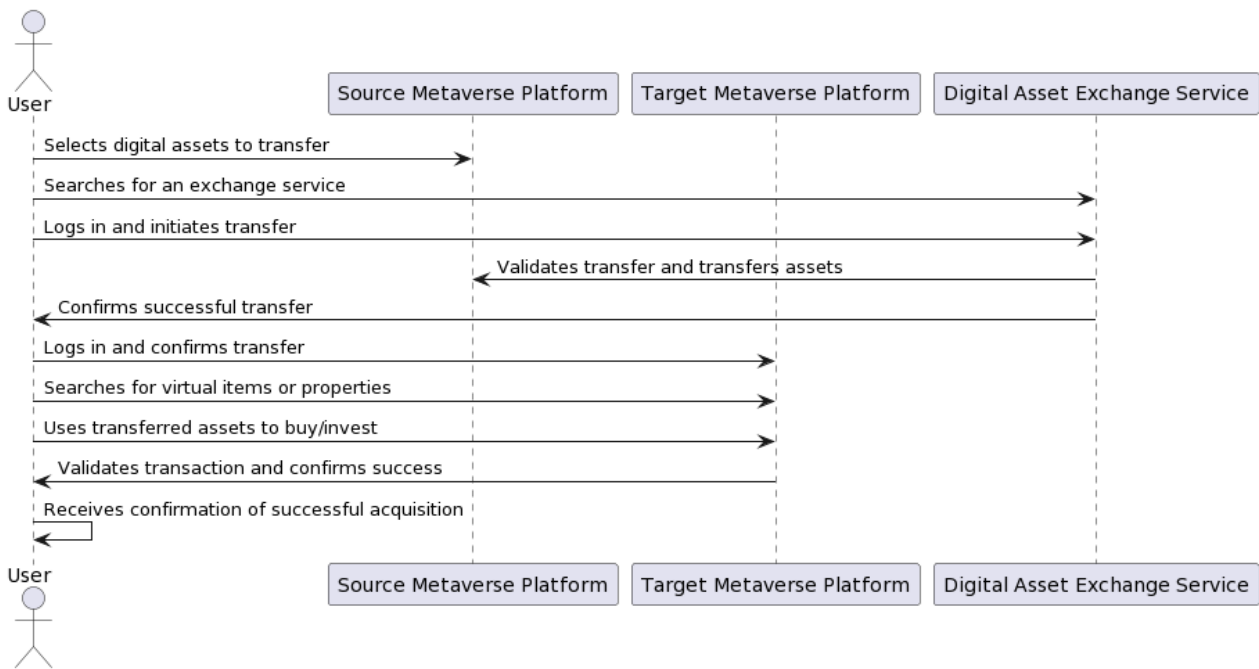


Figure 7-12 – Service flows for the digital asset exchange over metaverse cross-platforms

The user, who has accounts on both the source and target metaverse platforms, decides to transfer digital assets from the source platform to the target platform.

1. The user selects the digital assets they wish to transfer, such as virtual currency, real estate, or virtual items.
2. The user finds a digital asset exchange service that supports both the source and target metaverse platforms.
3. The user logs into the digital asset exchange service and initiates the transfer of their digital assets from the source platform to the target platform.
4. The digital asset exchange service validates the transfer and transfers the digital assets from the source platform to the target platform.
5. The user receives confirmation that the digital assets have been successfully transferred to the target platform.
6. The user logs into the target metaverse platform and confirms that the transferred digital assets are now available in their account.
7. The user searches for virtual items or properties that are exclusively available on the target metaverse platform and that they wish to purchase or invest in.
8. The user uses the transferred digital assets to buy the virtual items or invest in the exclusive properties.
9. The target metaverse platform validates the transaction and confirms the successful purchase or investment.
10. The user receives confirmation that they have successfully acquired the virtual items or invested in the exclusive properties on the target metaverse platform.

7.7 Metaverse Tour: Seamless exploration across multiple platforms

The metaverse tour service allows tourist to select a customized tour that takes them through different metaverse platforms. With seamless transitions between platforms, users can explore a variety of attractions and environments, ranging from natural landscapes to virtual concerts and cultural experiences. Additionally, the service provides an opportunity for social interaction with friends and other users, allowing for shared experiences across the metaverse.

7.7.1 Description

User A and user B decide to take a virtual tour together and select a virtual tour package on metaverse platform A that they both like. This virtual tour package includes not only the tours offered by metaverse platform A, but also the tours offered by metaverse platform B.

While on a virtual tour, **user A and user B discover a virtual gift shop on metaverse platform A**. To commemorate the trip, they decide to purchase a hat souvenir that they can wear on their avatars while traveling. They can attach the hat souvenir to their avatars while traveling and keep it attached to their avatars as they move between metaverse platforms.

While exploring the virtual world on metaverse platform A, user A and user B see that a virtual event that is part of their virtual tour package is being offered on metaverse platform B, so they move to metaverse platform B. The virtual event is offered on metaverse platform B, and user A and user B decide to attend. Their avatars move from metaverse platform A to metaverse platform B without any registration or signup.

User A and user B attend and enjoy the event on metaverse platform B, and then return to metaverse platform A to continue the virtual tour where they left off.

