Introduction to the Digital Space

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1. Japan Digital Space Economy Federation

The Japan Digital Space Economy Federation (hereafter referred to as "the Federation") is an economic organization established in April 2022 with the goal of revitalizing economic activity in digital spaces and contributing to the sound development of the Japanese economy and the enrichment of people's lives.

The Federation's activities are broadly divided into two main committees:

1. The Policy Committee, which conducts policy proposals and public awareness initiatives, and
2. The Business Enhancement Committee, which carries out cross-company proof-of-concept (PoC) experiments among member organizations.

In 2022, the Policy Committee published a Report on Economic Development in Digital Spaces, and in 2024, released the Metaverse Literacy Guidebook to promote understanding and awareness of the metaverse. In 2023, the Business Enhancement Committee published two PoC reports: one on operating virtual stores in digital spaces, and another on implementing virtual offices. It is currently planning three additional PoC initiatives: virtual malls (e-commerce in digital spaces), metaverse university (education and training in digital spaces), and industrial metaverse (digital twins). All of these reports and outputs are available on the Federation's official website (in Japanese), and readers who are interested are encouraged to take a look.

As of January 6, 2025, the Federation has 134 member organizations. General members include companies from a wide range of industries, such as telecom, media, and technology (TMT), finance, real estate, manufacturing, retail, gaming, and entertainment. Supporting members also include local governments and industry associations.

2. What is digital space?

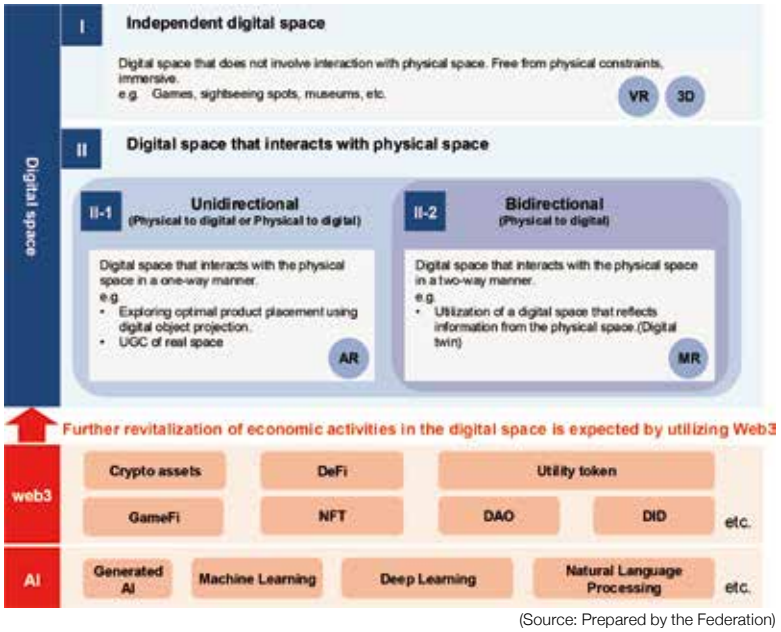
The author defines digital space as "a virtual three-dimensional environment constructed on the internet, where multiple participants can join, interact, and communicate with one another."

The clearest example of this concept is the so-called metaverse. However, because there is no universally accepted definition of the metaverse, the following classification system is used:

I. Independent digital spaces:

These are digital spaces that operate independently of the

Figure : What is digital space?



(Source: Prepared by the Federation)

physical world, without interaction between the two. Technically, this corresponds to virtual reality (VR). Examples include games and virtual museums created with 3D computer graphics (3DCG).

II. Digital spaces that interact with the physical world:

II-1. Unidirectional (physical → digital or physical ← digital):

These are digital spaces that incorporate unidirectional interaction with the physical world. This corresponds to augmented reality (AR).

For example, a physical sculpture could be represented as a digital item (such as an NFT) within a digital space for exhibition or sale.

II-2. Bidirectional (physical ↔ digital):

These digital spaces support bidirectional interaction with the physical world. This corresponds to mixed reality (MR). For instance, a digital space may faithfully replicate a physical environment, with real-world movements mirrored in the digital space (i.e., digital twins).

The Federation believes that utilizing Web3, a decentralized version of the internet built on blockchain technology and functioning without centralized administrators, can enhance user experiences in digital spaces. As such, Web3 is within the scope of the Federation's activities and areas of study. Similarly, the Federation sees strong potential for AI to complement interfaces within digital spaces and includes it within its scope of consideration as well.

3. The source of value in digital space

When it comes to utilizing digital space, its primary source of value lies in making possible what is difficult or impossible in the real world. For example, consider a history lesson on the pyramids of ancient Egypt. In the real world, students typically learn through textbook images or videos. But with digital space (imagine, in this case, a highly detailed reconstruction of the pyramids within the metaverse), students can explore a full-scale virtual pyramid, including areas that are inaccessible in real life. Moreover, as long as the technology supports it, students from all over the world can join the same lesson simultaneously.

