Report on Asset Classification and Tokenization – WG8

Introduction

The key research motivation was to understand classification to assist in the development of two PWI:

1) Tokenization methods for creating digital representations of multiple commodities and asset classes.

2) Representing Non-Financial Digital Assets using Tokens on DLTs.

These PWI were part of Working Group 8 of ISO/TC 307, Blockchain and Distributed Ledger Technologies. During the first part of the research, WG8 was dedicated to Non-Fungible Tokens, whereas it is currently headed as "Tokenization of assets".

Offering tailored tokenization solutions for asset representation hinges on developing useful categories of real-world and digital assets.

Physical asset categories are wide and encompassing. Tokenization enables tracking physical assets throughout their lifecycle, potentially circular economy, and digital product passport objectives. This was the emphasis of the original research presented to WG8.

Digital Asset regulatory intervention has heavily emphasised financial assets to ensure protection of market integrity, financial stability, and investors, restriction of any systemic risks, encouragement of sustainability and fintech innovation.

Exploring digital asset classification beyond financial assets is crucial for multiple reasons:

1) It highlights areas with limited regulatory interest in the tokenization space.

2) It unlocks tokenization opportunities previously unexplored.

3) It creates innovation for new business models enabling secure digital asset exploitation.

Background – Summarised Findings

Classification of Asset Classes, Commodities, financial and non-financial assets: Legal, Regulatory and other Considerations

This report offers summarised insights into the classification of assets to facilitate discussions about digitally representing assets, using tokenization for representing, tracking and managing assets, and implementing digital product passport regimes, like the EU digital product

passports. This discussion ties asset classification with tokenization, demonstrating how blockchain and other DLTs can help represent and create new asset classes.

Various legal and regulatory perspectives are worth discussing about asset classification. Discussing these classifications is essential for understanding how different types of assets—whether physical or digital—can be tokenized, enabling their digital representation and facilitating more efficient tracking and management across various sectors.

It's essential to distinguish **between physical and digital assets.**

Physical Assets

Physical assets are tangible items, such as real estate, raw materials, or consumer goods, which have a physical presence and can be touched or seen. In contrast, digital assets are intangible and exist in digital form.

Key concepts for physical assets include commodities, Real Estate, Raw Material, and Consumer Products.

Various Perspectives for Commodities

The US Code Chapter 1(Commodity Exchanges) provides a broad definition of commodities, encompassing Agricultural products, metals, and energy resources, as well as financial instruments like futures and forwards. The US framework governs how these commodities are traded on exchanges, emphasizing the role of commodities in financial markets.

Under the EU Markets in Financial Instruments Directive II (MiFID II), commodities are considered within the scope of derivatives. This directive regulates how commodity derivatives are traded within the European Union, aiming to ensure transparency, stability, and efficiency in financial markets.

Harmonised Commodity Description and coding system (HS) is an internationally standardized system used to classify traded products. It assigns specific codes to commodities, facilitating international trade by ensuring that goods are consistently identified across countries.

Commodity Codes in the EU nomenclature: The classification system outlined in Article 1(2) of Regulation (EEC) No 2658/87 and its Annex I standardizes the description and coding of commodities within the EU. These codes are crucial for regulatory compliance and the harmonization of trade across EU member states.

Digital Assets

Digital assets are assets stored and transmitted electronically. ISO 22739:20 defines a digital asset as an asset (3.1) that exists only in digital form or that is the digital representation of another asset.

Digital Assets may be classified into financial and non-financial digital assets based on their nature and function.

Regulatory perspectives for digital assets:

CFTC (US). The Commodity Futures Trading Commission conceptualises digital assets as anything that can be stored and transmitted electronically, and which has associated ownership or use rights.

Digital assets can represent physical or virtual assets, value or a right, or they can constitute intangible assets that exist in digital form without a physical counterpart.

Digital assets may take many forms and utilise various technologies, such as distributed ledger technologies (DLT) → which results in what we call 'tokenization'.

The OECD provides that any asset can be tokenized and rights to such asset be represented on a distributed ledger.

Depending on what they represent or their design, function, use, or nature, digital assets may fall under different regulatory remits. This also applies to DLT-based digital assets that we typically call tokens or crypto-assets.

Digital Assets: Financial Assets

Digital Financial Assets are a significant category of digital assets.

Broadly, digital financial assets are digital assets that qualify as financial assets under applicable law, or which have an economic function of financial instruments.

This category includes cryptocurrencies, like Bitcoin, which are DLT-based payment tokens native to the blockchain network they support, digital bonds and securities, derivatives traded in digital form, digital tokens that qualify as financial or payment instruments.