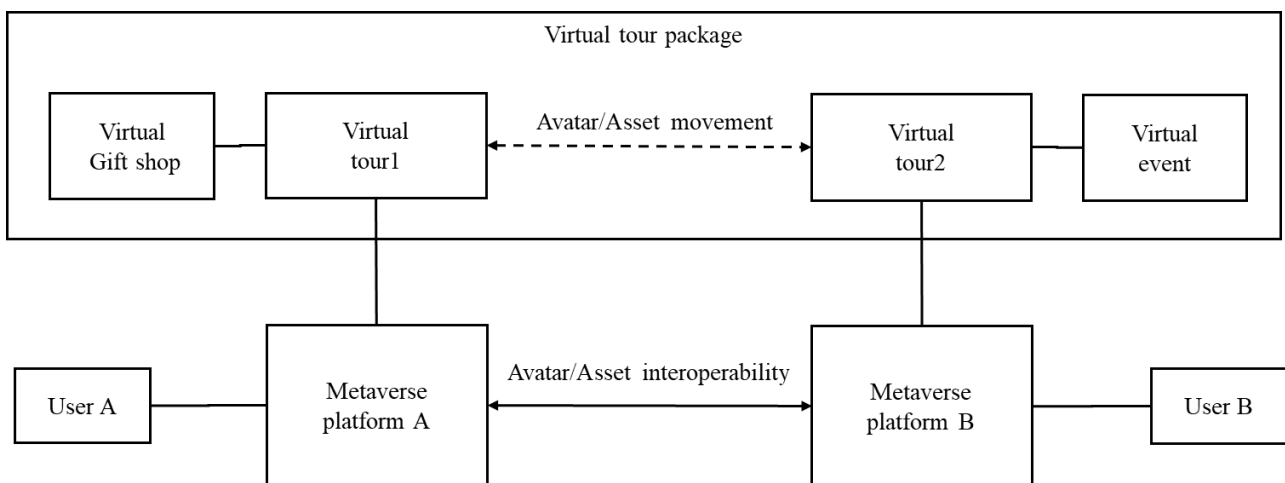


Figure 7-X – Concept of the metaverse tour

[Editor's Note: It is necessary to check out the activity of FG-MV WG2 on metaverse tours.]

7.7.2 Assumptions

The assumptions related to this use case include the following;

- It is assumed that tourists have the necessary equipment and devices to access various metaverse platforms.
- It is assumed that there is an established partnership or integration between metaverse platform A and metaverse platform B to ensure seamless transitions between the two platforms.

- It is assumed that their avatars can seamlessly move from metaverse platform A to metaverse platform B without additional registration or sign-up.
- It is assumed that the platform has implemented appropriate security measures to ensure the safety and privacy of users during the tour, including measures to prevent unauthorized access to personal information and virtual assets.

7.7.3 Service scenario

This clause describes the typical service flow for metaverse tour service.

[Editor’s Note: the flow should be elaborated further.]

