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Thematics & Cryptocurrency

The Future of Tokenised Assets

Distributed Ledger Technology is being explored by companies that are re-engineering their data architecture and testing what new benefits or market opportunities could be unlocked. This report explains the technology and why equity investors should take notice. Interest follows crypto cycles.

DLT x Tokenisation: Distributed Ledger Technology (DLT) is a different way of storing data – of which blockchain is the best known example. The technology has the potential to modernise various industries and asset classes either through re-purposing corporate databases or creating tradable digital assets. The rise in cryptocurrency prices in 2020/21 has meant the market has focused on the latter but the former is even more important for equity investors as DLT adoption could materially lower costs once fully implemented as headcount requirements decline. While the technology of distributed data storage has been around for some time, bullish crypto price action triggered a new wave of corporate experimentation with the technology. Tokenisation is the act of creating a digital representation of the asset on a database. We believe investors will increasingly be confronted by the opportunities and challenges that this process entails.

Opportunities and challenges: Some of the key challenges for this new technology to address are regulatory approvals, infrastructure requirements and standardisation. To a degree, growth of DLT and corporate interest in it will also be a function of crypto price cycles. DLT is now entering a broadening proof-of-concept phase as companies explore revenue opportunities, cost benefits and transparency potential. While DLT is not the most efficient IT infrastructure to harmonise and verify data, there are specific use cases in which benefits are starting to outweigh the aforementioned challenges.

Equity investors should take note: This technology – and in particular crypto blockchain – has seen previous hype cycles in 2013 and 2017. However the current cycle is notably different for two reasons: **(i) material capital deployment**: In 2021/22 we have seen a clear acceleration in investor activity. In blockchain/Web3 venture capital we have seen a 609% increase of capital deployed in 2021 (vs 169% across VC). **(ii) Greater momentum in corporate exploration**: Among the top 100 largest public companies globally, >80 are actively working on DLT solutions for infrastructure inefficiencies with at least 25 already having a live product. This will not happen uniformly and some industries will have no need to use DLT at all. Applications are most advanced in logistics, financial services, staples, software and healthcare.

Longer-term potential: Technology is always evolving. We believe over time it will exert influence on investment portfolios from three directions. **(i) On business models**: Tokenisation could benefit supply-chain transparency, credit

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scoring and insurance among others. The integration of the technology will be a serial process and we do not expect all industries will see equal adoption. **(ii) Tokens in traditional portfolios**: digital assets can help to democratise certain investments by lowering investment sizes and diversifying investment opportunities. It allows investors to gain exposure to previously inaccessible types of investments, either in the form of tokens, coins or tokenised assets (for example tokenised real estate, art, loans). We see increasing interest from early stage and alternative investment managers in digital assets and expect that these will, over time, find their way into more traditional investment portfolios as a new type of alternative investment. **(iii) A new market infrastructure**: The equity and fixed income markets are already extremely efficient in their current form, and this makes replacing the current market infrastructure in favour of a DLT-based one hard and costly. Yet, in the long term (10y+) with the advent of CBDCs and programmable money this may change. We explored how this could happen and what this could mean for Investment Banks in Climate, Crypto, and Competing in This Cycle.

Why should portfolio managers care?

Tokenisation and distributed ledger technology are increasing in popularity. Existing companies seem willing to experiment with the technology and are now leveraging the benefits. Meanwhile DLT is also empowering new ecosystem-based business models to develop in a meaningful way.

We argue that the success of the technology presents both opportunities and threats to investment portfolios. Portfolio managers need to have a basic understanding of the technology, its potential, the risks for their portfolios and for other traditional asset classes.

Before assessing this impact it is important to clarify some of the terminology.

- **Distributed Ledger Technology (DLT):** A form of data infrastructure that allows for data to be stored and kept up to date across multiple entities and to be simultaneously accessed, validated and updated. Once stored, the data is immutable. **Blockchain** is one of many types of DLT.
- **Coin:** Digital asset that sits on its native blockchain. It serves as a means of exchange within the ecosystem of its blockchain.
- **Token:** Digital asset that can represent (i) a unit of value of a blockchain-based organisation which unlocks a service (utility token) or (ii) an electronic certificate indicating ownership of a tangible or intangible asset (security token). Tokens are used by projects that operate on top of the distributed ledger.
- **Tokenisation:** In this report, unless specified differently, we will refer to tokenisation as the process of creating a digital copy (token) of an asset and putting it on the distributed ledger. The information stored in tokenised form can include asset type, ownership details, valuation, legal framework, optionality, and settlement requirements, among other elements that enable significant customisation opportunities for issuer and owner to elect.

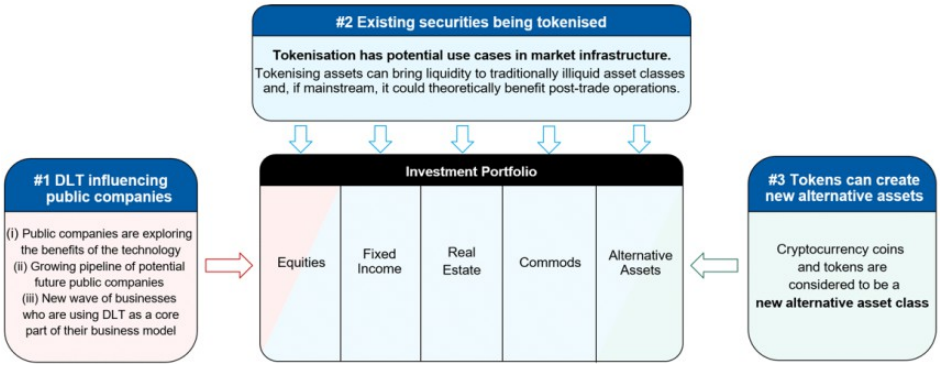
Tokenisation is not limited to DLT

The act of tokenisation is not only achieved by creating a digital representation of an asset on a distributed ledger (DLT).

There are other ways of tokenisation:
(i) Tokenisation by creating a **digital representation of an asset on a centralised ledger** like a cloud database
(ii) Tokenisation by creating a **physical token** that represents an asset. The most common example are casino chips. We explore the concept that tokenisation has been around for a long time later in this report.

We expect the effect of distributed ledger technology, tokens and coins on a traditional investment portfolio to be threefold:

Exhibit 1: Impact of distributed ledger technology, tokens and coins on the investment portfolio



Source: Morgan Stanley Research

#1 DLT innovation influencing publicly traded companies

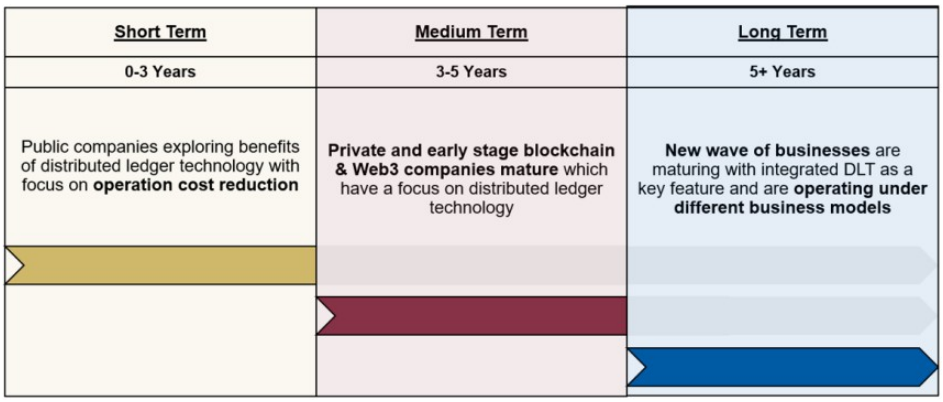
We believe portfolio managers should be mindful of the basics of distributed ledger technology and tokenisation's potential effects on companies. Both early-stage and mature companies are exploring the technology in tandem. We believe that the impact of DLT adoption on companies is likely threefold:

- **Short Term (0-3 years)**
  DLT becomes more mainstream, **meaning companies and multinationals start exploring the benefits of the technology.** Across different sectors we find examples of initiatives with the main focus on operational cost reduction.

- **Medium Term (3-5 years)**
  There is a **growing pipeline of potential future public companies** receiving large amounts of funding to support their DLT projects. Some of these companies may choose to enter public markets and become part of the equity investment universe.

- **Long Term (5+ years)**
  There is a **new wave of businesses that are using DLT as a core part of their business model**. DLT empowers ecosystem-based business models which rely on different revenue models and economics to generate value for their users and investors. It is still unproven if these new business models will ultimately be competitive. Nonetheless, investors should be mindful of their existence and the impact on public comps. These businesses are the Web3 companies that have DLT-enabled decentralisation as a core feature of their business model.

Exhibit 2: Timeline of distributed ledger technology's impact on public companies



Source: Morgan Stanley Research

A. Public companies are already exploring the benefits

We believe implementation of DLT for operational cost reduction and increasing transparency will have the most impact short term. There are plenty of examples of companies leveraging the technology in sectors like healthcare, retail, travel & mobility, financial services, entertainment and communication. Currently ~72% of distributed ledger projects have operational cost reduction as the primary objective. See examples later in this report.

The distributed ledger increases transparency relative to a centralised database. This combined with DLT's immutable nature offers many companies an innovative way to keep track of enterprise resource planning (ERP) systems, inventory and other administratively driven processes within the organisation. It is also becoming increasingly easy to integrate the distributed ledger technology into these processes. By putting company assets and data on the ledger through tokenisation, organisations are able to leverage operational efficiencies.

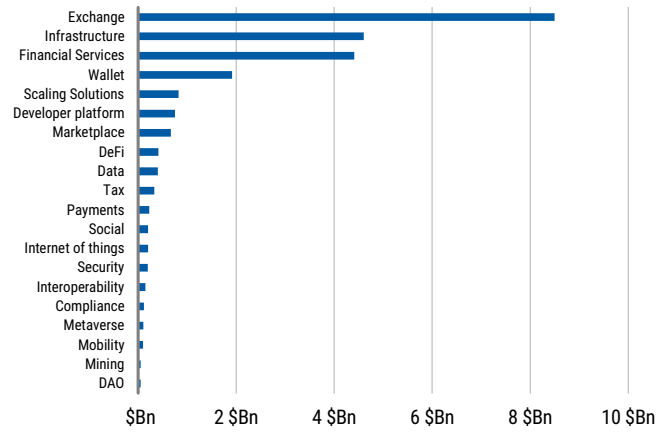
In recent years, we have seen initiatives across industries with the aim to implement distributed ledger technology into the existing tech stack or across multiple companies to integrate it across value- and supply chain. As these projects and initiatives come to fruition, we expect to see even more organisations using distributed ledger technology and tokenisation to gain a competitive edge.

For the moment businesses are mainly focusing on proof-of-concepts and short-term gains from the implementation of DLT. Once familiarised with the technology, we expect they will shift their focus to tackling broader company and industry challenges using DLT. Due to the network effect of DLT, companies will most likely work together through partnerships with multiple stakeholders across the value chain and industries with the intention to share the same ledger.

B. Growing pipeline of future public companies

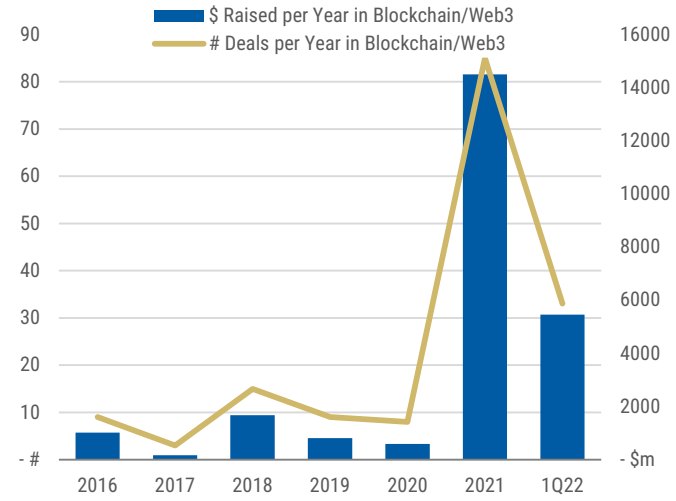
We have seen an increase in capital deployed in blockchain and Web3 in recent years. Up until 2021, we saw a low double-digit number of deals that raised more than $50m in blockchain start-ups and scale-ups. Since 2021 there has been a significant pick-up in activity with 85 deals in 2021 that raised more than $50m.

Exhibit 3: $m raised by blockchain or Web3 companies by service since 2016



Source: Pitchbook

Exhibit 4: $m raised by blockchain companies and number of deals done in total YoY

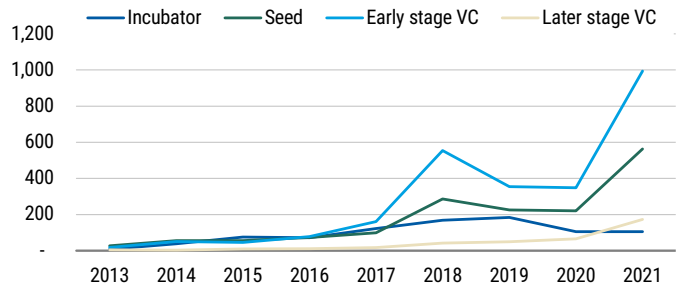


Source: Pitchbook. 2022 is an estimate based on the first 3 months of the year.

Blockchain and Web3 are themes that have seen particular and considerable increases in interest from investors – with an 830% increase in capital deployed: from $3bn in 2020 to $25bn in 2021. Despite some valuation contraction in 2022, we are seeing this trend continuing into 2022.

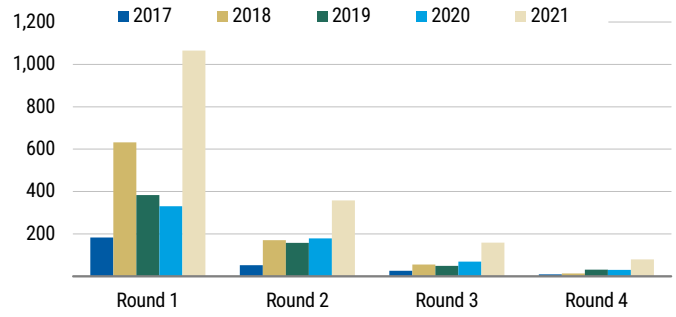
The increase in deal activity and capital flowing into blockchain and Web3 should accelerate scaling of these emerging innovators. As these companies become more mature, they will likely start having an impact on a broadening number of industries and legacy competitors as they leverage operational benefits of DLT. To assess and anticipate potential impacts on the existing portfolio, investment managers should familiarise themselves with blockchain and Web3 as an investment theme.

Exhibit 5: Annual number of blockchain and Web3 deals per VC stage



Source: Pitchbook

Exhibit 6: Number of blockchain and Web3 deal since 2017 across different rounds



Source: Pitchbook

C. Companies built on distributed ledger

Distributed ledger technology and consequently blockchain and tokenisation are often characterised as 'silver bullets' that can easily solve the most difficult business cases. They are not silver bullets. Nonetheless, we still see the technology as promising albeit nascent. Cost reduction is currently the most prominent use case. However as more talent and resources gravitate towards companies embracing the technology, the

discovery of new use cases should increase; as with any emerging technology, the "killer app" remains elusive.

Besides operational efficiencies, DLT facilitates transactions between its users. Since every user of the DLT has a copy of the ledger, which is simultaneously updated, participants can trust the state of the ledger to be correct and up to date. This relies on the assumption that the information is entered correctly as immutability implies that past records cannot be edited.

With DLT there is no need for stakeholders to rely on a central entity to maintain and update the state of the ledger. Yet, this could create issues in heavily regulated industries

Traditional businesses across different industries have tried to provide users with some type of peer-to-peer interactions. In reality however, there still remains a strong dependency on a centralised party to instill trust and facilitate transactions or interactions. For these businesses, overseeing any type of interaction between users is often a core feature on which the revenue model of the business is built.

Through the integration of peer-to-peer transactions as a core part of the value proposition, we are starting to see businesses that are fundamentally built on different revenue models. They no longer rely on a role as central facilitator to generate profit. Instead they have other ways of creating value for the business and its investors. Integrating DLT in this way is especially useful for business models where the success of the business is heavily reliant on network effect and new users joining the platform or service. This is achieved through the use of Utility Tokens, which unlock company services. Some examples are Arweave, Helium and Audius.

Facilitating peer-to-peer transactions is not the only value proposition of DLT, but it is one with potential. It is important to remember that new businesses that rely on DLT as a core building block will at some point become mature. When this happens it could be that, depending on the industry, some more traditional businesses that haven't embraced specific elements of DLT might start to struggle to stay relevant.

While this is still some time away, investors should be mindful of some of the new businesses being founded and the potential impact (opportunities or challenges) they could have on existing companies across different industries.