To understand and classify digital financial assets, we need to understand financial asset classification. We identify classifications of financial assets in various binding, authoritative, or influential sources.

For example,

- ISO 10962: Equity, Debt, Collective Investment Vehicles
- MiFID II (EU): financial instruments including equities, bonds, futures, swaps
- Securities Act and Securities Exchange Act (US)

It is important to understand that digital financial assets are not new or solely linked to DLT.

- Traditional financial instruments (such as securities) in dematerialised form.
    - Securities exist in electronic-only format in a “dematerialised” form.
    - Tokenized securities, according to the OECD, could be seen as a form of cryptography-enabled dematerialised securities based and recorded on a decentralised ledgers powered by DLTs, instead of electronic book-entries of central security depositaries.

Various Perspectives: Crypto-Financial Assets

- Markets in Crypto-Assets Regulation (EU)
    - regulates crypto-assets such as stablecoins (asset-referenced tokens and e-money tokens) and other crypto-assets such as utility tokens
    - exempts crypto-assets qualifying as already regulated products under financial and insurance laws and does not regulate unique and not fungible tokens
- United States
    - SEC assesses whether digital assets qualify as "securities" including "investment contracts," and other instruments under the federal securities laws.
    - CFTC provides that digital assets may be deemed to be a commodity, swap, or other derivative under US law
- FINMA distinguishes between asset tokens, payment tokens, and utility tokens depending on their economic function. Asset tokens represent assets such as debt or equity which are traditional financial assets.

Digital Assets: Non-Financial Assets

Some digital assets do not represent or constitute financial assets.

We would call them non-financial digital assets. It is worth exploring how these could be further classified:

- Digital assets of a non-financial nature may include digital content such as digital art, audio, media, or other content
- They may also constitute digital Intellectual Property. For example, the Intellectual Property Office of Singapore defines digital intellectual assets as any intangible asset that exists in a digital format, e.g., copyrighted work, trade secrets
- Tokenized assets that do not tokenize or represent financial assets, but other assets or value such as intellectual property or digital art
    - According to the OECD: Intangible assets, such as intellectual property, can be tokenized, creating new digital assets
    - Digital art and collectibles can be tokenized and create a new digital asset, and the digital art itself could be deemed as a digital asset.

Based on the above:

1. a digital asset may act as a digital representation of goods whether physical goods or digital content, including digital art, media files or intellectual property. Such representation is directly linked to physical or digital goods.

2. a digital asset can exist purely in digital form. These standalone assets, such as digital illustrations or paintings, do not represent or derive from any physical, digital, or virtual item.

This understanding is also consistent with ISO 22739:2020.

Connection to EU DPP (mainly for physical assets)

This Ecodesign for Sustainable product regulation (ESPR) sets performance and information standards for almost all physical goods in the EU. The ESPR will introduce a digital product passport, which the EU defines as a ‘digital identity card for products, components, and

materials, which will store relevant information to support products' sustainability, promote their circularity, and strengthen legal compliance.'

Digital representation in the form of product information being tagged on physical products and traceability of physical products are central to the Regulation and the EU DPP that the regulation is designed to support.

In terms of scope, ESPR to any physical goods that are placed on the market or put into service, including components and intermediate products.

The ESPR defines "products", "components" "intermediate products", "energy-related products" (for energy-related products specific labelling requirements are imposed). The definitions on products, components, and intermediate products are used to ensure that the Regulation affects the broadest types of physical goods. It is noted that digital content that is an integral part of a physical product is to be included in the scope. An example of this could be the software of a mobile phone.

The regulation aims to enhance its objectives by implementing broad, horizontal ecodesign requirements across various product categories, defined as 'product groups' such as electronics and textiles.

The regulation also deals with unsold consumer products, offering relevant definition for end products targeted at consumers.

Therefore, we see that the EU DPP and ESPR framework deploys wide physical goods definitions to extend ESPR requirements to the broadest possible products. It is important to consider these in designing tokenization solutions for digital passports for products that are consistent with the EU DPP framework.

The Commission will conduct a prioritisation of products to be regulated under this Regulation. The identified priorities are batteries, iron and steel, aluminium, textiles, furniture, tyres, detergents, paints, lubricants, chemicals, energy-related products, electronics, cement.

This brings us to the discussion of EU DPP. Understanding the fundamentals of this framework is important to show how digital representation of assets is crucial for the sustainable management of products.

The Digital Product Passport (DPP) is an initiative by the European Commission designed to enhance transparency, traceability, and sustainability of products throughout their lifecycle. By

providing detailed information on a product's origin, environmental impact, and safety through digital records, the DPP aims to promote sustainability and regulatory compliance.