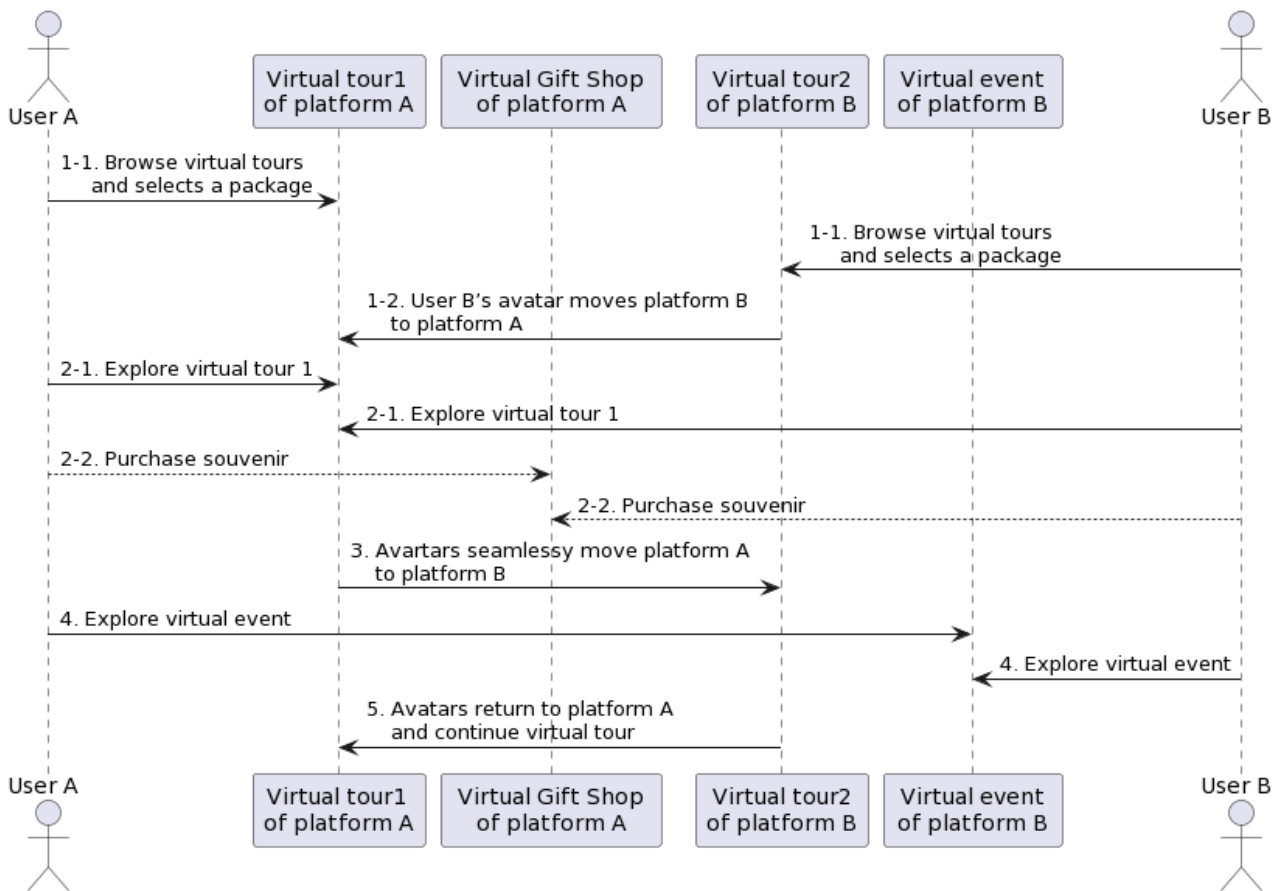


Figure 7-Y – Service flows for the metaverse tour service use case

1. User A and user B browse a virtual tour package that they both like. The selected virtual tour package includes tours offered by platform A and platform B. To use the virtual tour together, user A accesses virtual tour1 on metaverse platform A, user B accesses virtual tour 2 on metaverse platform B and then moves to virtual tour 1.
2. While on the virtual tour on platform A, user A and user B notice a virtual souvenir shop and decide to purchase a souvenir to attach to their avatars during the tour. The two users purchase a hat as a souvenir that they can wear on their avatars as they travel from platform to platform.
3. While exploring the virtual world on metaverse platform A, user A and user B see that a virtual event that is part of their virtual tour package is being offered on metaverse platform B, so they move to metaverse platform B. The virtual event is offered on metaverse

platform B, and they decide to attend. Their avatars move from metaverse platform A to metaverse platform B without any registration or signup.

4. User A and user B attend and enjoy the event on metaverse platform B
5. They return to metaverse platform A to continue the virtual tour where they left off.

7.8 Metaverse Signage: Product promotion with seamless transitions cross-platforms

[Editor's Note: the relationship with existing digital signage Recommendation might be added in Appendix II.]

Signage refers to any type of communication that provides information or guidance to users. In the metaverse, signage can be used for various purposes, such as wayfinding, displaying information, promoting events, and branding in a virtual space.

- Wayfinding: In large virtual worlds, signage can be used to help users navigate and find their way around. This could include directional signs, maps, or landmarks that help users orient themselves within the space.
- Informational displays: Signage can also be used to display information to users in the metaverse. For example, a museum might use signage to provide information about exhibits or historical artifacts.
- Event promotion: Signage can be used to promote events or activities within the metaverse. For example, a virtual concert might use signage to advertise the time and location of the event, as well as provide information about the performers.
- Branding: Just like in the physical world, signage can be used to promote brands and products in the metaverse. This could include billboards, product displays, or even virtual storefronts.

7.8.1 Description

Metaverse signage is virtual signage that displays wayfinding information between different metaverse services offered within the platform. In this case, in addition to its primary purpose of providing directions in the virtual space, the metaverse signage provides a link to the product marketing metaverse, which provides more information about the advertised product.

The product marketing metaverse is a metaverse dedicated to that brand, built to promote and sell products, and can include a virtual storefront or product showcase where users can interact with products in a more immersive way. By creating a service dedicated to a specific brand on one metaverse service platform, rather than multiple different metaverse service platforms, businesses can effectively showcase their brand and products in the most effective way.

A user can access the different metaverses on the platform through metaverse signage that provides wayfinding information within the virtual environment. Metaverse signage is accessible on Metaverse Platform A. A user is browsing the virtual space and comes across a link to a metaverse promoting a specific product. The user decides to enter the metaverse to learn more. When the user clicks the link, the user is redirected to a product marketing metaverse that provides a virtual store or product showcase. This metaverse is powered by Metaverse Platform B, a dedicated platform for promoting featured products.

This allows avatars to move between different Metaverse platforms while maintaining their appearance, identity, and functionality. Instead of having to create a new avatar on each platform the user utilizes, users can create a single avatar that can be used in multiple virtual worlds. Using the same avatar across different platforms not only helps users maintain continuity and identity, but

also reduces the time and effort required to create a new avatar for each platform. After exploring the product, the user chooses to return to the metaverse service platform A.

[Editor's Note: it might be considered that metaverse signage service provider as a 3rd party provider could promote product services to several metaverse platforms.]

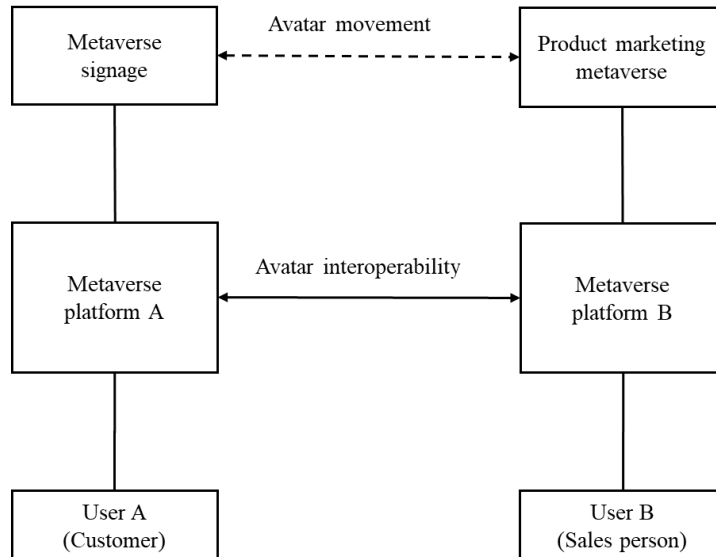


Figure 7-15– Concept of the metaverse signage use case

7.8.2 Assumptions

The assumptions related to this use case include the following;

- It is assumed that the metaverse service platform A allows users to navigate the virtual environment and interact with the signage.
- It is assumed that product marketing metaverse of the metaverse service platform B is specifically designed to promote branded products through virtual stores or product showcases.
- It is assumed that the metaverse service platform B allows avatars to move from metaverse service platform A while preserving their appearance, identity, and functionality.