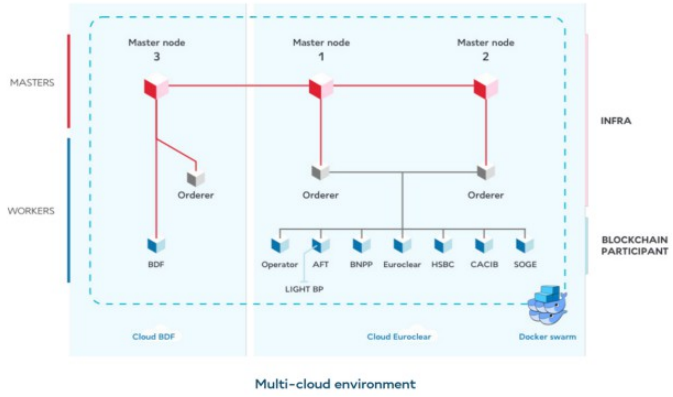
#2 Tokenisation has potential use in market infrastructure

We think tokenisation has the potential to increase liquidity as more investors can access opportunities and change financial markets as digitisation should speed settlement. Regulators are a critical partner on this journey as market participants need their approval for streamlined approval processes, IT infrastructure changes, counterparty limits, etc. Incumbent banks also need regulators to allow them to participate in cash crypto assets to fully participate in this asset class. Our Global Banks and Diversified Financials team, led by Betsy Graseck, wrote about this in their deep dive on the topic, which can be found here: Climate, Crypto, and Competing in this Cycle. While they believe there are material regulatory changes required first, they have estimated this to be a $14-16bn revenue opportunity for the global corporate and investment banks.

On the one hand, cryptos are a new asset class that we think will find a place in investors' portfolios in its own right, which has been explored in Competing for Growth. Regulation is the defining factor determining whether banks can fully gain access to this revenue pool given current regulations. Moveover, asset classes that were traditionally illiquid and only available to a limited pool of institutional investors may become more easily accessible and tradable, if or when they become tokenised.

As far as the existing market infrastructure is concerned, we think some markets are already fairly efficient and liquid. Therefore shifting to a DLT infrastructure may not be desirable, as it would require a material investment in new technology, and would require wide adoption for it to ultimately make sense economically – we are thinking about cash equity trading for example, or some more liquid parts of the bond market. The area where we think a DLT market infrastructure would bring the highest benefit is in post-trade operations, where for example an experiment on issuing French government bonds on a DLT and settled in CBDC has shown that there is scope to save costs, reduce the need for reconciliation, and make settlement faster as shown in Exhibit 7.

Exhibit 7: Proof-of-Concept of DLT-based market infrastructure potentially making post-trade more efficient (based on IBM experiment in 2021)



Source: Euroclear, 2021 experiment in collaboration with the French Central Bank, Euroclear, IMB and French banking players like BNP Paribas, Credit Agricole, SocGen and others

Exhibit 8: T+0 EoD makes most sense in experiment of French government bonds testing DLT

Source: Euroclear, 2021 experiment in collaboration with the French Central Bank, Euroclear, IMB and French banking players like BNP Paribas, Credit Agricole, SocGen and others

While there seems to be some cost savings rationale behind moving to a DLT technology, we would caveat that some experiments in this direction (for example by ASX in Australia, or SDX by SIX in Switzerland) have failed due to how difficult it is to have every market infrastructure participant agree on changing to a new technology.

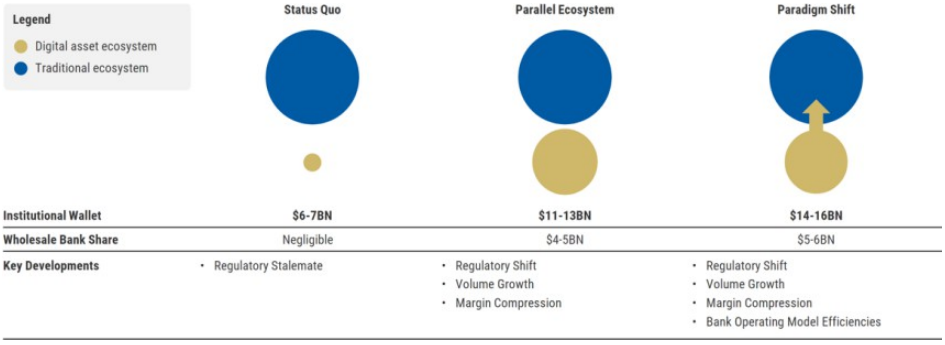
Regulation is key in the sense that, for example, at the moment it is not possible to legally represent Equity on the DLT. For this reason the European Council and the Parliament agreed in 2021 on a DLT pilot scheme to test the development of the European infrastructure for trading, clearing and settlement of DLT-based financial instruments. This will be done in a controlled, "sandbox" approach, whereby temporary derogations from some requirements under the EU's financial legislation will be allowed to test underlying functionality. This approach effectively means a three year period of testing to see if it makes sense to move ahead with new legislation that would allow

traditional equity to be issued on a DLT.

Moreover, for the financial infrastructure on the DLT to really accelerate, we also need a risk-free asset to settle assets in like a CBDC (Central Bank Digital Currency), or stablecoins. However there is no clear regulation on stablecoins in the US, and there are only three live CBDCs in the world (Nigeria, the Bahamas, and the Eastern Caribbean Central Bank), while major central banks (in particular the ECB and the US Fed) are only at research or wholesale pilot stage. We think CBDCs will ultimately go live in the main economies globally, and tighter and clearer regulation will come for stablecoins, but we see this as a medium to long-term shift for financial markets (5-10yrs) rather than a short term one.

Finally, issuance of wholesale CBDCs for cross-border use, allowing direct transfer of funds between countries, would eliminate the need for correspondent banks and make cross-border payments cheaper safer and faster, as the mBridge project by BIS shows (full details can be found here): this seems quite revolutionary to us for wholesale banking, although subject to CBDCs being launched first.

Exhibit 9: Future evolutionary paths for Wholesale Banks in Crypto, 5-year horizon – for more details on this analysis, please see our note Climate, Crypto, and Competing in This Cycle



Source: not to scale. Source: Industry public information, Oliver Wyman analysis.

#3 Digital assets are a new asset class

Digital assets are a new asset class

Digital assets, both in the form of coins and tokens, can be considered a new alternative asset class. They unlock a new way for investors to invest into specific themes or ideas.

- **Coins**, which are digital assets that have a native blockchain, can have different economic models and risk/reward characteristics than the existing traditional asset classes, making it reasonable to approach them as a new asset class.

- **Tokens**, which can represent digital assets or a service/utility, should increase as digital assets become more prominent. The programmable nature of tokens make them a very versatile asset, allowing investment across different sectors from real estate to fine art and collectibles. Through tokens the investor can gain exposure to a wider variety of alternative investment opportunities, making it a new alternative asset class.

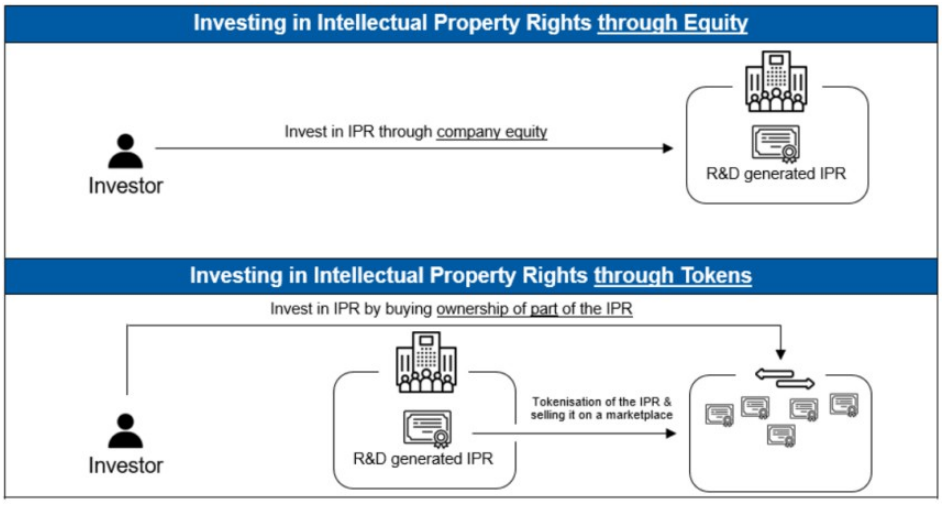
Example - Tokens x Intellectual Property

Intellectual Property Rights (IPR) give individuals/groups the right of exclusive permission-of-use of their invention over a specific period of time. The tokenisation of IP allows for the ownership of patents to be fragmented into multiple parts. This allows for the distribution of the IP across multiple parties on the open market. This way parties can buy into the IP and (i) use the IP in production or (ii) buy it as an investment. Investors who are interested in the IP can invest directly into the IP, which will be distributed across many companies.

Previously investors who were interested in investing in a particular IP (for example a new type of technology) had to invest in the company that held the specific IP rights. Tokenisation of IPs unlocks a new way for investors to gain exposure to innovative ideas. They can invest directly into the IP instead of having to buy a more diluted exposure via the equity of the holding company.

Intellectual Property is marked by large amounts of regulation and poor transparency. There are some obvious legal hurdles and ideally there would be a supranational regulatory framework in place. Despite this, blockchain is expected to increase the efficiency of the IP of companies and individuals.

Exhibit 10: Intellectual Property Rights investing through Equity vs Tokens



Source: Morgan Stanley Research

Real World Examples - Successful & Unsuccessful

DLT as a new for companies to harmonise and verify data

Distributed ledger technology and blockchain are ways to harmonise and verify data. Given the novelty of the technology, implementation can be complicated and expensive, making traditional databases still quicker and cheaper to use for smaller projects. As more developers and businesses move into DLT we expect the opportunity costs to go down, further driving adoption.

For large scale projects the economics are already stacking up and we are seeing implementation of DLT across industries. Improving data architecture within a company and reducing costs is the obvious benefit; however the technology really scales when DLT is integrated across an entire value chain of companies and stakeholders. Integrating DLT provides all parties involved with one single source of truth without a single point of failure.

Examples of DLT integration

The following are examples of industries that saw corporate benefits from adopting DLT:

Healthcare Services

Distributed ledger technology (DLT) and blockchain allows users to verify and authenticate healthcare data in a permissioned and open source approach. This makes the technology well-suited to empower users to have self-sovereignity over their medical data such as patient records, disease progressions and much more. Pilot programs are running where insurers and hospitals share patient medical data to verify insurance and medical records.

Example: In 2020, IBM helped Moderna, the COVID-19 vaccine maker, to track the vaccine supply chain, allowing multiple participants to view, update and share sensitive data.

Anti-Money Laundering

Distributed ledgers can help financial institutions to collaborate and combat money laundering by allowing them to share data analytics and information on transactions and anomalous activities. By sharing data of specific transactions a rich and dynamic pool of high-risk actors and their webs of activities can be generated. By sharing data of transactions on a DLT, financial institutions can more easily map the flow of transactions of specific actors to further combat money laundering

Example: The Monetary Authority of Singapore (MAS) has been co-creating COSMIC, a shared DLT between six major banks in Singapore and the platform is scheduled to go-live in 2023. In its initial phase, COSMIC will focus on risks related to the abuse of shell companies, illicit misuse of trade finance, and evasion of United Nations sanctions.

Provenance

As data on the distributed ledger is stored and synchronised in multiple places, it is a system that enables tamper-resistant record keeping without the requirement of a central party or intermediary. Distributed ledgers can help establish the provenance of physical or digital items. In addition to establishing the provenance of goods across supply chains, DLT can also be used to track the provenance of identity, credentials, registries and other assets.

Example: Companies such as Glencore, Umicore, Tesla and CMOC share a distributed ledger across the cobalt supply chain. This allows the cobalt to be easily and effectively traced from the mine to the battery.

Luxury

Luxury is a sector that is plagued by product counterfeits. Since data on the DLT or blockchain is immutable (i.e. cannot be changed), it can be used for tracking individual products throughout the entire product cycle. Companies like Prada and LVMH are already rolling out programs leveraging the technology to reduce counterfeiting and to understand the secondary market.

Example: In 2021, LVMH, OTB, Prada Group and Richemont jointly created the Aura Blockchain Consortium with the aim of introducing more transparency and traceability of luxury brands by leveraging a single global blockchain solution.

Insurance

Blockchain, and especially smart contracts, are proving to be very useful for the insurance sector. It allows the automation of contract and claim settlements in a transparent and quicker way. Requests for damage claims are managed and automatically executed by the smart contracts. The additional transparency of the shared database also prevents fraudulent behavior such as claiming multiple damage claims on the same case.

Example: Bharti AXA, a motor insurer, replaced paperwork and manual processing with a system built by LedgerTech that cut the time to complete damage assessments to minutes rather than hours or days, offering real-time reporting of claims.

Creator Economy

Even before the inception of the internet, musicians and other artists have been victims of piracy. This has only increased with the internet where copies are easily made and quickly distributed. DLT allows content creators to distribute their work and receive royalties as soon as the creation is being "used". This dynamic disintermediates some centralised parties that were previously in charge of distribution and charging users for these creations. In November 2021, Ed Stanley and Ed Aubin wrote about luxury, creators and their opportunity in the Metaverse.

Trade Finance

Trade finance can be perceived as having slow execution with high bureaucracy. In trade finance the payment is not released until the counterparty has the physical good in their legal control. This process can be perceived as slow, especially if the information around the physical goods is operating on a different network than the financial information, resulting in trapped liquidity for participating organisations. DLT and blockchain can be leveraged to significantly reduce time and costs incurred during transactions. Besides transforming this market, the reduced time in processing of credit lines allows businesses to run more efficiently as they optimise working capital requirements.

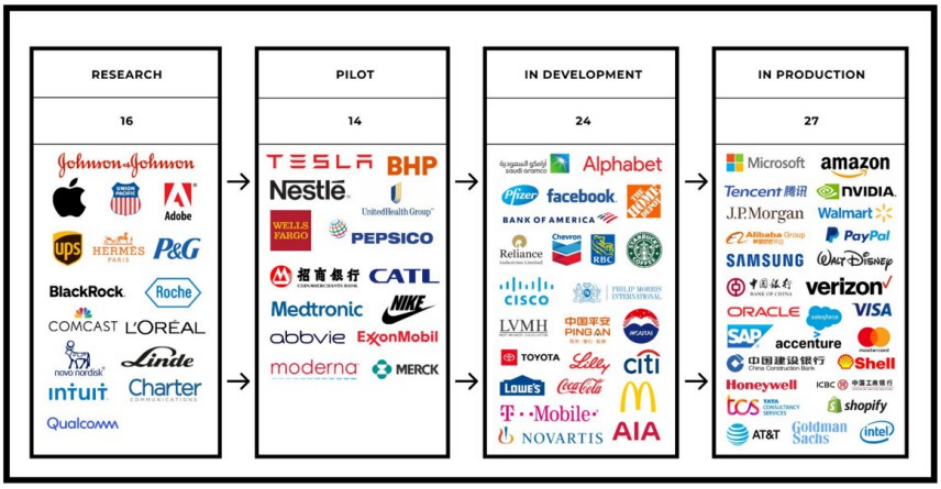
Financial Markets

DLT is also seeing adoption in financial markets. Besides what we discussed above, around new asset classes emerging (cryptos or tokenised assets), and long-term potential for the current market infrastructure to migrate on to a DLT set up, Decentralised Finance (DeFi) also deserves a mention. DeFi uses the technology to facilitate peer-to-peer transactions through the use of decentralised finance applications. DeFi aims to be an alternative to the traditional, central financial system as it focuses on reducing the impact of centralised entities on financial services and products.

While the promise of no intermediaries seems appealing, and DeFi proponents are pitching DeFi protocols as a way of improving the current financial system, in reality, we have not seen much evidence that DeFi protocols are a more efficient / effective version of the current financial system – rather DeFi protocols often seem to us as a way to attract cash flow to enrich the protocol operators. To this we need to add the fact that DeFi is hack-prone and at risk of financial crime given anonymity is a key feature. We think lack of KYC / AML will limit institutional involvement, and thus we don't see DeFi, in its pure decentralised form, becoming the new shadow banking system anytime soon - the need for KYC / AML will force DeFi to be more "centralised", in our view.

We recently published a note looking at DeFi and its potential.

Exhibit 11: Current users of DLT from the top 100 public companies



Source: BlockData

It is important to note the nuances about DLT's efficiency gains. DLTs often claims to be faster and cheaper than centralised data architecture. This is not always the case. As the technology is nascent, the benefits are highly dependent on the use case as the majority of efficiency gains are currently expected to come from disintermediation and savings in reconciliation.

Generally speaking it is more difficult for DLT to be considered a viable alternative in cases where existing architecture is already very efficient and already serves their intended purpose reasonably well. While theoretical use cases suggest reasonable improvement in efficiency, the technology is yet to demonstrate its superiority vs other solutions in many cases. Looking ahead, technological experimentation plays a critical role in assessing DLT's potential. As the technology is moving out of the shadows we are starting to see an open-minded willingness from a lot of large companies to experiment with DLT as they look to uncover the benefits while tackling the many challenges ahead.

What is the process of Tokenisation?

"Tokenisation" is nothing new

Press reports in the past year have frequently used the term "token" when discussing blockchain technology or cryptocurrency. **While the term is now frequently used, tokens and the concept of tokenisation have been around for a long time.**

Swapping assets or currencies for tokens had been common practice long before Bitcoin's creation in 2009. The act of tokenisation, while physical in nature, can be dated back to as early as the 16th century. Back then, the British empire suffered from a shortage of small coins for change. The government did not have the capacity to mint enough small coins, which were the primary means of exchange for merchants trading with urban areas. This forced merchants and local municipalities to mint their own tokens in order to facilitate trade. These tokens were made of copper, lead and tin and represented fractions of silver and gold coins. Throughout history there are other examples of tokenisation. Initially, it was used to reduce the risk of handling valuable items as financial instruments. Instead, surrogate equivalents (often coin shaped) were created to facilitate trade. A more recent example of tokens used in a closed environments are casino chips, which make the handling of money easier while reducing the risk of theft.