As part of the EU's Ecodesign for Sustainable Products Regulation (ESPR), that mandates that products meet specific design requirements aiming at sustainability and circularity, the DPP will eventually become mandatory for various product categories, with QR codes or barcodes offering centralized access to product information. Full implementation across the EU is expected between 2027 and 2030.

The EU Digital Product Passport (DPP) enhances transparency by providing detailed product information, including proof of authenticity and ownership. It serves as a powerful tool for managing the entire product lifecycle, from creation to disposal, while also supporting improved customer engagement through CRM functionalities. Additionally, the DPP offers a virtual representation of the physical product, allowing for enhanced interaction and usage. These benefits collectively drive sustainability, improve supply chain efficiency, and foster trust among consumers and stakeholders, supporting the broader goals of the circular economy.

Implementation

Implementing the Digital Product Passport (DPP) involves advancing some essential elements:

1. **Physical identifier**: Each product or its packaging must feature a unique and globally recognized standard, such as a QR code.
2. **Data storage and access system**: A trusted platform is required to guarantee data security, privacy, and ease of access.
3. **Standardized framework**: Clear and consistent guidelines are needed for organizing and encoding the data within the DPP, ensuring uniformity and coherence.
4. **The EU DPP also introduced a digital passport registry** (Article 13 of the ESPR regulation).

The regulation mandates the creation of a registry to store and manage essential data, including unique product identifiers and commodity codes. This connects with our conversation on classifying commodities and the importance of such classification in managing the lifecycle of a product using digital methods, such as tokenization.

Articles 9 to 12 of the Ecodesign Regulation describes the types of information that will form the digital passport for the relevant products.

While the EU DPP applies to physical assets, the underlying principles are relevant in the context of non-physical assets. These principles include:

1. Transparency and Traceability.
2. Sustainability.
3. Interoperability and Standardization.
4. Security and Data Privacy.

Key Points for Tokenization

Key areas to consider:

- Tokenization can represent both physical and digital assets
- Tokenization can create new digital assets and Markets. OECD mentions that tokenizing intangible assets, such as intellectual property, can create new types of digital assets and markets.
- Tokenization is particularly suited for unique digital art and collectibles through Non-Fungible Tokens (NFTs).
- Due to its flexibility, any asset can be digitally represented through tokenization.

Key benefits for representation of assets:

- Secure Storage:
    - Ensures that assets are securely stored and managed on a blockchain.
- Digital Timestamp:
    - Provides a verifiable digital record of the creation and modification of digitally represented assets. This certification, for example, may confirm the existence and ownership of digital intellectual assets at a specific point in time.
- Digital Rights Management:

    - Facilitates the management and enforcement of rights associated with assets.
- Evidence of Intellectual Property Ownership:
    - Serves as proof of ownership for intellectual property.
- Registration of Intangible Assets:
    - Offers evidence of registering intellectual property or other intangible assets that might not be subject to registration under applicable laws (e.g., copyright).

Key use cases:

- Tokenization may be used to align products with the EU DPP framework.
- Tokenization may be used for digital representation of physical assets, tying the physical product to crucial information.
- Tokenization may be used to ensure authenticity, ownership, and compliance and unlock significant utilities and benefits we have outlined.
- Tokenization may serve the objectives of the EU DPP:
    - Providing Storage of Information.
    - Enhancing sustainability.
    - In that endeavour, standardization is instrumental in how data is represented, shared, and validated on the blockchain. Classification of assets will facilitate this exercise.
    - Privacy protection: ensuring that the blockchain system maintains the privacy and security of sensitive data (like proprietary information or personal data).

Standardization

Standardization plays a crucial role in classifying assets for digital representation by providing a unified framework for consistent categorization across markets. It ensures accurate definitions essential for regulatory compliance and market efficiency. Additionally, standardization enhances the interoperability of digital assets across platforms, improving the reliability and usability of digital asset records and product passports.

Establishing uniform guidelines for tokenization ensures that digital tokens are consistently managed, supporting the EU Digital Product Passport initiative. This facilitates effective tracking, compliance verification, and sustainability efforts, offering a secure and transparent approach to product information.

* These key summarised findings derive from Deliverable 1 and are supported by an accompanying presentation delivered at the Sydney Plenary.

Subsequent Research – Emphasis on digital and non-financial assets

The initial research revealed that there are more detailed classifications for digital financial assets driven by detailed financial assets regulations. This encompasses conventional financial products in dematerialised form, financial products issued in digital form (like electronic money), and crypto-assets, DLT-based representations of value or rights.

Non-financial digital assets are digital representations of ownership, intellectual property rights, or other non-financial values stored on digital ledgers. Unlike financial digital assets, such as cryptocurrencies or tokenized securities, non-financial digital assets primarily represent unique digital content, intellectual property, or digital certificates rather than financial instruments. These assets leverage blockchain technology for verification, ownership transfer, and rights management.