7.8.3 Service scenario

This clause describes the typical service flow for metaverse signage service.

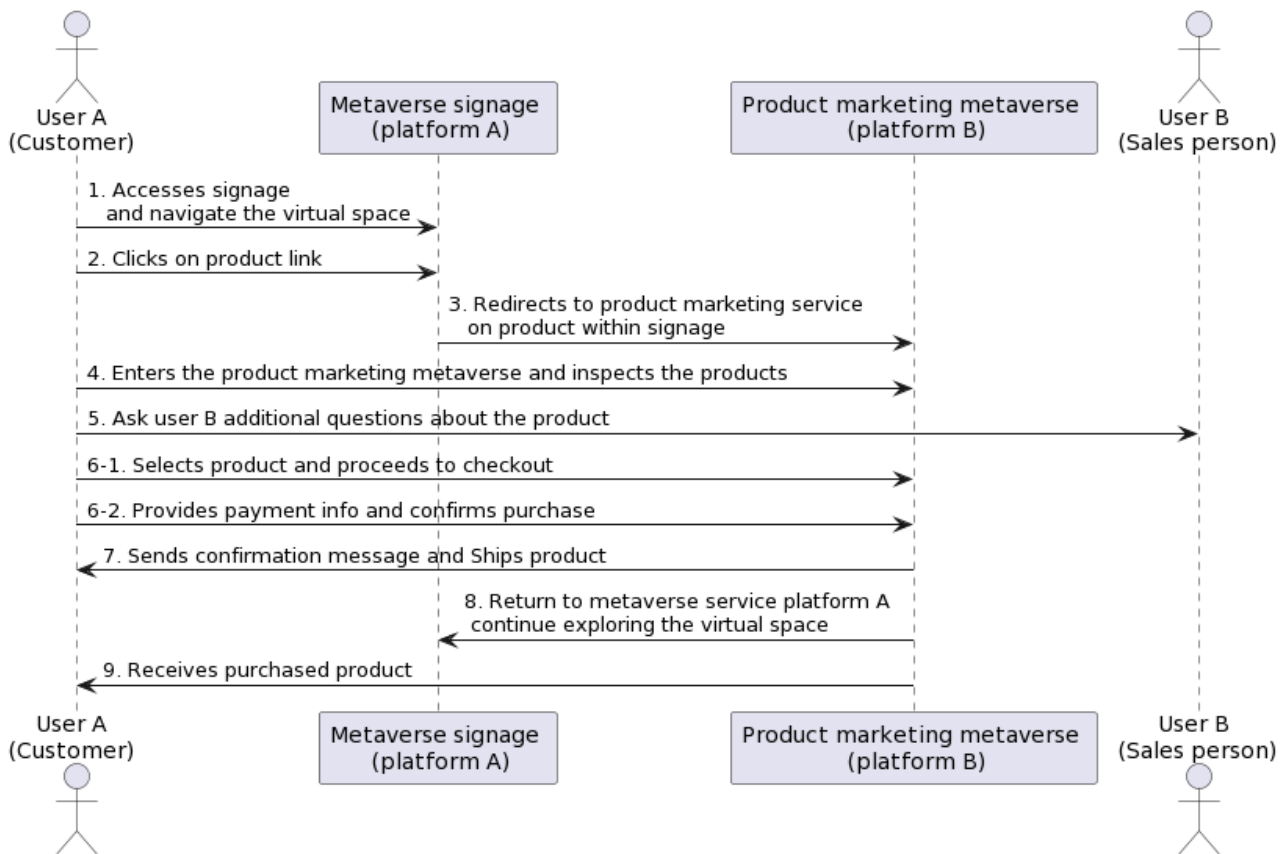


Figure 7-16 – Service flows for the metaverse signage service use case

1. User A finds various metaverses available in the virtual environment through the metaverse signage of metaverse platform A. User A explores the virtual space of metaverse platform A.
2. After navigating the virtual space, User A discovers a link through the metaverse signage that provides detailed information about a specific product. To learn more about this, User A decides to click on the link.
3. The link clicked by User A redirects to a product marketing metaverse designed for promoting a specific product. This product marketing metaverse is hosted on metaverse platform B and serves as a virtual store or product showcase. It offers users detailed information about the product and allows them to thoroughly examine and even purchase the product. Cross-platform interoperability makes it easy for users on metaverse platform A to utilize the product marketing metaverse built on metaverse platform B.
4. User A enters the product marketing metaverse of metaverse platform B. Utilizing virtual reality (VR) technology, User A can examine the product in a more immersive manner.
5. User A can also engage in additional queries and responses about the product with User B.
6. User A selects the desired product, proceeds with the payment, inputs payment information, and confirms the purchase.
7. The product marketing metaverse sends a purchase confirmation message to the user, finalizing the purchase and providing an estimated delivery date. The product is shipped to the user's address.
8. User A chooses to return to the metaverse platform A's metaverse signage. User A can continue using the virtual space of metaverse platform A.
9. User A later receives the purchased product from the product marketing metaverse.

7.9 Metaverse Office: Metaverse office over cross-platform

Metaverse office is a virtual office that allow users to collaborate and communicate remotely in a more immersive way. Users can access the virtual offices through the metaverse platform.

7.9.1 Description

Metaverse office entails leveraging metaverse technology to provide virtual offices and services, thereby offering an online work environment while maintaining the offline work environment and eliminating spatial limitations. In other words, it is beyond the typical online work environment of remote work and creates a virtual office environment. Users can access the metaverse offices through the metaverse platform and animate their avatars to walk into an office, work in a conference room, give a presentation, and so on. This makes it possible for people to work from anywhere, anytime, even if they are in different physical spaces, through the medium of the metaverse.