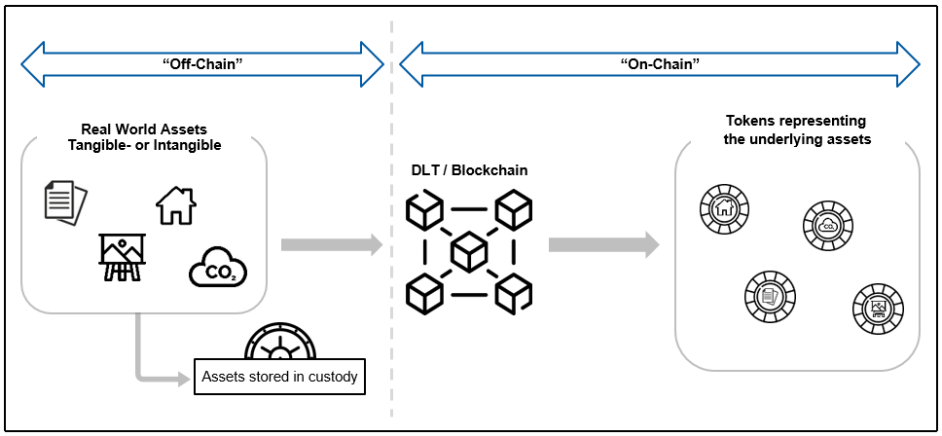
Tokenisation x Blockchain

"Tokenisation is the process of creating a digital token on the blockchain that represents a tangible and intangible asset. Common examples are financial securities, services, commodities or collectibles."

Tokenisation combined with blockchain has the potential to redefine how businesses and consumers operate across a wide variety of sectors in a global economy. This new combination comes with a wide variety of benefits and new use cases. Some of the examples are increasing operational efficiencies for companies, redefining asset ownership in the economy and empowering the creator economy.

Tokenisation creates a digital representation of a tangible or intangible asset on the blockchain, which is called a "token". **The token serves as an electronic certificate, representing the underlying asset and its properties.** The token becomes a medium of exchange for the holder who wants to exchange the ownership value of the underlying asset through trading the token. Benefits like transparency, integrity, and automated execution of transactions can be leveraged when assets are being tokenised and reflected on the blockchain or distributed ledger.

Exhibit 12: Tokenisation, the process of moving assets "on chain"



Source: Morgan Stanley Research

New Building Block

Tokenisation has the potential to change the way individuals and businesses operate within the economy, society and the political system. It serves as a new technological building block that at its core improves transparency and trust between actors in the economy and society.

Examples of impact on **businesses:**

- Execute contracts
- Supply chain & asset provenance
- Access capital markets

Examples of impact on **individuals:**

- Access to information
- Ownership of assets

Foundational, not disruptive

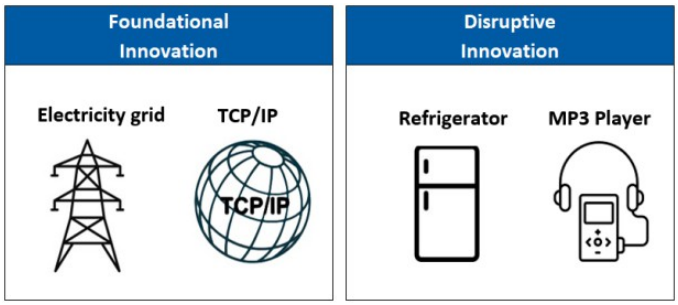
The benefits of DLT, which are in part unlocked through tokenisation, have the potential to impact society in a significant way. While we also agree on its potential, we don't believe that it is a disruptive technology as many claim it to be. Tokenisation and blockchain do not challenge traditional businesses and players with lower-cost services and replace incumbents quickly. Instead we believe this is a foundational technology. Powered by blockchain technology, tokenisation has the potential to create new foundations on which to build the economy and society. So rather than disruption, **we expect tokenisation to be a gradual force of change over the next decades as its impact increases, propelled by waves of technological innovation and adoption.**

Exhibit 13: Foundational vs Disruptive Technology

Foundational Innovation	Disruptive Innovation
foundation for **innovation in economic, political and social systems**	**challenges existing business model** through low costs, rapidly **overtaking incumbents**
abstract and **theoretical**	clear **business value proposition**
adoption takes **decades**	adoption takes **years**
enables new complex **systems**	enables **new applications**
requires decades of infrastructure development to allow adoption	almost **immediately allow disruption** of existing industry

Source: Morgan Stanley Research

Exhibit 14: Examples Foundational vs Disruptive Technology

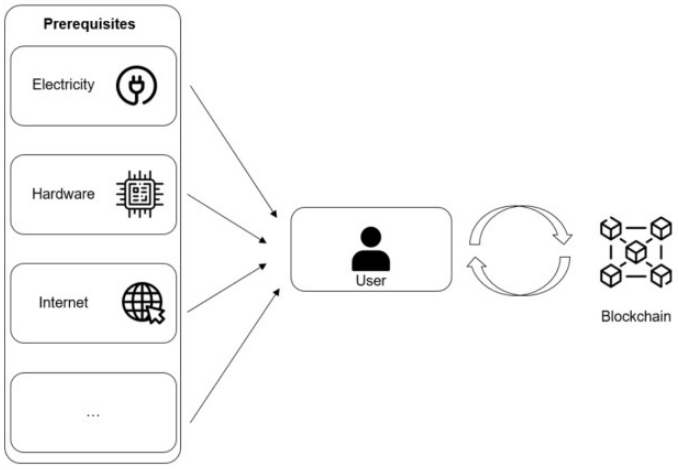


Source: Morgan Stanley Research

The prerequisites

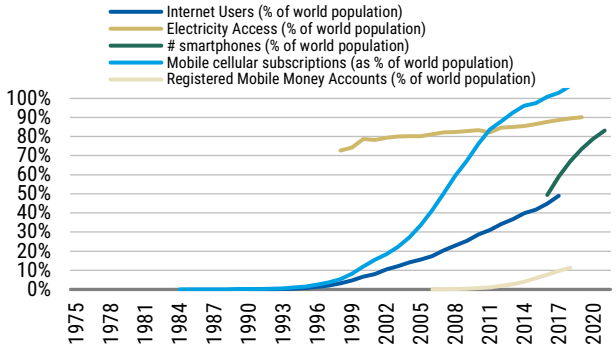
While tokenisation and blockchain have enormous potential, realistically it will take decades for the technology to become truly embedded in our economic and social systems. The technology is still nascent but many expect it to have the potential to fundamentally change the way companies and individuals operate within society. The infrastructure requirements and barriers to adoption are still significant and require time, e.g. in areas like technology, governance, infrastructure and other. Exhibit 15 gives an indication of the core pieces of infrastructure that are required to access tokenisation and blockchain technology. Electricity, Internet, Hardware and more are all prerequisites. This means the adoption of tokenisation and the technology is dependant on the adoption rates of these prerequisites. This required infrastructure needs to be available in full. Without it, users would not be able to interact with the distributed ledger or their wallet with tokens.

Exhibit 15: Required tech to interact with the blockchain



Source: Morgan Stanley Research

Exhibit 16: Technology Adoption



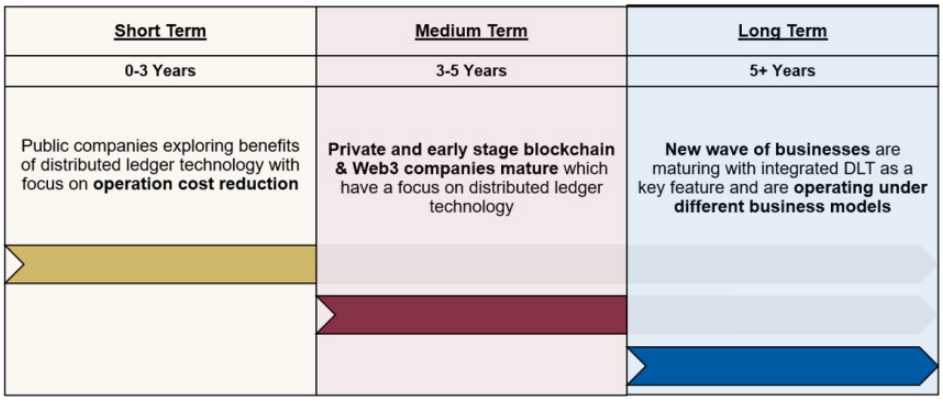
Source: Ourworldindata, Morgan Stanley Research

As mentioned before, the act of tokenising assets has been around for some time. To fully understand why blockchain technology and the act of tokenising assets on chain will have such a big impact we will need to have a closer look at the underlying technology, some use cases that are around already as well as clarifying some common misconceptions.

Chart Gallery

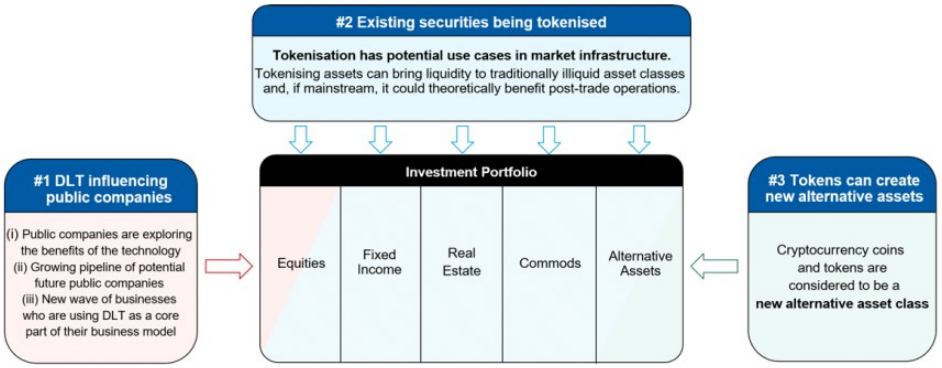
We use specific terminology throughout this report. While we attempt to explain as we go, please see the Glossary at the end of this note.

Exhibit 17: Tokenisation and distributed ledger technology is set to have an impact on public companies...



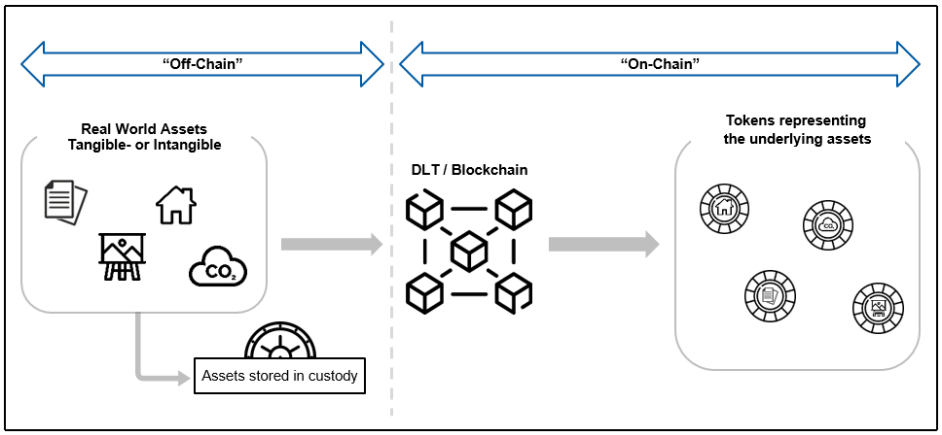
Source: Morgan Stanley Research

Exhibit 18: ...as well as on the broader investment portfolio



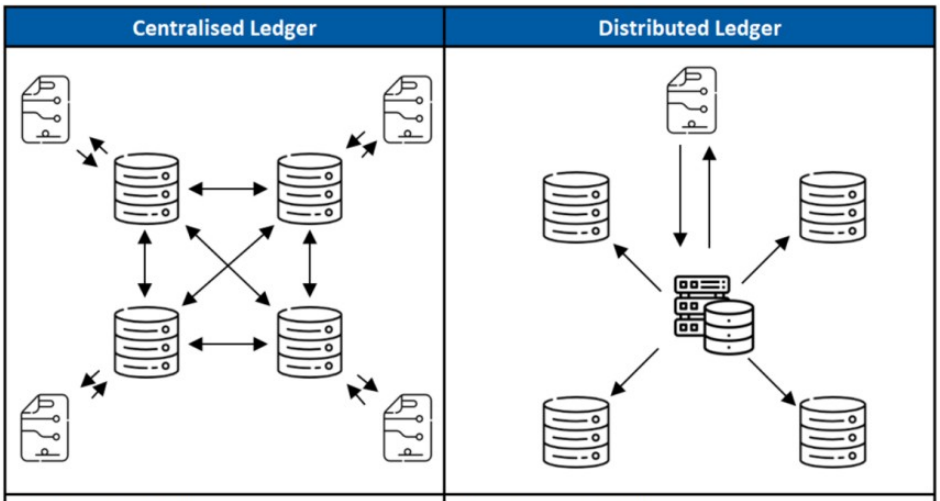
Source: Morgan Stanley Research

Exhibit 19: Tokenisation is the process of creating tokens that act as a digital representation of tangible/intangible assets and...



Source: Morgan Stanley Research

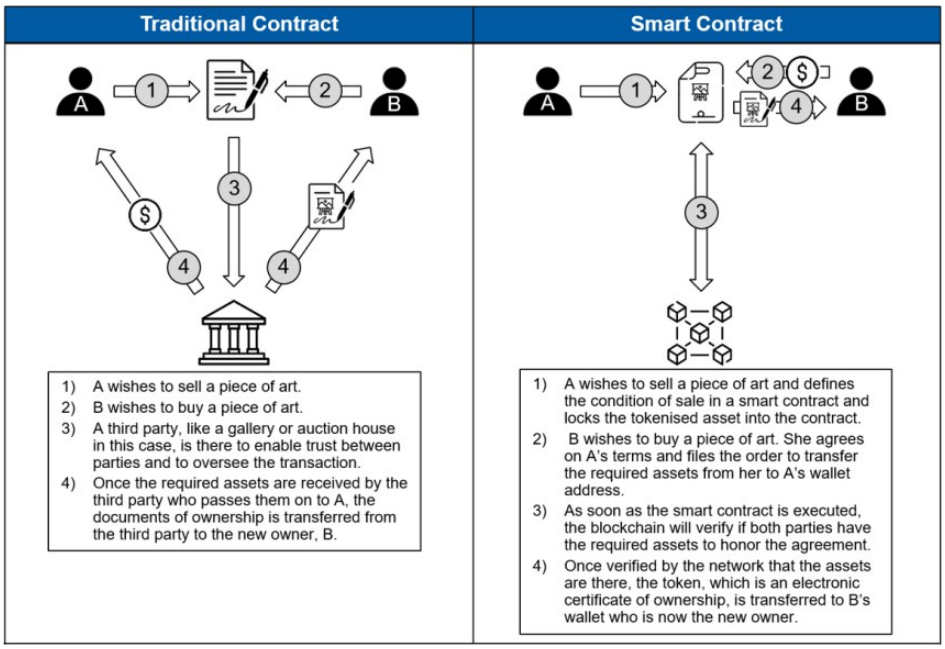
Exhibit 20: ...which is stored on a distributed ledger...



Centralised Ledger	Distributed Ledger
- Single point of failure	- No single point of failure
- Involved 3rd parties & middle man	- Peer-2-Peer
- Ledger governed by central entity	- Ledger governed by consensus
- Ledger backup required	- Resilience increases as participants grow
- Trust in central entity required	- No trust in central entity required

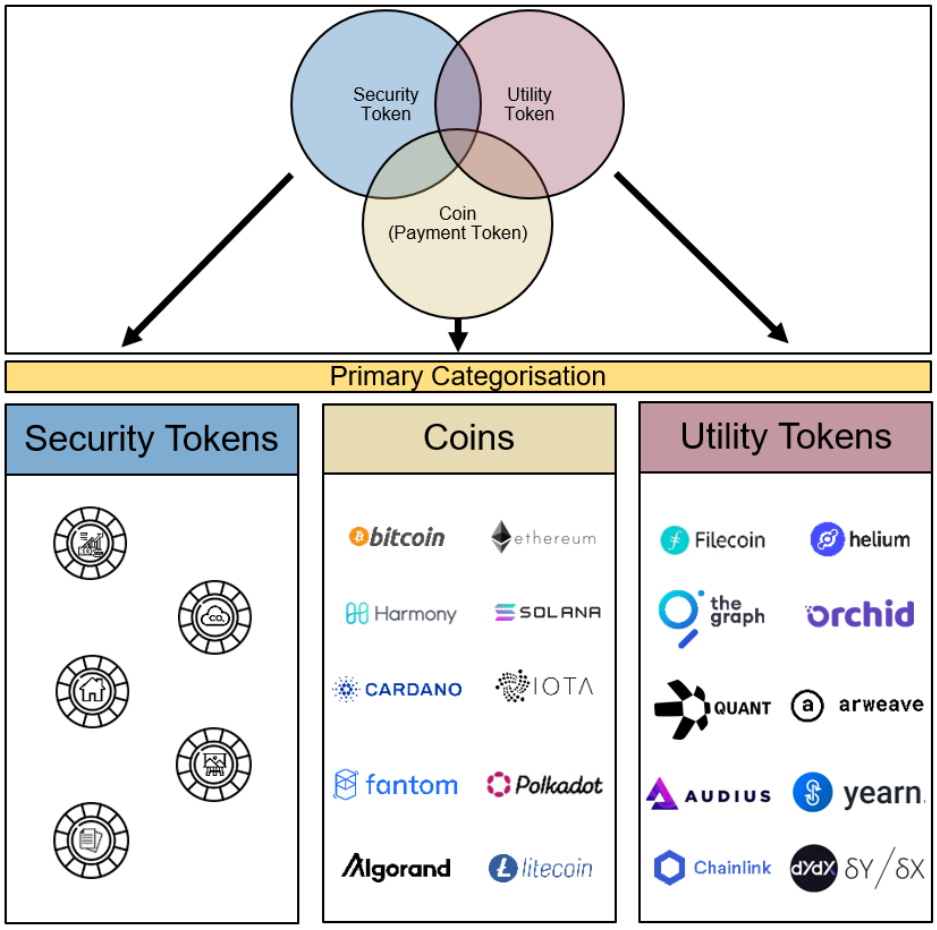
Source: Morgan Stanley Research

Exhibit 21: ...on which transactions are managed and controlled by smart contracts



Source: Morgan Stanley Research

Exhibit 22: Digital assets are the native assets that operate on the distributed ledger and can be divided up in Security Tokens, Utility Tokens and Coins...