Non-financial digital assets play an increasingly significant role in the digital economy, as their tokenization enables new markets and enhances the usability, traceability, and security of digital content. Through blockchain and distributed ledger technology (DLT), these assets gain immutability, transparency, and interoperability, making them attractive for applications in art, entertainment, intellectual property management, and certification.

→ Significant Development: Focus of WG8 changes to Tokenization of Assets.

Further research

Further research suggests there is scope for tokenizing specific categories of digital, non-financial assets. Non-financial digital assets are digital representations of ownership, intellectual property rights, or other non-financial values stored in digital form or digital ledgers (like distributed ledgers). Unlike financial digital assets, non-financial digital assets primarily represent unique digital content, intellectual property, or digital certificates rather than financial

instruments. These assets may leverage conventional, emerging, new, or emerged technology, like distributed ledger technology, for digital representation, verification, ownership transfer, and rights management.

Non-financial digital assets play an increasingly significant role in the digital economy as they pertain to intellectual property rights, like inventions, trade secrets, trademarks, patents, copyrighted software, or other copyrighted, like literary works, music, subsisting in digital or intangible form.

Importance of tokenization

Subsequent research reveals that tokenization is crucial for non-financial digital assets. Beyond traceability, tracking, and other provenance benefits afforded by DLTs, tokenization:

- enables new digital markets;
- creates new digital business opportunities, such as the metaverse;
- allows secure, tracked, audited, and automated payment of royalties; and
- enhances the usability, traceability, and security of digital content.

Through blockchain and other DLTs, these assets gain immutability, transparency, and interoperability, making them attractive for applications in art, entertainment, intellectual property management, and certification.

Developments like Metaverse underscore the importance of non-financial digital assets, properly classifying them, creating or representing assets in the Metaverse in digital form via trusted technologies (like DLTs), tokenizing them, and standardizing their tokenized form.

Examples of Non-Financial Digital Assets – More details on Tokenization

Digital Art and Non-Fungible Tokens (NFTs)

NFTs represent unique digital items such as artwork, music, videos, and virtual real estate. Unlike crypto-assets or cryptocurrencies, also qualifying in the broad family of tokens, which are fungible (one unit is identical to another), NFTs are distinct and cannot be exchanged on a one-to-one basis. These tokens contain metadata that proves authenticity and ownership. Platforms like OpenSea and Rarible facilitate NFT marketplaces, allowing artists and collectors to buy, sell, and trade digital art.

Intellectual Property (IP) Tokenization

Intellectual property, such as copyrights, trademarks, patents, and trade secrets, can be tokenized to improve ownership tracking and rights enforcement. For example:

- A songwriter can tokenize their musical compositions, ensuring that royalties are automatically distributed based on blockchain records.
- A patent holder can issue digital certificates for licensing agreements, reducing the risk of infringement, and streamlining legal processes.

Tokenized Certifications and Digital Collectibles

Digital certificates, diplomas, and professional accreditations can be tokenized to provide verifiable proof of achievements. Universities and online learning platforms increasingly use blockchain-based certification systems to prevent fraud and ensure credibility. Similarly, sports memorabilia, gaming assets, and other digital collectibles can be tokenized for authenticity and tradability.

➔ NFTs are instrumental for non-financial asset representation, especially for digital art or media that is typically unique and not fungible by nature. However, representing non-financial assets extends beyond NFT applications and other tokenization options should be explored.

Regulatory Considerations

Regulatory approaches to tokenizing non-financial assets vary across jurisdictions, leading to inconsistencies in classification and oversight. Additionally, various tokenized non-financial assets are still monitored from a regulatory perspective. Their regulation has still not materialized at least in a consistent or comprehensive manner.

OECD recognizes that IP rights can be tokenized, allowing for new business models and monetization methods.

EU MiCAR (Markets in Crypto-Assets Regulation) explicitly excludes unique and non-fungible tokens (NFTs) from its regulatory scope (article 2(3)), focusing instead on fungible

crypto-assets like stablecoins, unbacked payment tokens, and utility tokens. MiCA cites digital art and collectibles as examples of unique and not fungible tokens (recital 10).

Nice Classification: twelfth edition of the 'Nice classification' allows for the registration of trademarks in classes covering their use in the metaverse → shift towards IP used in virtual words making exploration of tokenization of non-financial digital assets relevant.

Additionally, MiCA deems crypto-assets representing services or physical assets that are unique and non-fungible, such as product guarantees or real estate, as non-fungible and unique tokens excluded from its scope. While NFTs are mainly discussed in relation to digital art, they do have some functions for physical assets to the extent they are unique.