Metaverse office enables real-time collaboration by providing a variety of features and collaboration tools, including voice and text chat, video conferencing, file sharing, and presentation sharing. Users can also communicate and interact with others through avatars, navigate different spaces, and create a personalized work environment.

An advantageous feature of metaverse office is its compatibility across multiple metaverse platforms, ensuring that users can collaborate and communicate with team members and clients, irrespective of the platforms they utilize. This interoperability enhances connectivity and streamlines workflows, promoting efficient and effective remote work dynamics.

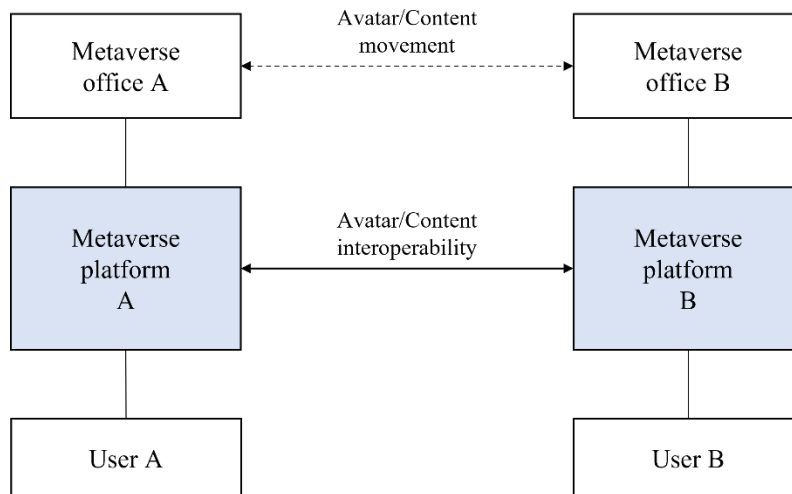


Figure 7-17 – Concept of metaverse office over cross-platform

7.9.2 Assumptions

The assumptions related to this use case include the following:

- It is assumed that each user accesses the metaverse office through the metaverse platform used by their company.
- It is assumed that there is an invite or join feature between metaverse platforms to go to each other's metaverse office and have a meeting in the same space on the metaverse office.

7.9.3 Service scenario

This clause describes the typical service flow for the use case of the metaverse office.

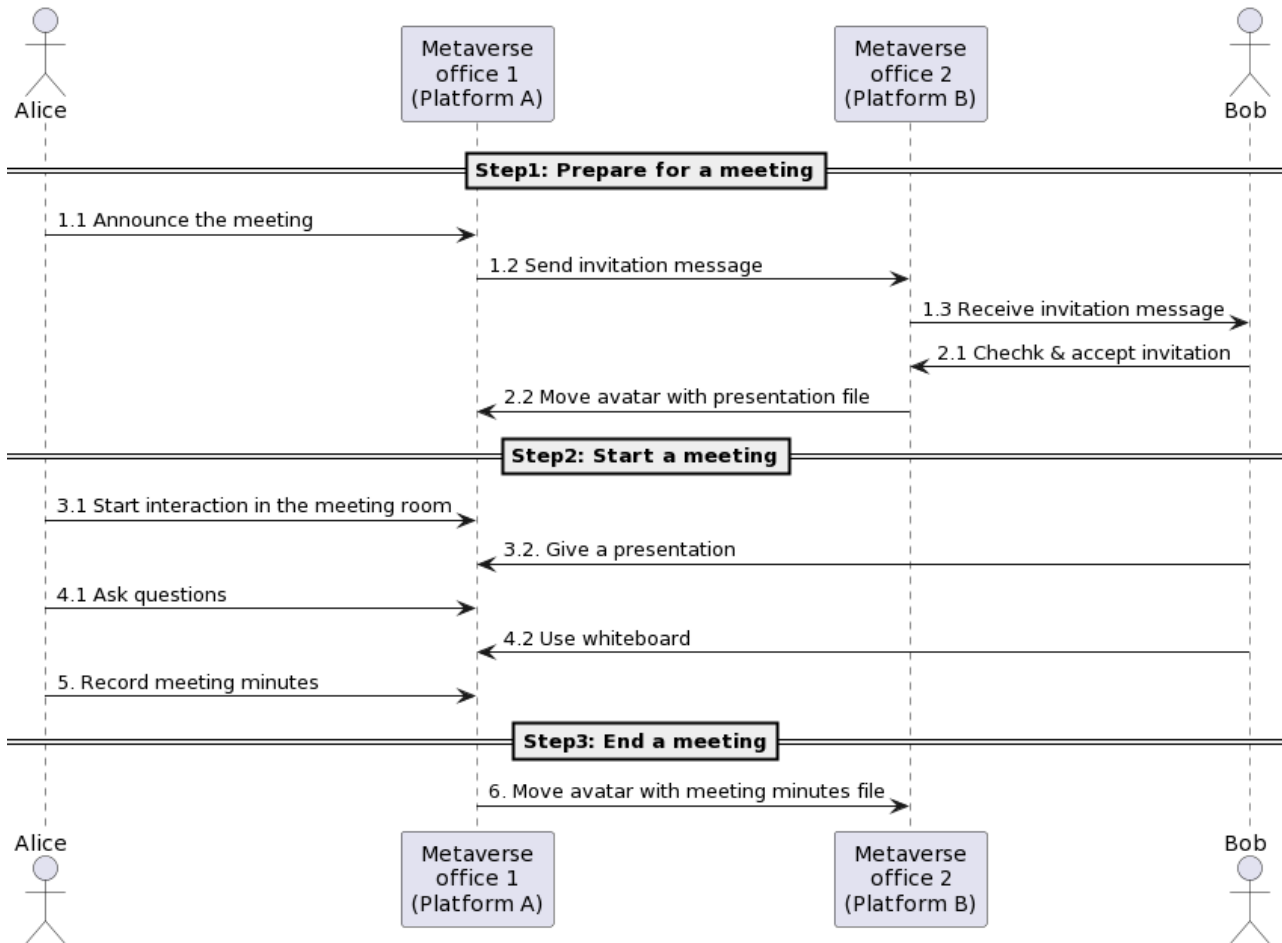


Figure 7-18 – Service flows for metaverse office use case

Alice and Bob are working in their company’s metaverse office, and Alice wants to invite Bob to her metaverse office conference room for a meeting.