Source: Morgan Stanley Research

Distributed Ledger Technology (DLT)

It is blockchain technology that brings additional value to tokenisation as it allows tangible and intangible assets to be put on the ledger. But what exactly is blockchain? What is the ledger? Why is it expected to be such a game changer for something as simple as tokenisation, which has been around for centuries?

Blockchain is a form of distributed ledger technology

There is a common misconception that Distributed Ledger Technology (DLT) and Blockchain are the same thing, mainly driven by the continuous headlines we have seen since 2017. Blockchain is actually the most popular form of distributed ledger technologies. There are currently five different types of DLT, categorised on how they store data on the ledger.

In essence, **a blockchain is a DLT where transactions are stored on an immutable ledger that consists of a string of blocks of data**. Each time new transactions are validated and stored on the ledger, a new block is added to the string of existing blocks.

What is DLT?

While the acronym DLT might sound like some kind of convoluted technological innovation, the term itself is actually very simple. Distributed Ledger Technology breaks up into:

1) Ledger

"A ledger is record-keeping system that keeps track of balances and records all transactions executed between different network participants"

Since the beginning of the trade economy, the ledger has taken a central role in recording and registering contract deals, payments and transactions. Evidence shows that the ledger has been used for over 5,000 years. The way ledgers are recorded has evolved over time. Initially materials like clay, papyrus and paper were frequently used together with the double entry system where two identical ledgers were maintained as verification. Distributed ledger technology can be seen as the next step in this evolution as ledger keeping and technology continue to intertwine. Information such as a registry, dataset, financial transactions and others can all be stored on the ledger.

2) Distributed

"Multiple parties hold a copy of the same ledger"

Distributed refers to the consensually shared and synchronised nature of the ledger, which is kept and stored across multiple locations and parties.

Distributed ledger technology is in essence a new way of keeping data. In the pre-digital age, ledgers were generally kept through the double entry method, used to instil trust

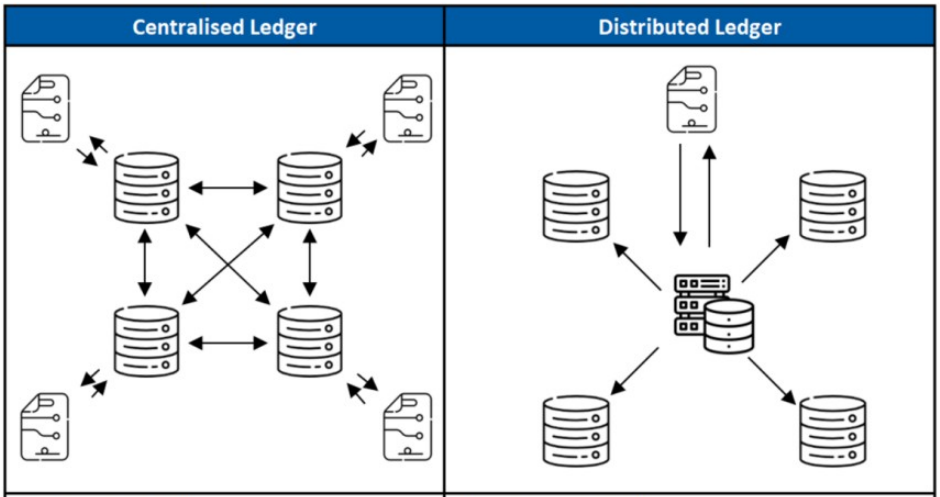
in the accuracy of the data. DLT is a database that exists across multiple locations. These locations can be situated across geographical locations and different participants. The database is stored in its entirety on each computer (node) on the network. This approach allows the ledger to be maintained on a peer-to-peer basis, effectively disintermediating any central party who usually is there to exercise oversight and instill trust in the database. The changes made to the ledger are reflected in the records of all computers (nodes), leaving all of them with the identical accurate representation (state) of the ledger.

DLT has the ability to store, record and exchange digital information amongst parties without the need for any centralised trusted authority. It is simply a new way to create a trusted ledger.

Traditionally data has been stored in a centralised database residing in one location with some possible back-ups. Benefits such as security and usability have historically outweighed the disadvantages of using central data storage. Recent technological innovation in distributed ledgers is now tipping the scale.

Data is becoming increasingly more important across different industries. As DLT is maturing, there is a clear choice to be made for organisations across the value chain between storing data in a centralised way or using distributed ledger technology. There are some clear differences between both ledgers in the way data is validated, processed and authenticated.

Exhibit 23: Centralised vs Distributed Ledger



Centralised Ledger	Distributed Ledger
- Single point of failure	- No single point of failure
- Involved 3rd parties & middle man	- Peer-2-Peer
- Ledger governed by central entity	- Ledger governed by consensus
- Ledger backup required	- Resilience increases as participants grow
- Trust in central entity required	- No trust in central entity required

Source: Morgan Stanley Research

In the context of centralised vs distributed ledgers it can feel like the term distributed and decentralised are synonymous. This is not true. The difference between both comes down to where the decision is made and where/how the ledger is physically stored.

- **Distributed ledger** means that the ledger is spread across various physical locations. The processing of ledger is done in multiple locations, however *the decision making* on the information on the ledger can be made in a centralised or decentralised manner.

- **Decentralised ledger** means that decisions on what information is stored on the ledger are made across different nodes or parties.

It is important to remember that "decentralised" is a subset of "distributed" and therefore all decentralised ledgers are by definition distributed but not necessarily the other way around.

Blockchain, one of many DLTs

All blockchain networks are distributed ledgers but not all of the distributed ledgers are blockchain networks. Blockchain is just one of (currently) five different type of DLTs. Out of the five, blockchain is the oldest and most popular one with the most applications.

Predating blockchain, the concept of a digital distributed ledger was theorised about in the 1990's and early 2000's. In 2009, Bitcoin was released, one of the first distributed ledgers that used a blockchain. Since then we have seen a rapid rise in the popularity of blockchain-based distributed ledgers like Ethereum, Hyperledger, Ripple, IOTA, etc.

To address the initial shortcomings of blockchain, other types of distributed ledgers have been created based on different concepts of ledger validation, all with the aim to improve the existing suite.

Given the pace at which DLT is evolving it is highly likely that more iterations of different types will be created. For now the five different types of DLT are:

- Blockchain
- Directed Acyclic Graph (DAG)
- Hashgraph
- Holochain
- Tempo

Blockchain still remains the most popular and attracts the most talent, likely because of the related tradable crypto asset market. With the constantly rising number of use cases of the technology, it is possible that another DLT becomes more suitable for a particular purpose. We know that blockchain has inherent inefficiencies related to how information on the ledger is validated. We discuss this later in the section on the blockchain trilemma. As development in competitor DLT data structures is young, it is unclear which of the above technologies will be perceived as most attractive over time. Currently we are seeing different blockchains being adopted for different use cases. Only time will tell whether there will end up being multiple types of DLTs or only a few.

It is even possible that the future of blockchain does not involve blockchain after all. At some point we might look back at blockchain as another failed experiment from which we learned valuable lessons. Despite this, DLT and blockchain currently present themselves as key building blocks in facilitating P2P interactions in the economy and broader society.

Exhibit 24 provides key characteristics of each of the distributed ledgers as well as their benefits and challenges.

Exhibit 24: Five types of Distributed Ledger Technology

DLT Technologies	Blockchain	DAG	Hashgraph	Holochain	Tempo
Time of Inception	2008	2015	2018	2018	2021
Examples	Bitcoin, Ethereum	NXT, Corda, Byteball	Hedera, Noia, Mingo	Holochain	Radix DLT
Tech	Structured via blocks, which are ordered in a linear sequence. It is comparable to a long list of records	Uses a non-linear data structure, allowing transactions to be completed in non-linear sequence	Multiple transactions can be stored on the ledger on the same timestamp	All nodes can validate the DLT independently without any forced consensus	Every node keeps a small part of the ledger, the nodes broadcast all their info to synchronise the shard
How is the Ledger Validated?	**Consensus** algorithms help nodes make the right decision	**Parallel Lined Transactions** Every transaction validates another one. Users are both miners and validators	**Virtual Voting** Faster agreement as each hashgraph has a copy of the node to predict other nodes' finding	**User Empowered** Users control data on the DLT, encouraging empowerment	**Logical Clocks** Rather than timestamps, it remembers transaction sequence to reach consensus
Transactions Per Second (TPS)	**Up to 100,000**	**Virtually uncapped**	**250,000+**	**Doesn't measure TPS**	**1,000,000+**
Pro	• Most established DLT with strong backing • Offers guarantees and cost efficient transactions	• Lower transaction fees • Speed increases as network grows • More decentralised given no requirement for miners	• Great speed due to instant sharing of data between participants • Transactions are processed in parallel, further increasing speed	• Energy efficient as all computational power is optimally used • Enabled edge devices, like smartphones, to act as part of the network	• Only the transactions where there is a conflict are validating, increasing speed • No need for special hardware to create dApps, coins or tokens
Cons	• Volume growth increases storage and bandwidth • Can be energy intensive • Relatively high transaction fees vs other DLTs	• High level of traffic needed to be able to operate • Fluctuations in network traffic leaves network susceptible to attacks	• Tech is not open source and has been patented, hurting decentralisation • Speed has been tested in static and private settings only	• Takes significant effort to protect private or secret data • Not efficient when running large datasets	• Still under development • Competing with other DLTs that are further in adoption cycle that have more mature ecosystems and developer communities

Source: Morgan Stanley Research

Why do we need more than one chain? Solving the Trilemma

There is a clear network effect to be gained if all stakeholders of a certain valuechain operate on the same blockchain. So why are there multiple blockchains and why more still being created today? There is a school of thought with developers who believe that the blockchain data structure itself has limitations that prevent it from scaling. Others believe that it is possible to scale without compromises, however this currently remains unproven. To solve for shortcomings of existing chains, new projects are continuously being launched which aim to solve scaling of the network without compromising in security or decentralisation. These new projects come in the form of either new blockchains or as new DLTs completely.

The trilemma is a model to conceptualise challenges that blockchain faces (Exhibit 25). It is important to note that there is no theoretical rule stating that all three aspects cannot be achieved at the same time. However a blockchain that has high scalability, high security and is decentralised is yet to be created. The roadmaps of some of the

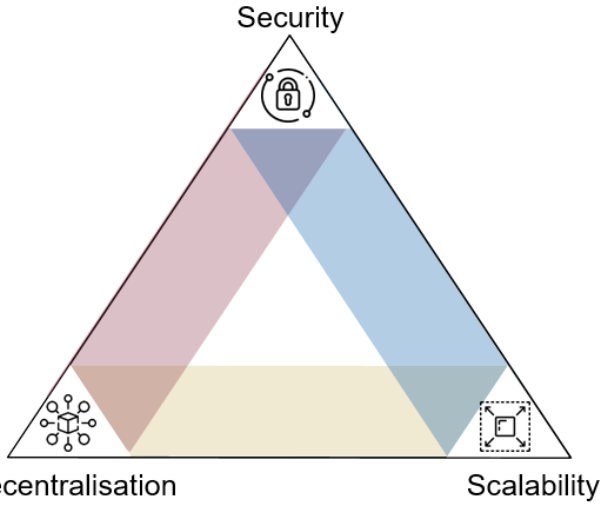
bluechip chains look promising however solving the trilemma has yet to be proven possible.

The blockchain trilemma is the concept that refers to the three main issues that developers encounter when building blockchains. Generally developers have to sacrifice one of the dimensions of the blockchain for the sake of the other two. These three dimensions are the following.

- **Security** - The blockchain can defend itself from issues, attacks and bugs
- **Scalability** - The blockchain can handle a large amount of transactions or throughput
- **Decentralisation** - The blockchain does not rely on a central point of control or is susceptible to single point of failure

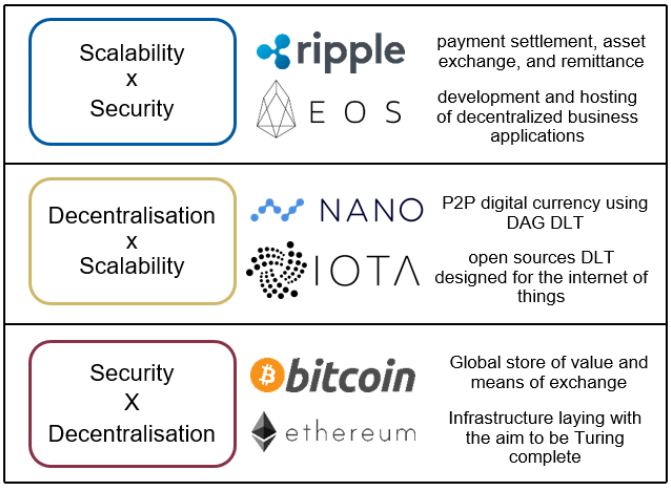
Depending on what type of data is stored on the chain or what type of users interact with the blockchain, the requirements for a certain level of security, scalability and decentralisation is required. Solving the trilemma is perceived as the 'holy grail' of blockchain and DLT. Given there is currently no single blockchain that perfectly integrates all three requirements, there is a place for multiple blockchains. Through changes in certain elements of the chain such as the consensus mechanism, the number of validators the blockspeed, blockchains position themselves to cater for specific use cases..

Exhibit 25: Blockchain Trilemma



Source: Morgan Stanley Research

Exhibit 26: Examples of blockchain trilemma



Source: Morgan Stanley Research

Below some examples of where some chains sit on the trilemma spectrum.

- **Scalability x Security** - Ripple (used for payment settlement, asset exchange, and remittance systems or international money and security transfers), EOS.IO (enables the development and hosting of decentralised business applications).
- **Decentralisation x Scalability** - IOTA (open sources DLT designed for the internet of things), Nano (P2P digital currency using DAG DLT).

- **Security x Decentralisation** - Bitcoin, Ethereum.

It is worth noting that the examples above are not static. Developers are constantly improving the chains through updates and forks. The best known example of this is Ethereum. In 2020 it started the migration to a new consensus mechanism, moving from Proof-of-Work to Proof-of-Stake. In doing so it hopes to solve for the scalability limitations of the chain while maintaining similar levels of decentralisation and security.

It also needs to be noted that categorising blockchains across the trilemma can be an arbitrary exercise. Scalability is often measured in throughput or transactions per seconds (TPS). This is quantitatively measure and can therefore be benchmarked. For decentralisation and security it tends to be quite different. Defining which chain is more decentralised or more secure is a difficult exercise as these characteristics are not simply measured by one or few metrics. They are more qualitative in nature and there is still debate in the community about when something can be considered decentralised or secure.

Permissions on the blockchain

It is important to note that, while the blockchain trilemma applies to all blockchains, it is most important for permissionless blockchains.

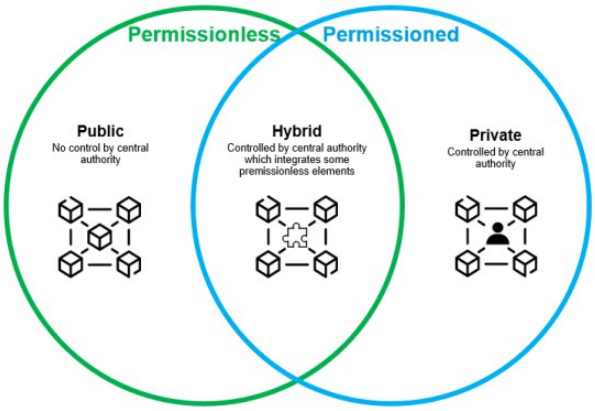
- **Permissioned** - Are closed or have an access control layer. This means that only pre-cleared participants can perform actions on the blockchain or access its data. Only a private group or individual has the authority to use the chain. These type of chains are often used by organisations handling proprietary or sensitive data.

- **Permissionless** - Are the opposite from permissioned. Anyone, without restrictions, can take part in the network and access information. These blockchains are the most decentralised and open to the public. Chain explorers provide transparency of the ledger and coin ownership is often a prerequisite for block validation.

Given that access to the blockchain has to be granted for a **permissioned network**, the level of decentralisation is less important as this can easily be adjusted for by the authorised organisation or individual. That is why generally speaking permissioned networks are more centralised than permissionless networks. This is because the number of stakeholders who need to interact with the permissioned is usually lower. The upside from a permissioned, less decentralised network is that there is a higher degree of customisation and scalability.