Another example is the training of skilled welders. In the real world, this typically involves observing a master at work and learning by imitation, or gradually acquiring the skill while facing risks of injury. In digital space (think of a welding training program using VR), trainees can practice both theoretically and experientially, without any physical danger.

4. Case studies

Digital spaces can broadly be categorized into consumer-oriented applications, such as those for gaming, social media, exhibitions, and shopping, and those geared toward industrial use, such as in manufacturing and construction. Below are examples for each category.

(1) Roblox

Roblox is a metaverse platform where users can create and share their own games and experiences, and interact with others. With approximately 350 million monthly active users (MAUs), it is fair to say that Roblox is one of the most successful platforms globally. A major factor behind its success is that even users with little experience in programming or 3D modeling can easily create games and experiences using Roblox Studio. The platform empowers users to bring their ideas to life, *truly making possible what is difficult to achieve in the real world*. For example, users can design games that simulate zero-gravity environments and alternate dimensions, or let players explore fantastical worlds or futuristic cities in real time. Imagination thus becomes reality in digital space.

Moreover, Roblox features its own in-game currency, Robux, which users can use to buy and sell games and avatar items. This allows for ownership of digital content that cannot be obtained in the physical world.

(2) Hitachi, Ltd. – "Worksite-Augmenting Metaverse"

The use of digital spaces extends beyond consumer applications to industrial and B2B domains as well. One such example is the "Worksite-Augmenting Metaverse" being researched and developed by Hitachi, Ltd. According to Hitachi, the Worksite-Augmenting Metaverse is a system that "replicates workplaces in three dimensions (3D) and collects data in various forms to provide people with an intuitive sense of how things relate to one another in order to streamline operations."*1 They have conducted research applying this approach to plant construction management and railway vehicle maintenance. In the author's understanding, the Worksite-Augmenting Metaverse has the following key benefits:

1. Data accumulation via a metaverse interface

In the Worksite-Augmenting Metaverse, real-world objects such as plant structures or the exterior and interior of train cars are recreated using 3D Computer-Aided Design (CAD). Through the metaverse interface, users can access a wide range of data, such as blueprints, inspection reports, field notes, audio recordings, and more. This data is accessible not only to on-site workers but also to personnel at headquarters or branches and other remote locations. Moreover, the use of AI can help members more easily locate the appropriate data they need.

2. The metaverse as a shared "space" that enhances

*1 Quoted from https://www.hitachihyoron.com/jp/papers/2024/07/04/index.html [https://www.hitachihyoron.com/rev/papers/2024/09/01/index.html]

communication

Traditionally, communication between sites or between the field and headquarters was limited to either in-person visits or online meetings such as video conferences. By leveraging the Worksite-Augmenting Metaverse, both field workers and head office staff, including those with decision-making authority, can gather in the same virtual "space" and engage in more realistic, effective communication. This capability proves useful not only for day-to-day operations but also for incident response and accident investigations. For example, if an accident occurs at a factory, it could be faithfully reconstructed within the Worksite-Augmenting Metaverse, enabling experts in remote locations to participate in a virtual inspection. This could lead to quicker identification of the cause and, if members of an insurance company are involved, could also streamline the claims process.

In this way, the Worksite-Augmenting Metaverse enables data visualization and remote collaboration that would be difficult or impossible in the physical world. Going forward, such applications are likely to see increasing use in industrial and B2B settings.

5. Challenges

In this section, we discuss challenges that have not been successfully addressed or realized—yet are expected to be overcome in the future—as the use of digital spaces continues to expand (hereafter referred to collectively as "challenges").

5.1 Challenges in consumer-facing digital spaces

A straightforward way to describe the challenges in consumer-facing digital spaces (imagine the Roblox example from Section 4.1) is this: "not enough users" and "not financially viable." In other words, compared to social media services, video platforms, or even the physical world, these platforms often struggle to attract enough users. For commercial enterprises aiming to leverage digital spaces for profit, it is not uncommon for the cost of planning, development, and ongoing operations to outweigh revenues—leading to financial losses—or for anticipated effects in marketing or branding to fall short of expectations.

At the root of these challenges lies the fact that the market is still in its early stages. To give a relatable analogy: the number of "digital space natives"—i.e., those who grew up with VR/AR/XR or the metaverse ("metaverse natives")—is limited mainly to teenagers and perhaps those in their early twenties. In Japan, for example, this demographic makes up less than 15% of the population. Older generations typically come into contact with digital spaces through specific triggers and try them out of curiosity. At the Federation, we hypothesized that there are more people who prefer to first understand what the metaverse is and what to be mindful of (what you might call the "cautious" group) than those who would jump in just because it seems interesting. With this awareness, we felt there should be a kind of introductory guidebook tailored to such users. We therefore launched a special committee in FY2023 to create the Metaverse Literacy Guidebook (hereafter, "the Guidebook"), which was published in January 2024*2.