1. Alice sends Bob an invitation to attend a meeting in Alice’s conference room to give a presentation. The invitation may include the meeting schedule, location, and a link to share the presentation file.
2. Bob receives an invitation from Alice, accepts the invitation, and uses his avatar to navigate to a conference room in Alice’s metaverse office. Bob takes the presentation file with him.
3. Alice and Bob have a real-time interactive meeting in Alice’s metaverse office conference room. They use their avatars to communicate through voice and gestures, and share their presentations on a virtual screen. Bob starts to give a presentation. Alice and the other participants can watch Bob’s presentation in real time, ask questions, and discuss it.
4. During the meeting, Alice and Bob can leverage the features of metaverse office to perform additional collaborative tasks. For example, they can share and edit documents simultaneously, or use a whiteboard to share and organize ideas.
5. Alice utilizes the platform’s features to record the meeting.
6. After the meeting, Bob leaves Alice’s metaverse office conference room and returns to his own metaverse office. Bob can take the meeting minutes file.

8 High-level requirements for metaverse cross-platform interoperability

Avatar interoperability realizes that a user’s avatar of a metaverse platform can visit other metaverses in another metaverse platform by using the same or similar avatar with the user’s characteristics.

[Editor’s Note: some of the requirements will be moved to future deliverables on functional requirements.]

[Editor’s Note: In the next meeting, this clause will be arranged to accommodate high-level requirements only, and the detailed ones will be hold in the living list for the time being. Contributions are solicited.]

8.1 Avatar interoperability requirements

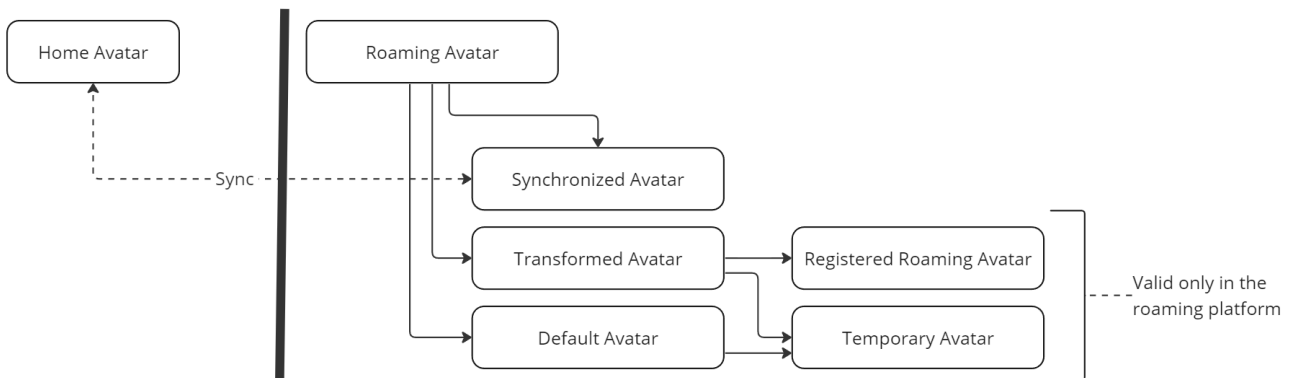


Figure 8-1 – Types of avatars in view of cross-platform interoperability

Figure 8-1 depicts the types of avatars in view of cross-platform interoperability. The home avatar is the original avatar managed by a user to represent the user’s identity, and it is customizable by the user within the original metaverse platform. The primary version of a user's digital representation in the metaverse resides exclusively within a specific metaverse platform or avatar service. When the home avatar goes to other metaverse platforms, it will become a roaming avatar, which is the avatar transitioning across various metaverse platforms from the original metaverse platform, potentially undergoing alterations or transformations aligned with the destination platform’s compatibility and features.

The roaming avatar will take the following types:

- **synchronized avatar:** the roaming avatar retains uniformity across metaverse platforms, mirroring the shape and attributes of the home avatar and seamlessly interchangeable among platforms. This avatar remains consistent across multiple environments through synchronization protocols or standards, ensuring users encounter an unaltered representation regardless of the metaverse they explore.,
- **transformed avatar:** the roaming avatar altered or adapted to fit into a specific metaverse platform. The changes might be due to compatibility issues or the unique requirements and characteristics of the target metaverse platform,

- **registered roaming avatar:** the roaming avatar that is registered on a metaverse platform after the user has visited it once. It may be a transformed avatar or a customized avatar that the user has created on that platform. It can be used again when the user revisits that platform,
- **temporary avatar:** the roaming avatar that is used temporarily when moving to a different metaverse platform. It may be a default avatar or a transformed avatar that does not have any connection to the user's home avatar. It may be discarded or replaced when the user leaves that platform, and
- **default avatar:** the roaming avatar which provided by a metaverse platform for users who haven't customized their own or when their roaming avatar isn't compatible.

The synchronized avatar is identical and synchronized with the home avatar. The transformed avatar is a modified version of the home avatar by the target platform. The default avatar is a basic avatar that is provided by the target platform and does not reflect the user's identity. In the case of a transformed avatar, it is possible to register it to the target platform for reuse in the next visit. If it is not saved, it will be a temporary avatar that is volatile on leaving.