Given the fact that the **permissionless network** is public, they are generally less scalable because it takes more effort to reach consensus to approve transactions when there are more validators. Something that generally takes more time vs with a few authorised people. The upside is that transparency of the ledger is higher because anyone can access the data and there is no control layer for access making barriers to entry lower.

Exhibit 27: Public & Private networks



Source: Morgan Stanley Research

Exhibit 28: Permissionless vs. Permissioned

Permissionless	Permissioned
Public - no requirements to join	**Closed** - Requires permission
Fully **decentralised**	**Centralised** or **decencentralised**
Transactions are **transparent**	Transactions are **private**
Difficult to scale	Easy to scale
Open-source	**Developped private**
Trustless	Trusted

Source: Morgan Stanley Research

Challenges ahead

DLT and blockchain are still emerging technologies. Despite the promising potential there are still shortcomings and unanswered questions. Below a list of some of the challenges that lie ahead for DLT and blockchain. Some are speedbumps, others are potential roadblocks:

- Uncertainty of regulation
- Lack of proof of concept on global scale
- Balancing transparency, security and privacy
- Energy-intensity

How is the data managed and controlled? Enter Smart Contracts

As discussed before, DLT are ledgers that empower existing businesses and new ecosystem based business models. The type of information stored on DLT materialises in the shape of tokens. These DLT-based tokens are generic in nature and represent a wide variety of things. From representing assets to unlocking some service or even a means of exchange, tokens can represent a wide variety of things.

All these tokens are controlled and managed by smart contracts. These smart contracts operate on top of the blockchain/DLT and execute certain actions automatically based on specified prerequisites or conditions. Smart contracts are guided by code and can be highly tailored to the needs of the chain or its actors.

Smart contracts manage tokens on the DLT and mainly facilitate execution of agreements between parties. Because the smart contract is completely code based and sits on the blockchain there are some benefits as well as some challenges to using smart contracts versus a centralised approach of transaction execution.

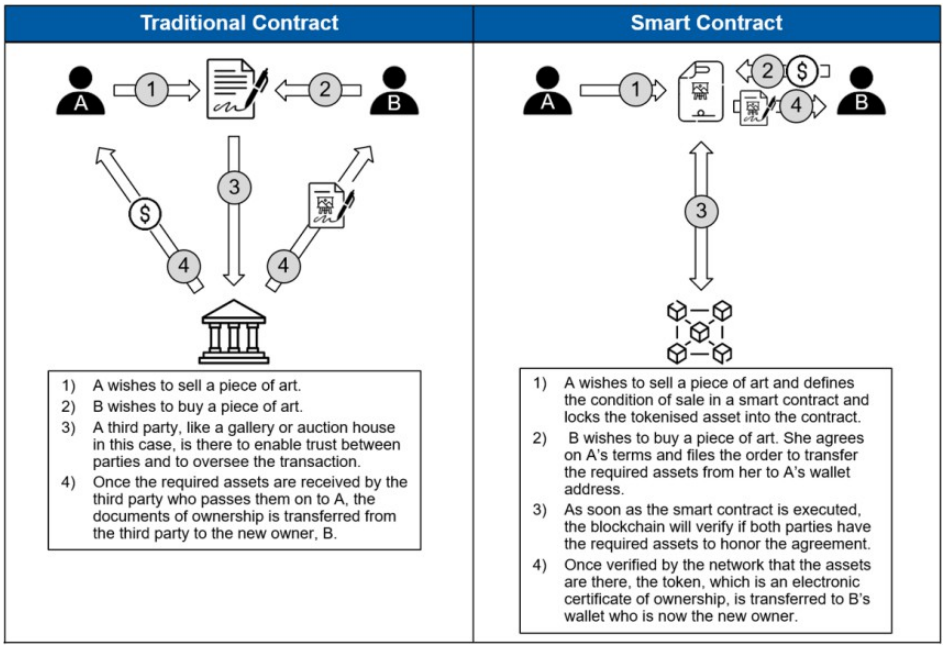
Benefits:

- **Speed** - Smart contracts automate transactions, saving time in processing.
- **Security** - Smart contracts are encrypted, keeping information secure.
- **Accuracy** - Automated contract execution eliminates errors during the execution process.
- **Neutrality** - Contract execution is ruled based and actions taken are unbiased, purely based on code.

Challenges:

- **Changeability** - Errors in the initial written code are difficult to change one the contact is in use.
- **Potential loopholes** - The written code is purely transactional in nature. Whether or not parties act in good faith cannot be verified purely on code based transactions.
- **Terms definition** - Traditional contracts can be opaque, therefore it is not always easy to translate the existing contracts into a pure code based set of rules.
- **High difficulty and high risk** - DLT users frequently need to interact with smart contracts however in its current state only specialised individuals know how to create them. The cost of loopholes and exploits in the code can be economically significant, making it punishing for entry level users.

Exhibit 29: Traditional- vs Smart Contract Execution



Source: Morgan Stanley Research

It is important to note that smart contracts can only base their actions on the available information on chain. So there is a need to feed smart contracts real world data or data

from other chains if it is needed as condition for the contract to be executed. This need is taken care of by oracle nodes such as Chainlink which will be discussed below.

Coins & Tokens

In this section, we clarify some of the terminology used in the cryptocurrency and blockchain areas as this is key to understanding the implications of the technology.

Digital Assets

So what exactly are cryptocurrency, coins and tokens? To answer that question it is easiest to start with what they all have in common. They are all digital assets.

Digital assets are non-tangible assets that are stored in a digital format. Other examples of digital assets are images, PDFs, spreadsheets, and audio files. The definition of digital assets is ever expanding as technology evolves but in essence a digital asset can be any content, stored in any type of digital format, that provides value to the holder of the asset or others.

Within blockchain, coins and tokens serve as the main digital assets. Coins and tokens are a subclass of digital assets that leverage cryptographic technology to guarantee authenticity of the digital asset. In doing so it removes the risks that the digital asset gets counterfeited or in the case of a digital currency (coins) that there is double spending.

Coins & Tokens

Coins and tokens are both digital assets that leverage cryptographic technology. The key difference between these two digital assets is that coins (or cryptocurrencies) are the native asset of a blockchain and tokens are operating on an existing blockchain. Both coins and tokens are traded on cryptocurrency exchanges.

Exhibit 30: Coins vs Tokens

COIN	TOKEN
Build into a blockchain (native to its own)	Build on top of existing blockchain
Store of value & means of exchange	Valued by finite amount of merchants & platforms
Coins distributed mainly through mining	Tokens distributed through drops, offerings, tokenomics
Requires significant resources and know-how	Easy to create
Examples	**Examples**
Bitcoin, Litecoin, Ripple	USDT, Chainlink, VeChain

Source: Morgan Stanley Research

1. Coins

A coin, or sometimes referred to as a payment token, is an asset that operates on its own blockchain network. For example bitcoin (BTC) operates on the Bitcoin network and ether (ETH) operates on the Ethereum network. These coins are generated by the native

blockchain protocol as a reward for validating transactions. **Coins can be traded or can be used as a medium of exchange on the blockchain. Many users consider these coins to be stores of value**. In much the same way, coins act as traditional money for users who use the blockchain to do transactions. If someone wants to use a specific blockchain (e.g. Ethereum) to do a transaction, the user needs to pay transaction fees in the native coin of the chain (i.e. ETH).

Exhibit 31: 10 largest cryptocurrencies by market capitalisation

Coin symbol	Coin name	Price (USD)	Market capitalisation (USDbn)	No. of tokens (mn)	Volume traded in 24h (USDbn)	7 day price change (%)	30 day price change (%)
BTC	Bitcoin	$29908	569.37	19	23.78	-15.9%	-25.2%
ETH	Ethereum	$2041.64	246.48	121	13.20	-22.7%	-32.5%
USDT	Tether	$1.003	75.96	75752	51.72	0.1%	0.1%
USDC	USD Coin	$1.005	51.30	51080	9.28	0.8%	0.6%
BNB	BNB	$294.72	49.45	168	1.94	-19.5%	-29.0%
XRP	XRP	$0.43	20.59	48343	2.45	-27.0%	-41.4%
ADA	Cardano	$0.53	18.01	33820	0.87	-30.1%	-42.8%
BUSD	Binance USD	$1.006	17.88	17735	13.33	0.8%	0.7%
SOL	Solana	$51.29	17.28	337	1.36	-35.2%	-49.1%
DOT	Polkadot	$11.29	12.56	1112	1.00	-18.2%	-37.1%

Source: Coingecko, Cryptocompare, Morgan Stanley Research. As of 15-May-22

2. Token

Tokens represent either (i) units of value of projects that organisations or individuals build on top of an existing blockchain or (ii) intangible or tangible assets. Generally tokens have far more versatility than coins. Because tokens are built on top of another blockchain, which operate through coins, tokens and coins can be subject to similar dynamics. Despite this they are a completely different type of digital asset with their own use cases.

With the blockchain industry going mainstream, we expect the number of use cases for tokens will grow as they will be embraced by a wider audience of corporate and individual users. For the moment tokens are categorised in two separate segments based on the purpose they serve. These are utility tokens and security tokens.

Exhibit 32: 10 largest tokens by market capitalisation

Coin symbol	Coin name	Price (USD)	Market capitalisation (USDbn)	No. of tokens (mn)	Volume traded in 24h (USDbn)	7 day price change (%)	30 day price change (%)
LEO	LEO Token	$4.94	4.62	936	0.00	-6.0%	-13.8%
FTT	FTX Token	$31.42	4.29	137	0.04	-10.6%	-24.8%
LINK	Chainlink	$7.32	3.40	467	0.43	-28.7%	-46.5%
UNI	Uniswap	$5.2	2.37	456	0.15	-27.7%	-45.1%
MANA	Decentraland	$1.27	1.92	1506	1.29	-7.8%	-40.0%
FIL	Filecoin	$8.69	1.78	205	0.19	-34.6%	-53.5%
AXS	Axie Infinity	$22.26	1.74	78	0.41	-22.8%	-52.5%
SAND	The Sandbox	$1.38	1.68	1228	0.56	-29.6%	-50.6%
CAKE	PancakeSwap	$4.25	1.26	296	0.08	-41.6%	-46.5%
AAVE	Aave	$87.47	1.20	14	0.15	-34.0%	-49.2%

Source: Coingecko, Cryptocompare, Morgan Stanley Research, As of 15-May-22

Example Utility Token

Chainlink and its token LINK is an example of a utility token that needs to be paid in order to unlock the service that Chainlink has to offer. We will describe below how Chainlink works as an example but note that there are hundreds of utility tokens in the market.

What is Chainlink? Founded in June 2017, Chainlink is a project that aims to incentivise a global network to provide real-world data to different blockchains and smart contracts. The project is solving for the "oracle problem" which refers to the limitation of distributed ledgers and smart contracts in that they cannot obtain information outside their network. Instead they rely on external sources to provide the information. Smart contracts only have access to information that is already "on chain" such as historical transactions, wallet addresses, and tokens. To solve this, Chainlink has developed technology to aggregate and translate real-world information and provide it to the blockchain and smart contracts. Doing so significantly widens the use case of blockchains and smart contracts.

How does Chainlink work? It uses a network of decentralised nodes (computers) that are tasked with supplying real world (off-blockchain) information. This data can be simple, like answers to questions such as "What is the current temperature in London?" or "What is the colour of grass?". The process starts with smart contracts, which sit on top of a blockchain, requesting specific information from the Chainlink Network. The smart contracts can choose specific nodes to provide the data or they can rely on Chainlink's process to identify the nodes. Once appointed, the nodes collect the data through external sources and reach a consensus on what the correct data is before sending it to the smart contract.

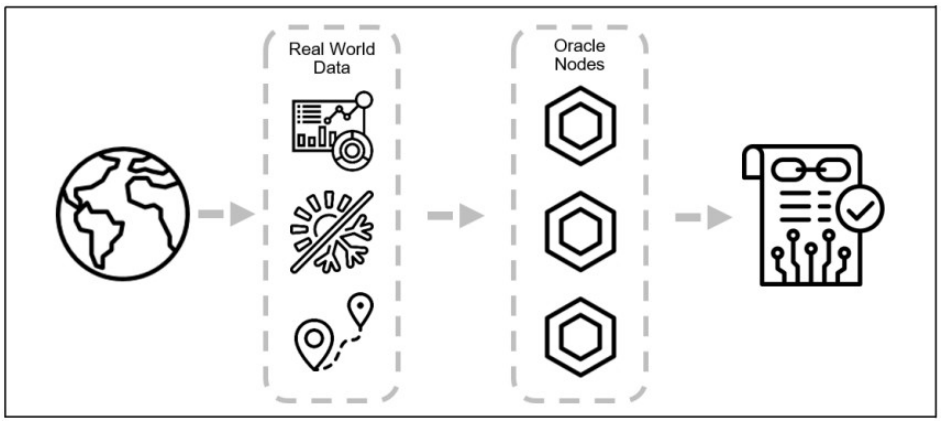
What is the utility of the token? LINK is the utility token used by the Chainlink network and is running on the Ethereum blockchain. There is no minting (creation) or burning (destruction) of the tokens so the LINK supply is fixed at 1 billion of which 467 million are in circulation. This means price action for LINK is driven by supply/demand dynamics. LINK plays a key role as it is the only currency that can be used to interact with the Chainlink network. As an incentive for nodes to provide the external information to the smart contracts, they get remunerated in LINK tokens for operating the node. The number of LINK tokens required for the service is determined by the Chainlink node operators and depends on demand dynamics of new information requests. To incentive service continuity, the nodes are required to stake (lock in) LINK tokens to demonstrate their commitment. In case nodes deliver wrong information they might be penalised and see their LINK stake being reduced.

Chainlink continues to expand support to other blockchain environments as adoption of smart contracts and blockchain drives the demand for Chainlink's services. As of end 2021 the Chainlink Network is connected to +1,000 projects, which are supported by +700 Oracles who in total delivered 1.1 billion data-points on chain over the year (Exhibit 34).

2a. Utility token

A utility token is a token that has a form of functionality within the blockchain network it inhabits. At its core, the utility token allows the owner to perform a certain action on the network. In reality this translates in a wide variety of possible use cases. **A utility token unlocks a product, service or even both for the holder.** Utility tokens can serve any purpose the developer has in mind and the tokens are required to access the service or product on the blockchain ecosystem. **While coins (payment tokens) are seen as digital money, utility tokens can be compared to parts of software.** Utility tokens can be used by some as a store of value, however it is normally not part of their core design.

Exhibit 33: Chainlink providing real world data to smart contracts



Source: Morgan Stanley Research

Exhibit 34: 2021 Chainlink Dashboard

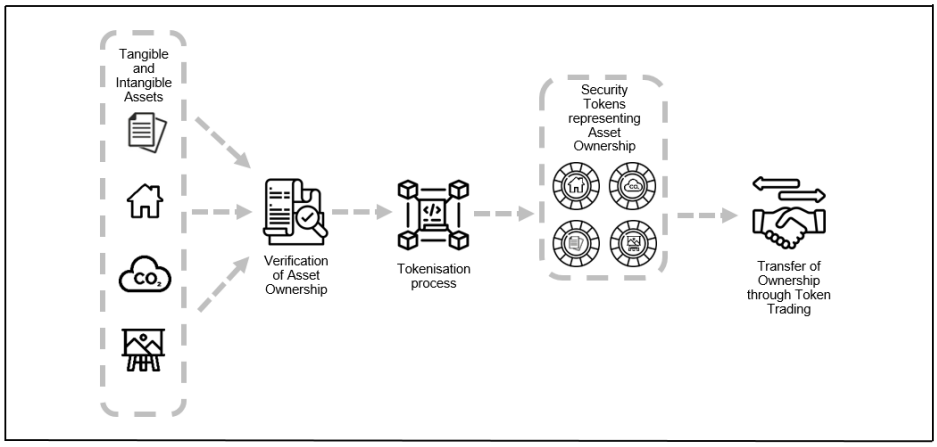
Source: Chainlink

2b. Security Token

A security token or asset token is a digital representation of a tangible or intangible asset on the blockchain that indicates right of ownership to that specific asset. Initially, security tokens mainly represented a right of ownership to a part of a company. They serve as electronic certificates to shares or stocks. As blockchain technology is becoming

more widely adopted, the range of assets that back up these tokens are increasing. Tokenisation of tangible assets is intuitive and was therefore one of the early use cases of tokenisation. Recently we have also seen real world examples of tokenisation of intangible assets such as deeds, intellectual property rights and others.

Exhibit 35: Tokenisation of Tangible/Intangible Assets



Source: Morgan Stanley Research

Tokenisations of assets and putting them "on chain" allows asset owners to leverage benefits of the distributed ledger such as increased transparency, liquidity and the instant finality of the transfer of ownership. As the use cases of security tokens increase, we are seeing a wider variety of assets being tokenised as well as an increase in the number of tangible and intangible assets being tokenised. Once an asset is tokenised, the information of the asset is coded and stored in the security token. This information reflects the characteristics of the underlying asset and can include details on the asset type, ownership, valuation, legal framework, optionality, and settlement requirements, among other elements. This enables significant customisation of the token by the issuer and owner.

Below are some common examples of assets that can be tokenised.