The Guidebook is available in two editions: one for general users and another for service providers, including platformers and business users. It is organized around ten themes, each providing easy-to-understand facts and advice—illustrated for clarity—that users should know before entering the metaverse. The business-focused edition offers suggestions on how service providers can create an environment in which users can confidently engage with the metaverse. The Guidebook aims to act as a kind of navigation tool for both users and businesses entering the metaverse economy, all while respecting the unique culture that has emerged within these digital spaces. We encourage all readers to take a look via the URL provided in the footnotes.

Now, in addition to the issue of awareness and adoption, there are also several technical challenges, as outlined below.

(1) Device evolution

Currently, the devices used to access digital spaces can be broadly categorized into: (1) mobile or PC devices, (2) head-mounted goggles, (3) smart glasses, and (4) spatial displays.

Category (1) offers easy access but provides a lower level of immersion compared to (2) through (4). Category (2) offers a high degree of immersion but is not ideal for extended use and may not be comfortable for everyone. Category (3), which is typically associated with AR, has not yet seen widespread adoption, perhaps because wearing glasses for long periods is not comfortable for everyone.

Category (4) is more commonly used in industrial settings, such as for viewing large-scale structures or in medical applications.

Each device type has its pros and cons and is suited to different use cases. However, if a device were to emerge that anyone could use comfortably and naturally, there is little doubt that it would dramatically expand the user base of digital spaces.

(2) Handling increased concurrent connections

Depending on the platform, digital spaces often have limits on how many users can be connected at the same time. This is because more simultaneous connections lead to increased data traffic and higher server loads. To accommodate more users, platforms may lower the quality of 3DCG (visuals) or reduce functionality (e.g., disabling voice chat in favor of text chat). However, this trade-off represents the classic dilemma between

*2 Please refer to the special site: https://jdsef.or.jp/metaverse_literacy_guidebook [https://jdsef.or.jp/metaverse_literacy_guidebook_en]

quality and volume. Fortunately, new technologies are emerging to address this dilemma, with the goal of increasing simultaneous user capacity without significantly sacrificing quality.

(3) Interoperability

In digital spaces, interoperability refers to the ability to seamlessly move between different platforms. For example, if a user on platform A could instantly jump to platforms B or C without needing to log out, user convenience would improve—and with it, overall user numbers. Efforts are already underway to make this a reality. Organizations like the Metaverse Standards Forum are actively discussing the establishment of interoperability standards across platforms.

5.2 Challenges in industrial applications of digital spaces

When it comes to industrial use, such as in manufacturing or construction, digital spaces are not a new concept if we include technologies like 3D CAD. In that sense, it is a "long-established domain." However, concepts like the Worksite-Augmenting Metaverse, introduced earlier, represent a domain that is expected to evolve further. This section discusses the challenges involved in the continued development of such future-oriented applications.

(1) Designing incentives for user participation

As discussed previously, one of the key values of industrial digital spaces lies in the accumulation of data through digital interfaces. To build a richer dataset, field workers need to actively input data. However, from the workers' perspective, this can often mean added workload; and in some cases, they may feel as though their actions are being monitored. For example, if a skilled worker is asked to share their know-how within the system, they may perceive this as an act that could jeopardize their job security in the long term. This creates a clear disincentive.

To address this, it becomes necessary to design incentives that encourage field workers to contribute data. These incentives could be financial, such as reflecting participation in performance evaluations, salaries, or bonuses, or non-financial, such as public recognition or awards for proactive contributors. In any case, effective incentive design will be essential for the widespread adoption and utilization of such systems.

(2) Expanding use cases

In theory, industrial digital spaces have a wide range of potential use cases. For example, in a digital twin environment, when a part breaks down on-site, it could be possible to order a replacement part directly from the digital space by adding purchasing functionality. Moreover, if the assets being digitized, such as trains or factories, are of public interest, the digital content could be repurposed for consumer use by excluding any sensitive information. For instance, companies could offer virtual tours of train cars or factories. These virtual experiences could even allow users to explore areas that would typically be off-limits due to safety concerns in real-world site visits.

6. Conclusion

This paper has provided an overview of the current state and challenges of digital space utilization, based on the activities of the Federation. Digital spaces hold significant potential to contribute to economic activity and social progress. Moving forward, the Federation remains committed to advancing efforts that unlock and maximize this potential.

Cover Art

Fireworks at Ryôgoku Bridge (Ryôgoku hanabi) from A Hundred Views of Musashi Province

Woodblock prints depict famous landmarks in Tokyo.

Kobayashi Kiyochika
(1847-1915)

Source: National Diet Library, NDL Image Bank
(https://rnavi.ndl.go.jp/imagebank/)