[Editor's Note: it is required to add high-level requirements for avatar interoperability. For example, Home avatar is required to move to other metaverses in other metaverse platforms as the roaming avatar with the same characteristics.]

8.1.1 Avatar appearance

This clause lists requirements regarding avatar appearance as shown in Table 8-x. These requirements will be used for specifying the protocol specifications regarding avatar migration and management.

Table 8-1 – Requirements related to avatar appearance

Req.ID	Requirements
AVIR-100	It is recommended to maintain the same avatar appearance across different metaverse platforms.
AVIR-101	It can optionally support the modification of the shape of avatars from other metaverse platforms, depending on the policy of the target metaverse.
AVIR-102	It can optionally discard or retain the changes to the avatar's appearance during the roaming depending on the policy of the target metaverse.
AVIR-103	It is required to be capable of recovering the previously used avatar's shape upon revisiting if the roaming metaverse platform maintains information about the roaming avatar.
AVIR-104	It is required to provide a default avatar if the target metaverse platform cannot accommodate roaming avatars.

8.1.2 Avatar migration and negotiation

This clause lists avatar migration and negotiation requirements as shown in Table 8-x. These requirements will be used for specifying protocol specifications regarding migration procedures.

Table 8-2 – Requirements related to avatar migration and negotiation

Req.ID	Requirements
AVIR-201	It is recommended to proactively exchange constraints, such as the number of polygons in an avatar, considering the performance implications when multiple users are located in the same metaverse space.
AVIR-202	It is required to deliver an error message with an explicit reason if a roaming avatar is not acceptable in the target metaverse during avatar migration.

8.1.3 Avatar synchronization

This clause lists avatar migration and negotiation requirements as shown in Table 8-x. These requirements will be used for specifying protocol specifications regarding avatar synchronization procedures.

Table 8-3 – Requirements related to avatar synchronization

Req.ID	Requirements
AVIR-301	It is required to synchronize with the user’s home avatar whenever the user changes the appearance of roaming avatar or swaps out accessories, outfits, etc. for platforms that support synchronized avatars.
AVIR-302	It is required to store and maintain the home avatar information, which includes avatar model, owner, metadata, etc., in a remotely accessible location. NOTE – The information can be stored in a home metaverse platform, avatar service platform, distributed user terminal, blockchain, etc.

8.1.4 Avatar delegation

Table 8-x – Requirements related to avatar appearance

Req.ID	Requirements
AVIR-401	It can optionally delegate the behaviour of the avatar to a third party, such as an AI service provider, when the user is not online. NOTE – It is also possible to support the AI avatar by a specific metaverse platform.
AVIR-402	

8.2 Asset interoperability requirements

8.2.1 Asset management

[Editor’s Note: some of requirements will be moved to future deliverable on functional requirement of asset interoperability.]

Table 8-4 – Requirements related to content sharing & policy

Req.ID	Requirements
ASIR-101	It is recommended to provide a way to buy, sell, exchange, rent, and lease digital assets from other metaverse platforms.
ASIR-102	It is required to enable users to set and manage the access rights and public scope of digital assets.
ASIR-103	It is recommended to integrate an API that allows real-time inquiry of digital asset transaction history and current ownership status that occurred in other metaverse platforms.

8.2.2 Asset migration

Table 8-x – Requirements related to asset identity

Req.ID	Requirements
ASIR-201	It is required to make digital collections and accessories purchased with NFTs available to users on the platform they moved to.

8.2.3 Asset exchange

Table 8-x – Requirements related to content identification

Req.ID	Requirements
ASIR-301	It is recommended for the exchange and trading of digital assets to be seamless across metaverse platforms.
ASIR-302	It is recommended that digital assets owned from other platforms should be available on the user’s metaverse platform.
ASIR-303	It is required to increase the interoperability and liquidity of digital assets by providing a way for other metaverse platforms to recognize, authenticate, send, and receive digital assets, allowing users to leverage their digital assets across different metaverse platforms.

8.3 Content interoperability requirements

8.3.1 Content management

...<snip>...

[Editor’s Note: some of requirements will be moved to future deliverable on functional requirement of content interoperability.]

Table 8-x – Requirements related to content management

Req.ID	Requirements
COIR-101	It is recommended that a common interface be provided for users to easily find the content they are looking for, including images, video, digital assets, events, and services that exist in a metaverse.
COIR-102	It is recommended to provide relevant data (tags, descriptions, etc.) about the content to make it easier for users to find and understand the content.
COIR-103	It is recommended to provide clear and explicit information regarding ownership, copyright, and licensing of the content.

8.3.2 Content format

Table 8-x – Requirements related to content identification

Req.ID	Requirements
COIR-201	It is recommended that user-generated or purchased digital content be portable and compatible independent of the metaverse platform.
COIR-202	It is recommended to use the VRM format for representing the avatar for exchanging the avatar model file across the metaverse platforms.
COIR-203	It is recommended to use glTF 2.0 for representing the digital items for exchanging the 3D model file except for avatar across the metaverse platforms.
COIR-204	It is recommended for the content format to be compatible across different metaverse platforms and allow users to retain their avatars and items.
COIR-205	It is required that when moving or sharing content between different metaverse platforms, the format of the content is converted or moved with compatibility. NOTE - When a target metaverse platform doesn't support a specific content format, it's either converted, displayed alternatively, or disabled.

8.3.3 Content sharing and policy

This clause lists avatar migration and negotiation requirements as shown in Table 8-x. These requirements will be used for specifying protocol specifications regarding migration procedures.

Table 8-x – Requirements related to content identification

Req.ID	Requirements
COIR-301	It is required that users share their content to other platforms. The metaverse platform assigns an externally accessible identifier to the user's content that they want to share.