Tangible assets tokenised:

- Precious Metals – Gold, Silver
- Commodities – Oil, Minerals, Coal, Carbon Certificates
- Real Estate – Individual and clusters of property

Intangible assets tokenised:

- Intellectual Property - Trade Secrets, Patents, Trademarks, Copyrights
- Deed
- Licences
- Customer Lists

Example - Tokenised Equity

Tokenisation of equity is one of the frequently used cases of security tokens. These tokens are a digital representation of equity shares and the process of tokenisation can be compared to asset-backed securitisation on a blockchain.

Benefits of Equity Tokenisation

- **24/7 Trading** - There are no constraints on the trading hours of tokenised equities. They can be traded around the clock.
- **Fractionalised ownership** - We see this being integrated with some traditional brokers already but tokenised equity allows for fractual share ownership, meaning investors don't need to buy entire shares.
- **Accessibility** - People worldwide can access the shares which was previously not the case for some markets.
- **Instant settlement** - Currently the benchmark in equities is a T+2 settlement. Due to nearly instant finality of transactions on the blockchain, settlement happens almost directly after completing the transaction.

Due to the accessibility granted by tokenising equity it is most common for private firms, without publicly traded shares, to tokenise equity. The increased accessibility to equity through tokenisation benefits both the issuer and the investor.

- **Issuer** - private market players like private equity and venture capital have broader access to capital markets.
- **Investor** - democratisation of capital markets as barriers to entry are lowered for investors who previously had no access to investment opportunities.

Generally there are two different ways to trade tokenised equity.

1. Tokenised equity traded through Centralised Exchanges (CEX)

Centralised crypto exchanges are similar to traditional exchanges. **CEXs are organisations that coordinate trading of digital assets on a large scale**. They typically keep order books of buyers and sellers and act as a central party that matches up both sides of the transaction based on order volume and prices.

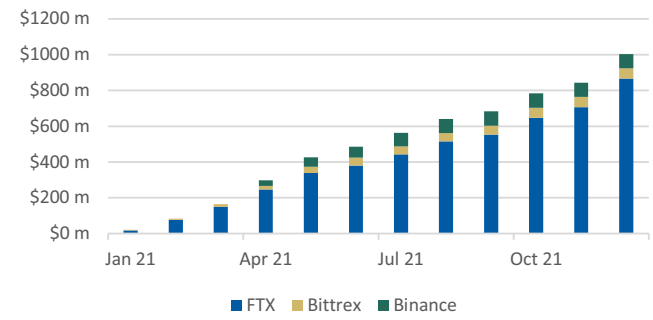
In 2021 we saw strong momentum in the tokenisation of stocks. It was the year in which three of the larger crypto exchanges trialed the trading of tokenised equity. Bittrex and FTX are currently the two largest platforms offering tokenised equities. These exchanges provide the opportunity for investors to buy tokenised equity but they are not the custodian of the underlying asset. Instead they rely on other companies, like Digital Assets AG, to do the operational and custody side of the tokenisation. Holders of the tokenised assets have dividend rights and can redeem the tokenised stock for the actual underlying asset, meaning the token is fully asset-backed.

In total, 28 stocks were tokenised and traded by the crypto exchanges in 2021 for a total volume of $1bn throughout the year. While still relatively small, it's an upward sloping trend. Tesla, Facebook, Amazon and Apple were all amongst the shares that got tokenised. FTX remains the largest exchange offering tokenised equities but this is a business model that will be replicated by smaller crypto exchanges as well as traditional exchanges.

To be clear, this process is different from issuing shares directly on the DLT: issuing shares directly on the DLT would make the post-trade operations simpler and more efficient when it comes to corporate actions for example, whereas tokenising shares as described here increases trading hours, allows for fractionalised ownership and instant settlement, but still relies on the existing market infrastructure as far as custody and post-trade operations are concerned, for example.

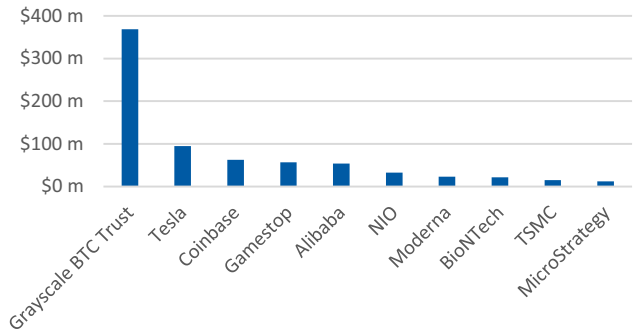
In Europe regulators are currently more strict on exchanges offering tokenised equity trading. In 2021 some crypto exchanges attracted attention from the UK (FCA) and German (BaFin) regulators after announcing the intentions to offer tokenised equity to European investors. While there is currently little clarity on the regulatory framework, the FCA confirmed that it is working with the exchanges to understand the product and the potential regulations that might apply. This is in contrast with the US where the regulator is allowing the tokenised equity to be traded. Until the tokens are more widely accepted by regulators globally the growth opportunities of the product outside of the US remain limited.

Exhibit 36: Cumulative tokenised equity traded on centralised exchanges



Source: Binance, Bittrex, FTX

Exhibit 37: Top 10 tokenised shares traded on FTX in 2021 by volume



Source: FTX

2. Tokenised equity traded through Decentralised Exchanges (DEX)

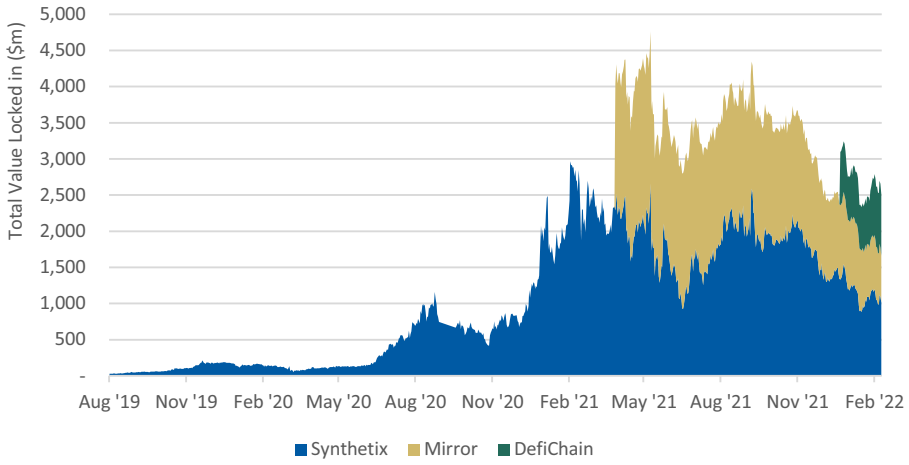
Decentralised exchanges are another type of exchange on which only digital assets get traded. **DEXs allow for direct peer-to-peer transactions in which there is no centralised party and traders interact directly with one another.** Decentralised exchanges are part of Decentralised Finance which we recently explored in depth in this report, Cryptocurrency & Banks: Decentralised Finance (DeFi): An Alternative Financial System?

Through protocols like Synthetix, Mirror and DeFiChain, investors can purchase tokenised shares of companies. The full explanation of how these protocols work is out of scope for this note. However what is important here is that the shares that trade on the protocols are synthetic shares. The price of these synthetic shares track the price of the actual company share, however the synthetic share is not backed by an actual

company share. Instead the synthetic share is backed by stablecoins, which reflect the value of the actual company share. The amount of stablecoins by which the tokenised share is collateralised is governed by smart contracts, which automatically add or reduce stablecoins to reflect the price movement of the actual company share.

While synthetic shares increase the liquidity at which shares can be traded, the downside is that owners of the token never receive voting rights or dividends of the shares as there is no ownership of the actual company share. It is simply pure exposure to the price action of the company share it mimics.

Exhibit 38: Total Value locked into the Mirror, Synthetix & DefiChain protocol



Source: DefiLama

There is an obvious risk that the value of the collateralised underlying asset (i.e. the stablecoins) does not reflect the same value of the actual traded shares. Currently this happens quite often and arbitrageurs rapidly trade the opportunity and close the spread between both the synthetic and actual share.

What is the intrinsic value of tokens?

We have been writing about cryptocurrency markets and prices in our other research reports. The market price of cryptocurrencies fluctuates every day in US dollar terms, in the same way that a company's equity price fluctuates. Investors will ascribe value to a digital asset for a variety of reasons but value shouldn't be confused with price as of today.

The price of cryptocurrencies and related digital assets rose dramatically in 2020 and 2021 due to global monetary and government stimulus, leading the crypto markets to trade in a speculative manner. Until cryptocurrencies, such as bitcoin, are used as currencies, they will retain a high correlation with global risk taking as represented by equity markets. There are however thousands of digital assets, all of which have a different purpose and user base. In our report, Cryptocurrency: High leverage meet regulation, when we considered the growth of the crypto industry, we suggested that in the end, the value of these crypto and digital assets will be related to their ultimate usefulness in our day-to-day lives, the demand side of the supply/demand balance. In the section below we list some of the factors that are considered to provide value by

the various types tokens.

Based on the classification of 'utility' and 'security' tokens, it can feel like the classifications of tokens is clear cut. This is untrue, often tokens have elements of both utility and security. And to make it even more complicated, the classification is not static. As the use case or value of a token within its ecosystem changes, the classification of the token can change as well.

Intrinsic value in tokens can in large part be brought back to the classification of the tokens. In order to value a token one first needs to know (i) what utility the token has within its ecosystem (ii) and what assets, if any, the token is backed by. As tokens become more complex and they adopt elements of both a security and utility token, it becomes more difficult to value them. The expectation is that token complexity will only increase as use cases for tokens find their way into new industries. In this report, we won't lay out a complete valuation methodology, but we will describe the building blocks as we explore how users may consider value within tokens.

1. Security token

Using the traditional financial framework, defining the value of security tokens is relatively straightforward. The token derives its value from the underlying tangible or intangible asset. When holding a security token, you, in theory, hold the same value as you would if you directly held the backed asset instead. For security tokens, the token itself just represents an electronic certificate of asset ownership. There are some cases where there is value to be ascribed to the benefits unlocked through the asset being tokenised vs the outright physical asset; however these cases are rare and will not be taken into account in the below.

The security token's value can be estimated using more traditional valuation frameworks. The (i) **market approach**, where you look at the value of comparable assets or (ii) **income approach**, where you look at the potential future cashflows of the underlying asset and token.

2. Utility Token

Defining intrinsic value of something that offers utility is a new concept for investors who have been operating in traditional finance. The big difference here is that utility tokens generally speaking do not have cashflows. Some tokens allow for staking (helping block validation) or asset lending – both activities that generate cashflow – however these are first derivative effects of the token's utility. These cashflows are generated through platforms in both centralised and decentralised finance (DeFi), which for the latter often implies liquidity provision and asset lending. Both of these are a result of asset allocation decisions rather than an effect intrinsic to the utility token. Therefore these cashflows cannot serve as the sole basis for a valuation framework.

As discussed above, utility tokens are used to exchange for services or applications within their specific ecosystem. Therefore the value of a utility token is tied to how many use cases the token has within its ecosystem and the demand from users for these services.

When assessing the value, investors also need to take into account other factors like momentum behind the expansion of the ecosystem and the utility of the token within as well as other aspects that are described by the issuers in the whitepaper and roadmap of the project like the total supply of tokens, the token distribution, when they get put into circulation, the potential dilution of the value of traded tokens (caused by new issuance) and deflation (caused by token burning). It should be noted that factors relating to token supply and the roadmap can change over time, at the discretion of the creators and that roadmap targets are often not achieved, meaning they need to be tracked.

Dimensions of Token Valuation

Utility x Security

Exhibit 39 illustrates the categorisation between utility and security tokens. In reality they blend together. Through a unique blend of both dimensions, a certain amount of value crystalises within the token. Tokens are dynamic in nature and therefore move across the grid below. In general, the more utility it offers and the higher the market value of the asset backing the token, the higher the overall value of the token.

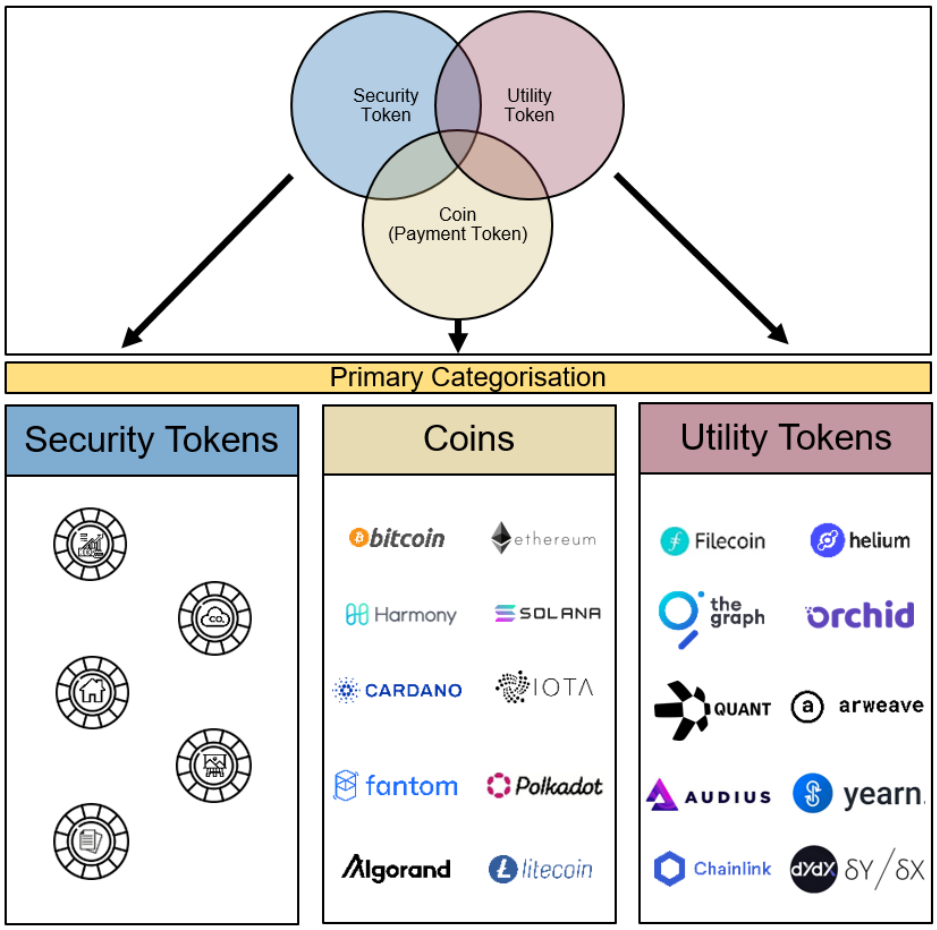
Coins x Utility Tokens x Security Tokens

The overlap in categorisation does not only happen within tokens but it can also happens between tokens and coins.

At the core you have three different elements of tokens and coins which all in their own way add value to these digital assets.

- **Utility Token -** Serves a specific use case within the ecosystem in which it operates.
- **Security Token -** Represents ownership of the underlying tangible or intangible asset.
- **Coin -** Serves as a mean of exchange and is used to conduct transactions on its respective blockchain.

Exhibit 39: Security Token x Utility Token x Coin



Source: Morgan Stanley Research

Tokens change over time

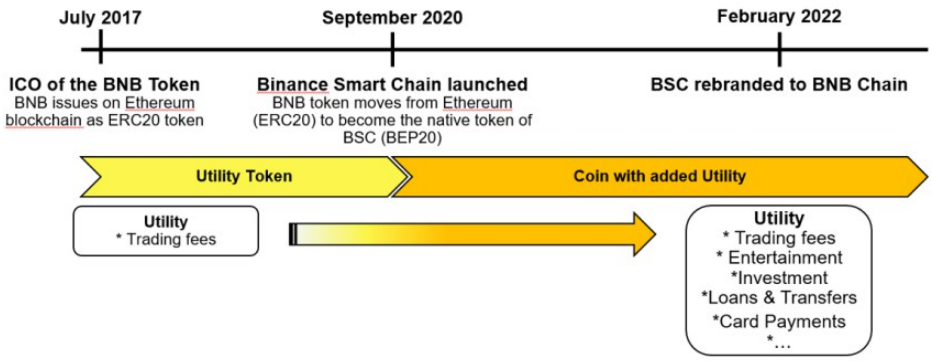
The value proposition of tokens and coins is not static within the ecosystem and it can rapidly change over time. These changes are often driven by decisions made through consensus about the direction of travel of the project. Exhibit 39creates the impression that there is a clear categorisation for the different types of tokens and coins. In reality the difference between all of them is less distinct.

Binance Smart Chain, now simply known as BNB chain, is an example of the usage of coins and tokens terminology and its dynamic nature. Initially BNB was a utility token built on the Ethereum blockchain created by the Binance crypto exchange and using the ERC-20 standard contract structure. BNB was distributed through an ICO (initial coin offering) in July 2017. It was a utility token that reduced transaction costs for customers who used BNB to pay for operations on the exchange.

In September 2020, Binance Smart Chain (now rebranded to BNB Chain) came into existence. BNB serves as the native coin and medium of exchange to perform transactions on the BNB Chain (as we discussed here). Over three years, BNB was reclassified from being a utility token to a hybrid coin x token. Due to the growth of the ecosystem in which BNB operated, the company behind BNB Chain aimed to expand the use cases of the BNB token by integrating it into a newly launched blockchain. Binance is continuously looking to expand the ecosystem in which BNB can operate to further

increase its use cases for different users.