MiCA makes further observations on the scope of truly unique and not fungible assets:

*The **fractional parts of a unique and non-fungible crypto-asset should not be considered unique and non-fungible**. The **issuance** of crypto-assets as non-fungible tokens **in a large series or collection should be considered an indicator of their fungibility**. The mere attribution of a unique identifier to a crypto-asset is not, in and of itself, sufficient to classify it as unique and non-fungible. The assets or rights represented should also be unique and non-fungible in order for the crypto-asset to be considered unique and non-fungible. The exclusion of crypto-assets that are unique and non-fungible from the scope of this Regulation is without prejudice to the qualification of such crypto-assets as financial instruments. This Regulation should also apply to **crypto-assets that appear to be unique and non-fungible, but whose de facto features or whose features that are linked to their de facto uses, would make them either fungible or not unique.** In that regard, when assessing and classifying crypto-assets, competent authorities should adopt a substance over form approach whereby the features of the crypto-asset in question determine the classification and not its designation by the issuer.*

In short:

- Fractional parts of unique and non-fungible crypto-assets should not be deemed unique and non-fungible themselves.
- Issuance in a large series or collection → indicator of fungibility
- De facto features → could make fungible and apparently unique and non-fungible token.

Implications for tokenization: consider whether some assets are truly unique and whether an NFT representation is necessary or suitable.

The absence of uniform regulation means that businesses and investors must navigate multiple legal frameworks, making standardization critical for long-term adoption and regulatory clarity.

Tokenized Non-Financial Assets – Market Impact

Tokenizing non-financial assets brings significant economic and technological benefits, fostering new opportunities for creators, businesses, and consumers.

Tokenization facilitates the emergence of entirely new digital asset categories, increasing the efficiency and liquidity of previously illiquid markets. Examples include:

- Virtual real estate in metaverse environments (see section on metaverse below).
- Music and video rights traded on blockchain-based streaming platforms.
- Gaming assets, where players can buy, sell, and own tokenized in-game items.

These developments empower creators as they enable direct monetization, removing intermediaries. Smart contracts on DLTs automate payments for the monetization of intellectual property represented through tokens. This enables a secure and verifiable way of earning royalties on each subsequent sale or licence for IP owners.

Tokenization of non-financial assets has a wide range of applications:

- **Digital Art & Collectibles**: Artists mint their works as NFTs, ensuring authenticity, ownership, and provenance tracking. (used as primary examples of NFTs by MiCA)
- **Academic & Professional Certifications**: Universities issue blockchain-based degrees, reducing fraud and improving employer verification. (see industry applications like block.co)
- **Supply Chain & Sustainability Credentials**: Companies use tokenized certificates to prove sustainability claims, such as carbon offset credits.

The increasing adoption of tokenization underscores the need for standardized terminology for tokens to ensure interoperability, legal clarity, and regulatory compliance.

Tokenization of Non-Financial Assets and IP – Legal and Regulatory Challenges

Tokenizing IP could present significant challenges deriving from inconsistent and unclear regulatory frameworks, lack of standardization in token terminology, the inherent borderless nature of tokens, which by nature implicates various jurisdictions.

Some of these challenges are:

- **Lack of standardized terminology**: No universal classification of digital assets leads to fragmentation and inconsistent legal interpretations.
- **Lack of regulatory emphasis on non-financial assets:** Current initiatives or laws focus on crypto-assets that have some kind of payment or other financial function (see MiCA, US FIT21 Bill).
- **Risk for unauthorised representation:** Tokens may represent intellectual property without proper authorisation → the added layer of digital representation may exacerbate the risk for non-authorised usage of IP through token representation.
- **Uncertainty as to legal recognition of tokens, particularly NFTs representing IP:** Tokens do not grant any IPR as such. Use of tokens might create confusion or uncertainty between the right to the token itself and the right to the underlying content, subject to IP protection. (see DRAFT REPORT on policy implications of the development of virtual worlds – civil, company, commercial and intellectual property law issues (2023/2062(INI)) Committee on Legal Affairs of the European Parliament)
- **Lack of standardized IP vocabulary** for defining tokenized and non-tokenized digital assets.

Challenges in Tokenization for Non-Financial Assets – Broader Considerations

Lack of Standardized Terminology

- Different regulators use inconsistent definitions for digital assets, making cross-border compliance difficult.

- Some jurisdictions classify NFTs as securities, others treat them as consumer goods, while others exclude them from regulation altogether.
- The absence of universally accepted terms for tokenized non-financial digital assets creates regulatory uncertainty.