COIR-302	It is required to ensure the security and privacy of the user's content by allowing users to set and manage access to and visibility of their content so that it cannot be leaked or misused without their consent.
COIR-303	It is recommended that when moving content to other metaverse platforms, the permissions and access controls set by the user should also apply to other platforms.

8.4 Identity interoperability requirements

[Editor’s Note: some of requirements will be moved to future deliverable on functional requirement of ID interoperability, and some of requirements will be moved to D5.2.]

8.4.1 Avatar identity

This clause lists requirements regarding avatar identification as shown in Table 8-x. These requirements will be used for specifying the protocol specifications regarding avatar migration and management.

Table 8-x – Requirements related to avatar identity

Req.ID	Requirements
IDIR-101	It is required that all avatars have a distinguishable identifier to ensure uniqueness within the Metaverse. This identifier is globally unique when combined with a metaverse identifier for avatars across metaverse platforms. NOTE – A user can have multiple avatars. The user may be able to select an avatar or multiple avatars for moving to the other metaverse depending on the policy of the metaverse platform.

8.4.2 User identity

Table 8-x – Requirements related to user identity

Req.ID	Requirements
IDIR-201	It is required to evaluate the reputation of users who want to move from other platforms to determine whether to allow the move.
IDIR-202	It is recommended to be able to determine the eligibility for moving based on the criteria of the target metaverse, such as age and appearance, of users intending to transfer from other platforms.
IDIR-203	It can optionally check the reputation of the user belonging to another platform through the agreement between platforms.
IDIR-204	It is required that the reputation data is written in a standardized way for the compatibility of reputation evaluation between platforms.

Table 8-x – Requirements related to user identity

Req.ID	Requirements
IDIR-501	It is required to provide globally unique user identifiers for consistent identification as users move to different metaverse platforms
IDIR-502	It is recommended for cross-platform identity authentication systems to have the ability to offer a variety of authentication methods, making it easy for users to choose their authentication method.
IDIR-503	It is recommended to use blockchain technology to securely and transparently record creation, authentication, validation, and updating.
IDIR-504	It is required for metaverse platforms to manage user access from other platforms based on the identity of the user. This identity can be received from other metaverse platforms or obtained in a variety of ways, including DID, blockchain, etc.
IDIR-505	It is recommended to support a single sign-on (SSO) across platforms.
IDIR-506	It is required for users to be able to link or unlink their identity to other platforms. NOTE – If a user is linked to a metaverse platform, the platform can access the profile consented by the user.

[Editor’s Note: requirements in above two tables need to be aligned.]

8.4.3 Metaverse platform identity

Table 8-x – Requirements related to metaverse identity

Req.ID	Requirements
IDIR-301	It is required to use a globally unique metaverse platform identifier on interacting with other metaverse platforms.
IDIR-302	It is recommended to use FQDN (Fully Qualified Domain Name) to be routable and accessible using the identifier.
IDIR-303	It is recommended to use the URI scheme for the metaverse service platform. NOTE – The scheme for metaverse platform needs further study
IDIR-304	

8.4.4 Metaverse identity

Table 8-x – Requirements related to metaverse identity

Req.ID	Requirements
IDIR-401	It is required to use a globally unique metaverse identifier on each metaverse for cross-platform interoperability.

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8.4.5 Asset identity

Table 8-x – Requirements related to asset identity

Req.ID	Requirements
IDIR-507	It is required to make digital collections and accessories purchased with NFTs available to users on the platform they moved to.
IDIR-508	It is recommended that digital assets be identified and verified using distributed ledger technology such as blockchain
IDIR-509	It is required that digital items have a distinguishable identifier to ensure uniqueness within the metaverse. This identifier is globally unique when combined with a metaverse identifier for avatars across metaverse platforms.

Appendix I

Use cases of metaverse cross-platform interoperability

This appendix provides a few actual use cases for metaverse cross-platform interoperability.

I.1 Metaverse zoo

In the vast metaverse of virtual zoos, three distinct realms emerge: the Herbivore Metaverse Zoo, the Bird Metaverse Zoo, and the Marine Animal Metaverse Zoo. Visitors from around the digital globe seek to explore these unique worlds, each dedicated to a specific facet of the animal kingdom.

As users enter their chosen metaverse, they embody virtual avatars and decide whether to immerse themselves in herbivores, birds, or marine animals. However, a ground breaking option awaits those seeking a broader adventure: the chance to explore interconnected zones that seamlessly bridge the boundaries of these separate metaverse zoos.

With this choice made, visitors traverse virtual landscapes, encountering everything from towering giraffes and majestic elephants in the Herbivore Metaverse Zoo to the vibrant plumage and songs of exotic birds in the Bird Metaverse Zoo. Delving even deeper, they can submerge themselves in the azure depths of the Marine Animal Metaverse Zoo, exploring the wonders of the underwater world.

As they navigate these interconnected zones, visitors may cross paths with fellow explorers who have made different metaverse choices. Together, they engage in joint activities, games, and quests that transcend the boundaries of their chosen realms, forging connections and friendships.

Beyond entertainment, these interconnected zones offer a unified learning experience. Information on conservation efforts, educational content, and real-world initiatives related to herbivores, birds, and marine animals is readily accessible, promoting awareness and action.

Visitors can exit this interconnected adventure at their leisure, with their progress saved for future exploration. This innovative approach fosters collaboration and learning while encouraging a deeper appreciation for the diverse wonders of the animal kingdom in the metaverse.

Appendix II

Current standardization activities for metaverse cross-platform interoperability

This appendix summarizes the current activities of other SDOs related to metaverse cross-platform interoperability.

[TBD]