Exhibit 40: BNB token evolution



Source: Morgan Stanley Research

Implications of tokens as an economic building block

By reducing the need for trusted central parties, tokenisation has the potential to enable new services and collaboration, which will blend together into a new type of economy, commonly referred to as the token economy or the "economy of everything".

As we laid out before, tokens are a generic unit of value that allow economic actors to quantify any source of value. Due to the open-source nature of the technology, anyone and everyone can effectively create a token of something of value and put it on chain. Previously the act of ascribing value to something was in most cases reserved for centralised entities or a large group of people. Through tokenisation, the economy may, in a bold scenario, be no longer dependant on centralised organisations to define the value within society.

Tokenisation is a new building block of the economic model. Through tokenisation and big data we can further quantify and assign value units to more aspects of our economic and social environment. For example, tokens can now represent a distinct form of value of something in a peer-to-peer community. DLT will serve as a foundation on which the new token economy is based.

Tokenisation allows the incorporation of all relevant information and value sources of a specific asset or resource. Rather than pure economic value, which solely relies on supply x demand, tokens have the ability to represent more social, cultural and natural capital. In doing so, tokens that are traded in the economy are not only a representation of economic value, but can also embody social-, ecological-, natural-, and utility-value.

Tokenisation as tool for environmental full-cost accounting (EFCA)

EFCA is a method of accounting where both direct and indirect environmental, social and economic costs and benefits are taken into the equation. This method of accounting is often cited as the one on which we can build a sustainable society. Current systems and solutions are relatively ineffective due to the complexity of the accounting equation.

Because tokens can represent much more than pure economic value and can also account for social and environmental value, it could be a useful tool to use for EFCA.

As highlighted, a token economy allows society to quantify and exchange new types of value. These tokens can be traded on centralised exchanges but the expectation is that there will increasingly be more peer-to-peer (P2P) transactions as the economy transforms. Moving towards this token economy effectively expands the economic environment in which economic actors can operate.

In the above we touched upon how value can crystalise within tokens. The reality is that a large part of the value that tokens trade at today is also based on the expected future value of the underlying asset and the utility the token will offer once the network effects come online.

What is the difference between tokens and traditional money as means of exchanging value?

Blockchain allows people to set up and coordinate networks on which they exchange value peer-to-peer. As we discussed before, tokens are what embody the value that is being exchanged between parties. What makes tokens a better exchange of value in these type of economic interactions has to do with the purpose they serve.

There are forms of value that can not be traded for fiat currency. Our traditional monetary system, which uses fiat currency as means of exchange, is based on a specific type of value. It is monetary value, which is based upon the utility and the economical logic of something within our traditional economy.

Tokens, which serve as the core building block for the token economy, differ from fiat currency in that they are more generic in nature. Because they are generic in nature, tokens can represent a broader set of value (Exhibit 41). Below are some examples of other types of capital.

- **Social Capital -** The capital/benefits that occur when an individual operates within a social network.
- **Natural Capital -** Part of the natural environment, which benefits society and the economy. Examples are water, clean air and soil quality.

- **Cultural Capital -** Ideas, symbols, tastes, and preferences that can be strategically used as resources during social and economic interactions. Examples are stories, history, language and speech styles.

In some cases fiat money can reflect the value of the above, however, we would argue that it is a suboptimal reflection of the actual value. The value of these reflected in fiat money is a first derivative of the actual value. With fiat money, these other values represent value based upon traditional economic logic and therefore they do not fully reflect the correct value of the asset. The limitation lies in the fact that in the traditional economy we only quantify and reflect value for the services that the asset delivers (i.e. water, food, commodities, services).

What is different with tokens is that they can account for the ecosystem in which these economic services and assets function such as the social, cultural and natural ecosystems. The programmability of tokens through coding language allows us to tailor how value exchanges happen. Specific constraints can be coded into the token that only allow the token to be spent on certain transactions or only allow exchange whenever some prerequisites are met.

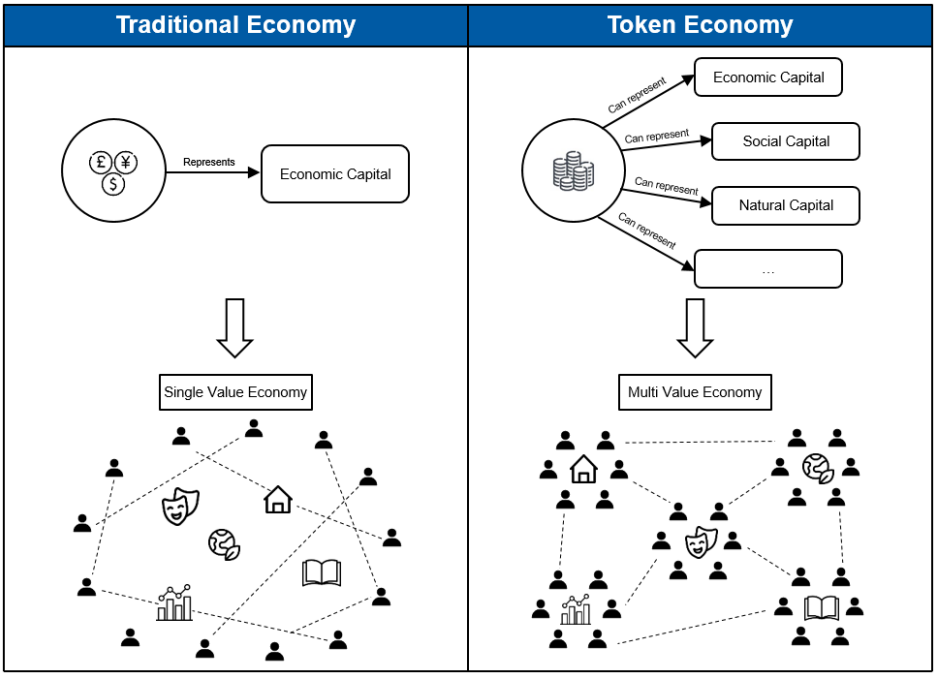
Specific Tokens - Example

Tokens are code based. Due to this specification it is possible to program limitations on the usability of tokens. For example it is possible to code restrictions so that the token cannot serve as a means of exchange for anything that does not uphold specific ESG criteria. It could be that the token can only be exchanged for:

- Eggs from free-range chickens
- Apparel products fabricated without slavery or child labour
- Sustainable mined minerals and gems

Besides allowing restrictions in the way that tokens can be spent, the programmable nature of the token also allows it to represent other types of capital. This means that a token cannot only represent the economic value of an object, but also for example the natural value of an object within the same token. Therefore the generic nature and programmability of a token can be a new tool to further improve environmental full-cost accounting (EFCA).

Exhibit 41: Traditional vs Token Economy



Source: Morgan Stanley Research

Non Fungible Tokens (NFTs)

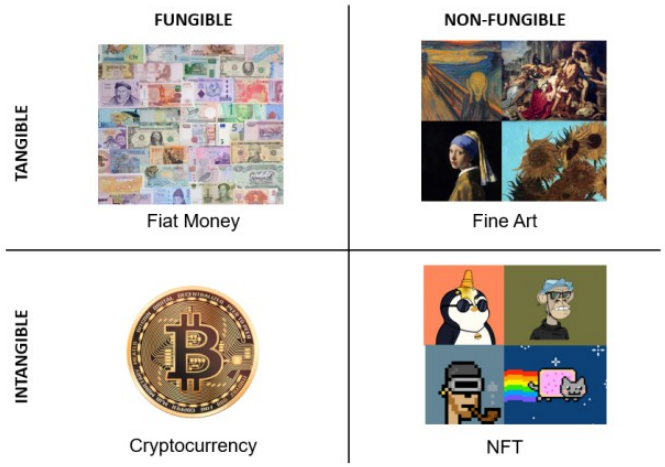
A Non-Fungible Token is a type of digital asset that represents a tangible or intangible asset. Just like with other security tokens the asset can be real-world or digital in nature. What is different for NFTs, relative to cryptocurrencies, is that each token is unique. The aspect of non-fungibility that is imbedded in the token means that each token is effectively a unique electronic certificate that is most often linked to a specific underlying asset. This means that NFTs are not interchangeable. While at first this can seem like a small detail, it has significant implications for the use cases of NFTs within the token economy.

NFTs are not a different categorisation of tokens. NFTs can be utility or security tokens or even both. The difference here is really the unique nature of the token, meaning the token also finds part of its valuation in asset scarcity.

Before continuing we need to define what fungible and non-fungible assets are:

- **Fungible -** Meaning something is replaceable with another identical item
- **Non-Fungible -** Meaning something is unique and can't be replaced with something else.

Exhibit 42: Examples (In)Tangible x (Non-)Fungible Assets



Source: Morgan Stanley Research

Exhibit 43: Fungible vs Non-Fungible Tokens

Fungible Tokens	Non-Fungible Tokens
Divisible Can be divided in smaller amounts	**Indivisible** The base unit of measure is the token itself
Identical All units have the same value and are identical	**Unique** Each token is unique, making it impossible to swap in between
Interchangeable Can be exchanged or replaced with another token of the same type	**Irreplaceable** Cannot be replaced or exchanged with another token of the same type
Applications Store of value Payments	**Applications** Gaming Utility Art Music
ERC-20 token standard	ERC-721 token standard
Stores value	Stores data

Source: Morgan Stanley Research

A non-fungible token, as the name suggests, is a digital representation of something unique that is not interchangeable. The creation of an NFT allows for the reflection of the unique nature of the underlying on chain by creating a unique, irreplaceable and indivisible token. NFTs are effectively electronic tags or identifiers that show the metadata of a specific object. People can trade the NFT and the changes of its ownership are recorded on the blockchain. What is important to note is that the object

to which the NFT is linked does not have unique properties, rather the NFT is a certificate to this specific asset. The underlying asset can be tangible or intangible.

2021 saw a significant increase in NFT activity mainly driven by the exponential rise in cryptocurrency prices leading to many entrepreneurs creating assets that increased demand for cryptocurrencies further. Speculative price markets drove further investment into NFTs, which led to more speculation. Prices of NFTs with pointers to image files that can be copied by anyone else were traded by retail investors enticed by promotions from celebrities and advertising across social media. There have been reports in the media that "record" prices were set for a particular NFT through a celebrity paying much more than the market price for the NFT (example 1, example 2), possibly sponsored by NFT or crypto companies. Other media reports say that the trading volumes were also inflated through incentives that allowed users to trade with themselves and earn rewards.

In 2021 the creator economy embraced the idea of creating NFTs as a new source of revenue. The most common applications of NFT were in gaming, arts, sports, media & entertainment, collectibles and digital real estate. While these NFT projects had a significant role in the adoption of the technology, it is important to remember that an NFT is just a digital certificate that represents a unique asset on chain.

This means that it can find use cases in any sector that operates with unique assets, products or services and benefits from migrating part of the business on chain (for any given reason). That is why NFTs are also finding applications in intellectual property, goods & supply chain, commodities and even decentralised finance, to name a few.

The past 18 months have been marked by NFTs coming out of the shadows followed by a phase of a lot of experimentation to find use cases of this new technology. The expectation is that as DLT technology becomes more ingrained in the economy and society, we will likely hear about new use cases but for transactional purposes rather than to trade as speculative assets as the market is currently focused on.

A brief history of NFTs

Long before putting unique digital objects on chain went mainstream and the term "Non-Fungible Token" was coined, people played around with the idea. Since the inception of the Bitcoin there has always been the desire of the blockchain community to use the ledger for more that just a digital currency.

This effort led to the creation of "colored coins" in 2013 and was one of the first attempts of the community to add functionality to Bitcoins by adding metadata to BTC transactions. The concept was eventually adopted by many protocols among which Counterparty, which was already decentralised in nature, allowing for unrestricted experimentation of users with these new building blocks.

On 3 May 2014, Kevin McCoy minted the first NFT named "Quantum". It was minted on the Namecoin blockchain, the first fork of Bitcoin established in 2011. Besides Counterparty, as a protocol on Bitcoin, Namecoin was the preferred alternative for the creation of NFT until Ethereum came around. Due to Counterparty's experimental nature and creative freedom we saw the creation of some pioneer projects like Spell of Genesis, Force of Will and Rare Pepes.

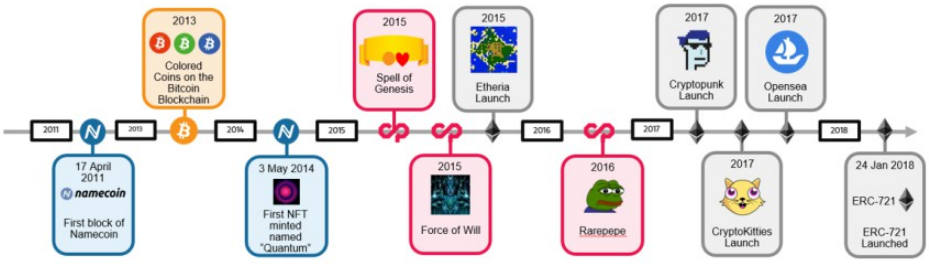
In August 2015 the Ethereum blockchain went live with the intention of becoming the world's supercomputer, armed with smart contract technology. From this spawned Etheria which arguably was the first NFT-related project on Ethereum. Etheria allowed people to buy and sell pieces of land and build on them. This project ended up being the predecessor of projects like decentraland.

Post the 2016-2017 ICO mania we saw the first "modern" NFT project coming online on Ethereum. This project was Cryptopunks which released 10,000 unique, algorithmically generated 24x24 pixel images of punks. The same year a big breakthrough in crypto gaming happened with the creation of CryptoKitties. Each CryptoKitty had unique characteristics and was an NFT on the Ethereum blockchain. The premise of the project is to mate them to create new unique cats. CryptoKitties was one of the first projects to add more functionality to NFTs. The project generated a lot of community attention as it highlighted the versatility that NFTs have to offer.

Meanwhile in early 2018 Ethereum adopted the ERC 721 standard, a set of rules to make it easy to work with NFTs on the blockchain. This in combination with CryptoKitties' popularity is arguably seen as the start of widescale adoption with Ethereum being the most dominant blockchain on which to mint NFTs and build protocols.

Later to address the desire for people to trade the NFTs, exchanges like OpenSea came into existence to facilitate trading. Opensea still remains the dominant exchange as it now transacts a wide variety of NFTs from digital collectibles to music, domain names and much more. Since 2017 many more NFT marketplaces have come into existence like SuperRare, Rarible, and Axie Marketplace – all targeting a specific part of the rapidly expanding NFT ecosystem.

Exhibit 44: The evolution of Non-Fungible Tokens



Source: Morgan Stanley Research

2021: The year of the NFT

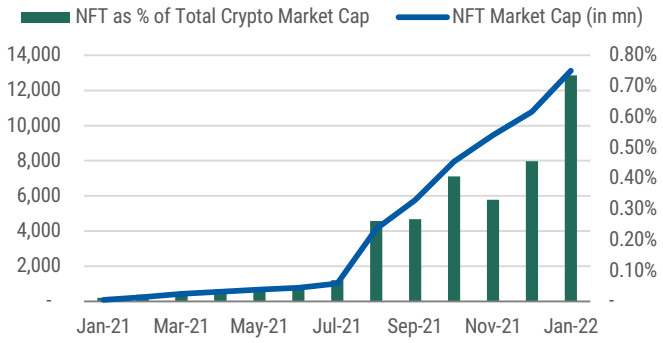
2021 is the year in which NFT went mainstream. In March 2021 Beeple sold the piece "Everydays: the first 5000 days" through Sotheby's for $69mn. Many quote this as the catalyst for the NFT summer. While this was a strong catalyst to get NFTs into the limelight, much of the foundation to make this all possible happened over the previous decade.

Since the beginning of 2021, the total combined market cap of NFTs increased 150x over 13 months, from $88 million to $15 billion (Exhibit 45). Looking at the activity over the year we see the initial spike in both wallet activity and traded volume on the week of

the Beeple sale (Exhibit 46) in March 2021. However it was only over the summer of 2021 that we saw a significant increase in activity. Between the beginning of July until the peak during the third week of August we saw a ~19x increase in the traded volume and ~6x increase in the total weekly active wallets. At peak levels in August there were a total of 35,000 active wallets trading a total of $1bn of NFT value during the week of 22 August. After the initial hype we have seen activity cooling off.

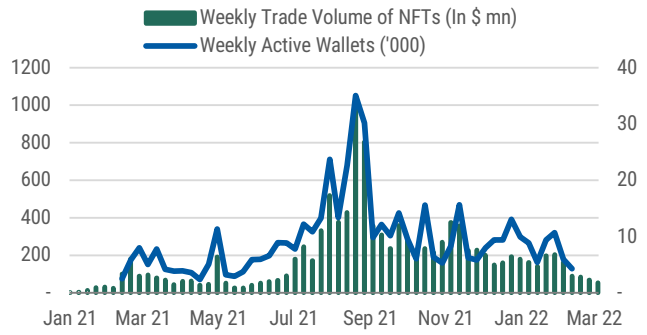
Here we are not commenting on the nature of the NFT trading activities or future expectations for price action. The US treasury has been concerned about NFTs being used for money laundering. Some of the trading boost in January 2022 was due to traders transacting NFTs between two wallets that the same trader owned and due to celebrities and influencers buying NFTs at materially above market prices possibly to help with the promotion of that particular NFT collection. The current elevated NFT prices traded in the market look unsustainable as crypto prices have declined and the monetary stimulus of the last few years is turning to tightening. Even prominent crypto creators have been cautioning on the NFT market recently (e.g. Vitalek Buterin the creator of Ethereum and C.Z. Zhao the creator of Binance exchange).