Regulatory Fragmentation

- Some countries treat NFTs as intellectual property, while others regulate them under financial laws.
- Standardization bodies, international organizations, and various national regulators have different approaches to digital asset classification.
- Many regulators focus on financial digital assets in their regulation, which creates a significant gap.

Interoperability Barriers

- Token standards (ERC-721, ERC-1155) are not universally applicable across networks.
- Challenge in using the proper token standard for various non-financial asset representations – We should consider whether NFT is suitable in all cases for non-financial assets or if tokens with apparent characteristics of an NFT should be treated differently.
- A token recognized in one country may not be valid in another, or a token may be recognized differently in different jurisdictions.

Addressing these challenges requires a standardized token vocabulary to align technical and regulatory frameworks.

New Developments: Metaverse and Tokenization

- The Metaverse is a persistent, immersive virtual environment that integrates multiple digital realities. Its growth is enabled by technologies such as virtual reality (VR), augmented reality (AR), artificial intelligence (AI), blockchain, NFTs, and spatial computing. Therefore, tokenization is relevant to the Metaverse developments, primarily through NFTs.

- The European Union Intellectual Property Office (EUIPO) commissioned a report, conducted by UNICRI, to examine the impact of the Metaverse on intellectual property (IP) infringement and enforcement. (Impact of Technology Deep Dive Report II, Impact of the Metaverse on Infringement and Enforcement of Intellectual Property, October 2024). The report highlighted new markets for **digital goods** allowing **virtual assets, digital art, and brand experiences** to grow.

*Metaverse could host an array of assets, ranging from digital, non-financial assets (like digital art) to tokenized physical assets. Therefore, both physical and digital assets can play a significant role in the Metaverse.

- Tokenization and NFTs provide a way to track ownership and authenticity of assets on metaverse – NFTs are popular in tracking ownership and authenticity for collectibles, digital art, or physical artefacts. The report notes that there are several types of NFTs, with the most common being a metadata file containing information encoded with a digital version of the work that is being tokenized. The report highlights the diverse use of NFTs, representing anything from "*commodities and loyalty points to shares, coins, works of art, and more. Any digital work, including physical goods which can be represented in digital form, such as a photo, video or a scan, can be turned into a non-fungible token*."
- Tokenization can prove critical for the operation of metaverse, representing an additional use case of digital representation of assets through DLTs.

Metaverse and Digital Twins – Beyond Intangible Assets

A digital twin is a virtual simulation of a physical object, system, or process, created by integrating real-world sensor data with computer simulations. (WIPO Conversation on IP and Frontier Technologies, 2024). Digital twins serve as digital counterparts of real-world assets, allowing continuous monitoring, analysis, and optimization. The concept, which has gained significant traction in industries such as healthcare, engineering, urban planning, and manufacturing, is also a foundational component of the Metaverse.

In the context of the Metaverse, digital twins play a critical role in optimizing industrial designs, enhancing healthcare delivery, and expanding educational opportunities. WIPO, in its report, highlights that digital twin technologies could enable low-emission industrial designs,

suggesting their relevance in sustainable development and resource optimization. The ability to create a real-time virtual replica of an object or system enhances decision-making, efficiency, and predictive maintenance.

Digital twins emerge as an area necessitating thorough research, since it constitutes the cornerstone of virtual environments. It is worth examining how these digital twins can be understood in legal terms and how they fit into existing legal and regulatory concepts, current understandings of assets and asset classifications, and the optimal underlying technology underpinning their operation.

From an IP perspective, digital twins raise challenges related to ownership, data protection, and enforcement – these challenges generally pertain to virtual environments. Since they involve the collection and real-time processing of vast amounts of data, it is challenging to determine who owns the digital twin. Indeed, this remains unclear based on most conventional legal and regulatory frameworks. In its aforementioned report on metaverse, WIPO emphasizes that digital twins are protected through a combination of IP rights, including copyright (for simulation software), patents (for unique processes and technical effects), sui generis database rights (for structured real-time data), and trade secrets (for proprietary modelling techniques).

A significant challenge with digital twins in the Metaverse is interoperability. Since different platforms and virtual environments operate on distinct standards and infrastructures, ensuring that digital twins function seamlessly across multiple Metaverse spaces requires harmonized technical and regulatory frameworks. The lack of standardization in the classification, representation, and protection of digital twins creates legal uncertainties and limits their cross-platform usability. Were tokenization to facilitate the development of these digital twins, similar interoperability issues would need to be addressed.

As digital twins evolve with real-time data input, their status as static or dynamic digital assets further complicates legal recognition, regulatory treatment, and enforcement. In traditional IP regimes, protection is granted based on fixed inventions, creations, and results of authorship, but digital twins are continuously updated and modified, making it difficult to establish a single point of authorship or ownership. These issues highlight the necessity for new legal frameworks and clearer IP governance tailored to the unique nature of digital twins in the Metaverse. This should be supported by classifying digital twins within the scope of digital assets.

As the Metaverse expands, digital twins will become increasingly important in bridging the physical and virtual worlds, providing businesses, policymakers, and individuals with accurate, real-time digital representations of the assets they interact with. However, addressing the legal, technical, and regulatory challenges surrounding digital twins will be crucial to ensuring their effective and secure integration within this emerging digital ecosystem.

Digital twins emerge as an area necessitating thorough research, as they are a cornerstone of virtual environments and play a critical role in asset representation within the Metaverse. Understanding digital twins in legal terms requires examining how they align with existing legal and regulatory frameworks, asset classifications, and tokenization models. As digital twins increasingly represent both tangible and intangible assets in tokenized ecosystems, it is essential to explore the optimal technologies that underpin their operation and ensure interoperability, security, and compliance within digital economies.

Challenges for IP Protection in Metaverse

- **Jurisdictional complexities**: The Metaverse operates across borders, making it difficult to enforce IP laws globally.
- **IP enforcement difficulties**: Unauthorized reproduction, counterfeiting, and trademark misuse in virtual environments create new legal challenges.
- **Grey areas in regulation**: Some forms of virtual property do not have clear **legal frameworks**, making enforcement inconsistent.
- **IP crimes** may arise in the Metaverse with inconsistent or unclear legal recourses for aggrieved parties.
- **Digital forensics difficulties**: IP crime in the Metaverse requires advanced forensic tools to investigate and gather evidence.

  In this context, blockchain and DLT analytics might be necessary, if assets would be represented through tokenization. Such tools require trained use from government authorities.

Next Steps – Standardized Vocabulary for Digital Assets

A standardized vocabulary is essential for digital asset adoption. This vocabulary will address various token applications facilitating asset representation on blockchain and other DLTs. Such standardized vocabulary should account for the various asset classifications, including those explored as part of this ongoing research.

A standardized vocabulary could offer various benefits to asset representation using tokenization:

Regulatory Certainty

- Standardized definitions will reduce legal ambiguities and improve compliance.
- It will prompt greater regulatory intervention to areas that are left outside regulatory interest for now, like non-financial assets.
- Regulators can align policies to recognize tokenized assets uniformly.
- It will enable authorities to align or tailor their existing asset frameworks and classifications to bespoke tokenization needs deriving from the underlying DLT.

Interoperability Across Blockchains

- A universal taxonomy will facilitate asset transfers across blockchain networks.
- Tokenized assets can be used in multiple applications without compatibility issues.
- A standardized vocabulary will facilitate understanding of various tokens and how they connect to existing asset categories and classifications.
- Such vocabulary will bridge knowledge between conventional asset representations, certificates, and forms, and tokenized representations among market participants, regulators, software developers, and the public.

Market Growth

- Consistent definitions and classifications will build investor confidence.

- Standardization will encourage institutional adoption and cross-border token recognition.

Research Findings and Outcome

The classification of assets is fundamental in facilitating their representation through tokenization and distributed ledger technologies (DLTs). The research confirms that distinguishing between physical and digital assets and further classifying them into financial and non-financial assets is essential to understanding how tokenization can be effectively applied across different asset types. This classification serves as a framework for structuring digital representations of value and ensuring that tokenized assets operate within clear legal and technological frameworks.

In the case of physical asset tokenization, the role of the EU Digital Product Passport (DPP) and the circular economy becomes particularly relevant. Tokenization of physical assets enhances provenance tracking, ownership verification, security, and immutability. Through DLTs, digital records of physical assets can be maintained transparently, ensuring that ownership remains tamper-proof and that regulatory requirements related to sustainability and product lifecycle management are met. These factors are critical in sectors such as luxury goods, supply chains, and real estate, where authenticity and traceability are crucial. However, tokenization is suitable for tokenization of broader classes of products.

The tokenization of digital assets has been predominantly focused on financial products from a regulatory perspective, including tokenized securities, stablecoins, and digital commodities. However, non-financial digital assets remain an area requiring significant research. Intellectual property (IP), digital certificates, and other intangible digital products have not been as extensively explored in the tokenization landscape, despite their potential to reshape digital ownership and digital rights management.

A key finding of this research is that the initial scope of working group 8 on NFTs is too narrow. While NFTs have been widely discussed as digital representations of assets, tokenization should not be restricted to NFTs alone. The digital representation of assets must evolve to accommodate a broader range of tokenized structures that extend beyond the current NFT framework. Tokenization can represent digital objects, but it can also encode/programme asset characteristics that can be securely exchanged, verified, and enforced.

This research also highlights the growing importance of non-financial digital assets, particularly in the context of IP and intangible assets, digital certificates, and new digital products. The emergence of these assets within tokenized systems has the potential to give rise to entirely new digital business markets, where ownership, licensing, and transactions occur seamlessly on decentralized infrastructures and automated processes (by way of example via smart contracts).

The Metaverse presents another critical area where asset classification plays a vital role. In immersive virtual environments, intellectual property and its digital representation become significant, as they underpin economic transactions, ownership, and licensing mechanisms within digital spaces. The ability to tokenize virtual real estate, in-game assets, and digital identities underscores the necessity of understanding how asset classification applies within the Metaverse. This research demonstrates that tokenization is a foundational component of digital economies and will play a central role in shaping how value is stored, transferred, and monetized in virtual ecosystems.

Another major finding is the urgent need for a standardized vocabulary for tokens. The asset classification framework must be refined with precise terminology that accurately captures the nuances of different tokenized assets. Without standardized definitions, inconsistencies in regulatory interpretation and technological implementation will continue to pose barriers to adoption. Therefore, the research underscores the necessity of developing a comprehensive vocabulary that aligns with asset classification and tokenization models, ensuring clarity for industry stakeholders, market participants, regulators, and developers alike.

Annex to Report

- OECD (2020), *The Tokenisation of Assets and Potential Implications for Financial Markets*, OECD Publishing, Paris, https://doi.org/10.1787/83493d34-en.
- Hyun Song Shin, Tokenisation for the real world, OCC Symposium on the "Tokenization of Real-World Assets and Liabilities" Washington DC, 8 February 2024
- European Union Intellectual Property Office, Impact of the Metaverse of Infringement and Enforcement of Intellectual Property: Impact of Technology Deep Dive Report II, October 2024
- Policy Department for Citizens' Rights and Constitutional Affairs Directorate-General for Internal Policies, Intellectual Property Rights and Distributed Ledger Technology with a focus on art NFTs and tokenized art, October 2022
- WIPO Conversation IP and Frontier Technologies, https://www.wipo.int/about-ip/en/frontier_technologies/, including section on Metaverse, 2023
- WIPO resources – WIPO Magazine:
    - Kathryn Park, Trademarks in the metaverse, March 12, 2022
    - Andres Guadamuz, Non-fungible tokens (NFTs) and copyright, December 10, 2021
    - Anne Rose, Blockchain: Transforming the registration of IP rights and strengthening the protection of unregistered IP rights, July 2, 2020.
- **Regulation (EU) 2023/1114 (MiCA)**:
    - Article 2(3): NFTs are excluded from scope if unique and non-fungible.
    - Recital 10: Clarifies examples of NFTs like digital art and collectibles.

    - Further notes: NFT series may indicate fungibility; classification should consider substance over form.

- **ISO TC 307**: Ongoing standardization efforts for tokenization and digital asset representation, highlighting the need for harmonised vocabularies. See also ISO/CD 18126.2

Feedback from WG8 meetings:

The feedback shared during the various project discussions, particularly around the importance of standardizing token representations across asset classes, significantly shaped my contribution on digital asset classification and tokenization.

My presentation on tokenized Digital Product Passports (DPPs) highlighted the value of fractionalization, liquidity, and interoperability, reinforcing the need for a framework for both physical and digital assets. The group agreed that this would be the objective of various and upcoming standardisation initiatives. This directly informed my emphasis on differentiating financial and non-financial digital assets, their respective tokenization methods, and the importance of a standardized vocabulary.

In particular, the insights on representing non-financial digital assets, like in-game items or metaverse objects, and the conversations around fungibility, lifetime tracking, and cross-ecosystem use cases, inspired the comprehensive structure I developed to frame tokenization beyond NFTs and across emerging asset types. Additionally, it affected the ongoing discussions of the group with two working group members presenting an outline for an NWIP on digital assets using tokens as it developed from the initial scope of the PWI (Representing

Non-Financial Digital Assets using Tokens on DLTs). The NWIP emphasised the data items and types representing various digital assets and emphasised the token lifecycle, consistent with the areas of my additional and ongoing research.

Additionally, at the time, I was also discussing a potential Preliminary Work Item (PWI) for a standardized vocabulary covering all asset types, aligning with my research into different asset classes, their relationship with tokenization, and the advantages of clear asset classification to support appropriate tokenization methods. I had relevant communication with the Convenor, addressing the need for a standardized vocabulary that would facilitate tokenization for broad categories of assets. These discussions both supported and reinforced my ongoing research into currently underexplored areas, such as media-related digital assets, digital assets in the metaverse, and other forms of intangible assets. This also marked the relevant of my ongoing research to broader standardization efforts.