Exhibit 45: NFT Market Cap Growth (in $Mn) and vs Total Crypto Market Cap



Source: Cryptoslam, Morgan Stanley Research

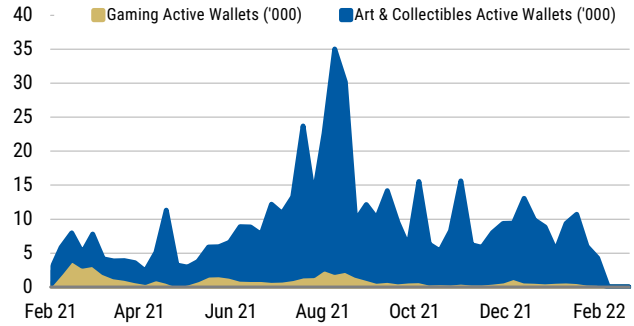
Exhibit 46: Weekly NFT Volume and Wallet Activity



Source: Cryptoslam, Morgan Stanley Research

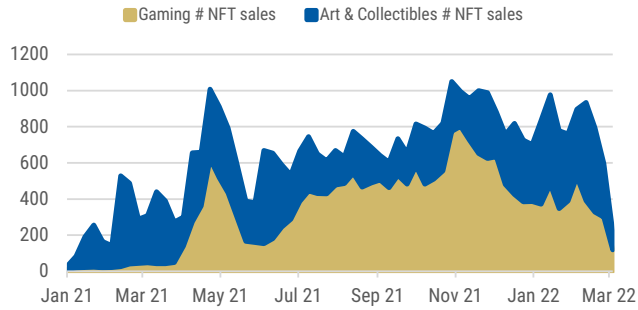
Exhibit 47 shows that the majority of the increase in the number of active wallets in 2021 was due to art and collectibles rather than gaming which was relatively small. From the start of the year until August 21 peak, the number of active users in art and collectibles increased ~15x after which it has normalised during the cooldown. What is interesting for the gaming NFTs is that while the number of wallets has remained relatively stable, the number of transactions in gaming NFTs has seen a significant increase (Exhibit 48).

Exhibit 47: Weekly active wallets by category in '000



Source: Nonfungible, Morgan Stanley Research

Exhibit 48: Weekly # of NFT sales by category in '000

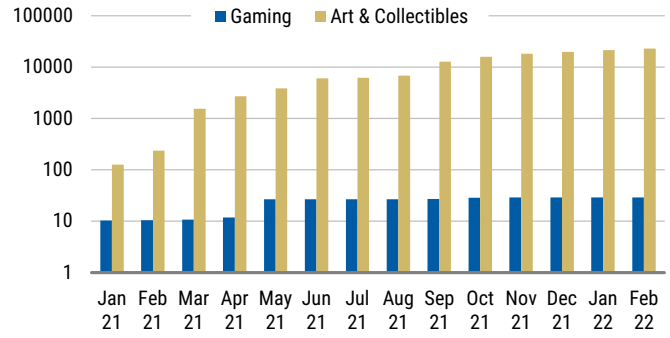


Source: Cryptoslam, Morgan Stanley Research

Gaming NFTs on average saw a price increase of ~2.5x and are currently sold at an average price of $29 per NFT. This is in stark contrast to the art & collectibles NFTs that had an average selling price of $127 in the beginning of 2021 and ended the year at $21,320 on average per sale (Exhibit 49).

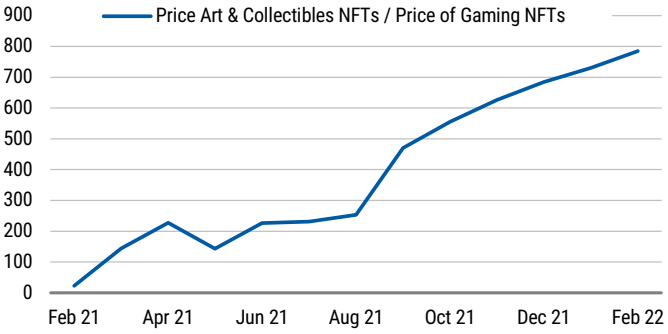
The wide and increasing spread between both types of NFTs highlights the speculative nature of art & collectibles that saw price inflation. Gaming NFTs represent assets in game and therefore already have a set utility and value within the gaming ecosystem. Art & collectibles' price increases have been strongly driven by speculation of investors on the future value of the NFT. The average number is also inflated by the strong price increase we have seen in the "Blue Chip" NFTs like Bored Ape Yacht Club, Cryptopunk and Cool Cats who have seen significant appreciation in value fueled by speculation and their status as prominent NFT projects.

Exhibit 49: Average price of NFT sale per category



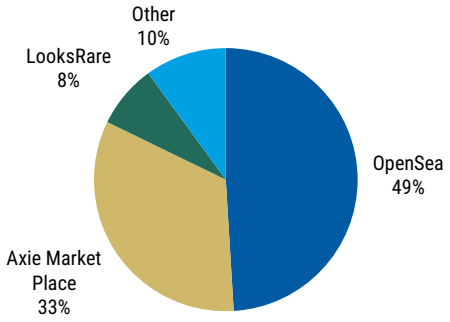
Source: Nonfungible, Morgan Stanley Research

Exhibit 50: Avg. Selling Price Art & Collectibles / Avg. Selling Price Gaming NFTs



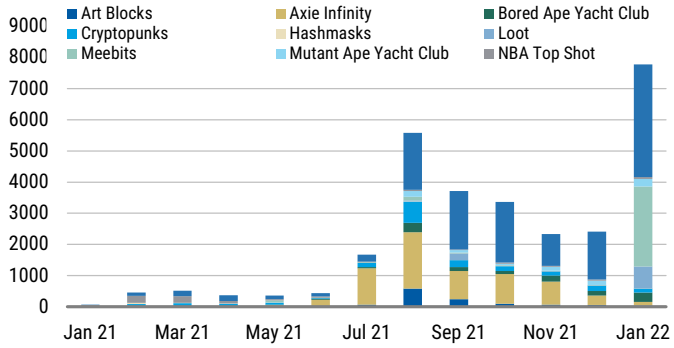
Source: Nonfungible, Morgan Stanley Research

Exhibit 51: Volumes Traded per NFT platform



Source: Nonfungible, Morgan Stanley Research.As of 21-03-2022

Exhibit 52: Monthly Volumes Traded Top NFT Projects

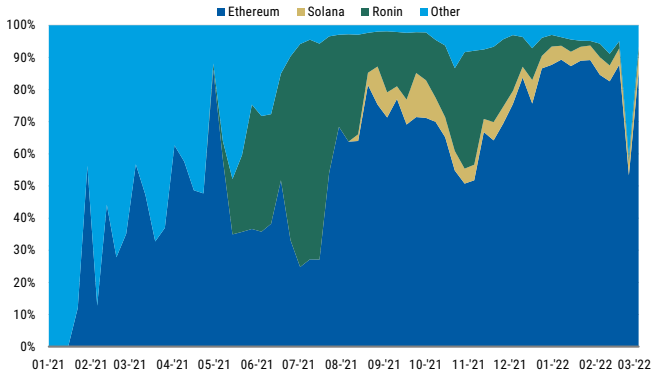


Source: Nonfungible, Morgan Stanley Research

Ethereum was the dominant chain for NFT projects to be hosted on until the end of 2020 (Exhibit 53). In late 2020 and early 2021, around 15% of Ethereum's gas fee (the transaction fees) were attributed to the largest NFT platform OpenSea. High NFT trading volumes were pushing up the transaction fees for other users on the Ethereum platform. As the variety of NFTs increased, so did the expectations and requirements of these projects regarding the chain on which they would operate. To cater for the increased demand, we have seen the rise of some other blockchains specialising in hosting NFT projects. Different projects prefer different chain and they make their choices based on characteristics of the chain, like transactions per second and transaction costs, smart contract programming language, and consensus mechanism.

Over the summer of 2021 we saw the rise of alternative NFT chains for Ethereum. High fees and low throughput were the main reasons for projects to migrate. Ethereum is losing NFT market share due to other chains providing better support and some projects like Axie Infinity and Defi Kingdoms are even launching their own blockchains. Despite this, the large majority of transactions are still happening on the Ethereum blockchain as ERC-721 remains the benchmark.

Exhibit 53: Weekly Relative NFT volume traded by Chain



Source: Cryptoslam, Morgan Stanley Research

Exhibit 54: Characteristics of different blockchains used for NFTs

	Native Token	Transactions per second**	Consensus Mechanism
Ethereum	ETH	15	PoW, PoS soon
Solana	SOL	65,000	PoH, PoS
Avalanche	AVAX	4500	PoS
Ronin	RON	NA	PoA
Flow	FLOW	10,000	PoS
WAX	WAXP	8,000	DPoS
Polygon	MATIC	10,000	PoS
BNB Chain	BNB	60	PoSA
Tezos	XTZ	40	LPoS

**** Transactions per second as of November 2021**

Source: Morgan Stanley Research. PoW - Proof of Work, PoS, Proof of Stake, PoH - Proof of History, PoA - Proof of Authority, DPos - Delegated Proof of Stake, PoSA - Proof of Stake Alliance, LPoS - Leasing Proof of Stake. Note that these are maximum transactions per second capacity as stated by the blockchain.

Looking ahead

The NFT market was created as a way to increase demand for cryptocurrencies. It did that and encouraged a speculative asset price bubble in NFTs, most prominently image-based NFTs that mostly give the user the ability to promote on social media that they own this NFT. Some, but not all of the image-based NFTs offer the owner the rights to use this artwork in other places, meaning the ownership of the NFT was simply to speculate on its price. The NFT market is likely to slow as a result of the weakness in broader crypto and equity markets. This doesn't meant that the technology will no longer be used, just that the enthusiasm of companies to create NFTs as a marketing tool or as a new source of revenue may adjust according to the market cycle.

2021 was a strong year for NFTs and brought the technology in to the limelight. The variety of industries that utilised NFTs to share content was broad. Creators will continue to use NFTs as a source of revenue as long as it remains profitable, which may itself be a function of user demand and broader crypto prices. Content creators in the arts, media, gaming and other creative industries have been the early adopters of NFTs as they see the most direct benefits from leveraging them. For these industries, NFTs have fundamentally changed the market dynamics. It has provided actors in the marketplace a new way to define ownership and re-design how transactions of these are done.

Looking ahead, the technology will continue to find applications in other fields, though the interest in creating NFTs will be cyclical with market prices. While there are still some questions from a regulatory point of view, NFTs are a powerful tool to represent unique assets on the DLT.

What are the benefits of tokenised assets?

Distributed ledger technology is a database that is shared and sychronised across a network of entities. In doing so they unlock benefits for the stakeholders, which we discuss below and illustrate this with some examples

A. Transparency

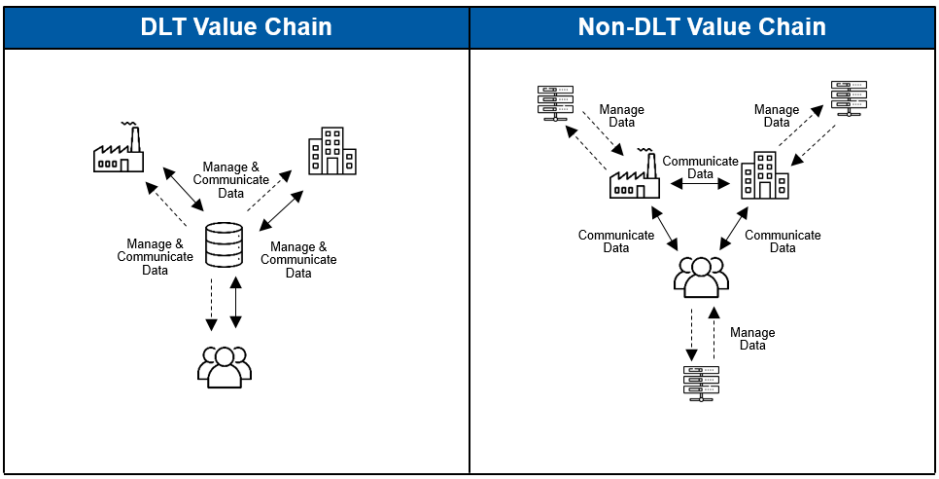
Tokenisation has the potential to pave the way for a more transparent market. Through distributed ledger technology (DLT), the records of historical transactions are distributed across different computers (nodes).

By storing data in a decentralised way, there is more visibility and transparency on the current state of the ledger. The record is updated whenever a consensus is reached by those who operate nodes on the updated state of the database. The possibility of having multiple parties verify data on the ownership and the transfer of value is a powerful tool in solving issues of transparency. Owners of an asset that has been tokenised are able to trace the history and past transactions of the asset.

All participants, within the perimeter of the DLT, can access and see all transactions that happen on chain. The perimeter is based on the characteristics of the DLT. There are public DLTs, which allow anyone to access on chain data, but there are also private DLTs, which only allow access to pre-cleared participants. The reason to add privacy-enhancing mechanisms to the DLT or even move to a private DLT is to protect some data. It is possible that competing organisations or projects use the same DLT infrastructure and require some additional privacy to avoid the leakage of sensitive information to unintended parties.

It is important to know that DLTs not only increase transparency within organisations but also for the wider ecosystem in which they operate. A DLT can be used as a single IT system on which stakeholders store data on ownership, rights, intellectual property, etc. In doing so that data is available for partners, competitors and other stakeholders operating in the ecosystem. That way they all have the same information of the digital representations of assets they work with. It adds operational efficiency, streamlining the ecosystem and value chain and can potentially unlock new ways of collaborating and cutting costs.

Exhibit 55: Tokenisation is driving transparency across the value chain/ecosystem



Source: Morgan Stanley Research

Leveraging the transparency DLTs offer is already happening across multiple industries. We are seeing the quickest adoption in industries with a lot of stakeholders who have non-standardised products and complex value chains.

Examples of Transparency

DLT x Luxury

Luxury companies are tokenising goods to control the secondary and counterfeit market. The Aura Blockchain Consortium is a partnership between LVMH, Prada and Cartier (Richemont) that created a private blockchain secured by ConsenSys technology and Microsoft. The project was started by LVMH, Prada Group, part of Richement and OTB Group in 2019 to track and trace the production of its luxury goods from raw materials to the point of sale and the secondary market. AURA went live in October 2021. By leveraging DLT's transparency capabilities, AURA (i) fights against counterfeiting, (ii) tracks luxury goods sold on second-hand platforms, and (iii) maintains a relationship with the successive owners during the lifetime of the product.

DLT x Food supply chain

Increasingly there is a demand from consumers and corporates to have better visibility and traceability of consumer goods throughout the supply chain. IBM started the Food Trust initiative in 2017 to leverage blockchain's DLT technology to increase transparency of the food-to-fork journey of products. Companies like Nestle and Carrefour are already partnering with the project. Members of the Food Trust believe the solution helps on multiple fronts including food fraud, food waste, brand trust and supply chain efficiencies. Across all blockchain business use cases, ~19% are supply chain related.

B. Fractionalisation (improved liquidity & accessability)

What is it?

Fractionalisation of tokenised-assets allows the conversion of assets into fractions that represent some part of ownership in the original asset. Said another way, fractional ownership is a partial or percentage ownership in an asset. Shares of the asset, in the

form of tokens, are traded between actors who all share the benefits of the asset such as usage rights, access, discounts and even cashflows. The concept of fractional ownership is not new and has been theorised about for quite some time. The arrival of DLT and smart contracts as new technological building blocks make it possible to ensure the ownership of fractions of an asset.

Lowering barriers to entry

Public blockchains are fundamentally global as they pose few barriers to entry beyond the required infrastructure (electricity, network, hardware) to access them. Due to the decentralised nature of the chain, individuals all over the world are able to tokenise their assets and trade them at any time. While this is a step in the right direction, the biggest breakthrough is achieved when combined with fractionalisation. Together this creates an easy way to divide and redistribute ownership of complex and highly valued assets. (i.e. Real Estate, businesses). Tokenisation enables people to invest in assets that were previously unaccessible.

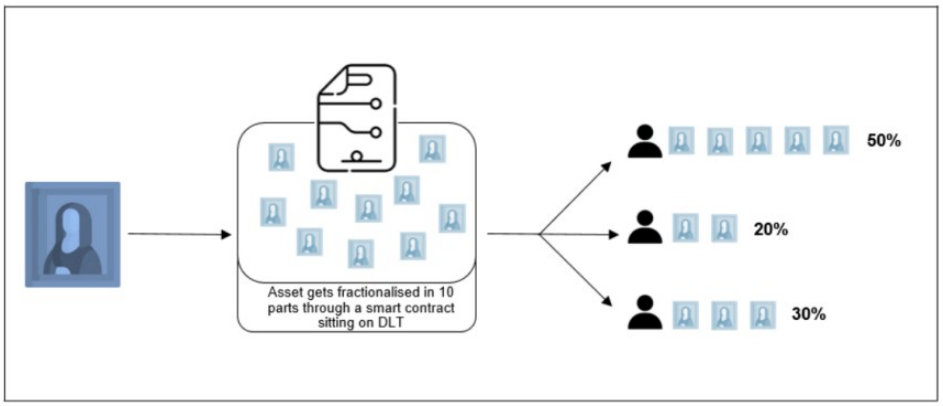
With access to a centralised service provider no longer being a necessity, investors are no longer limited due to geographical reasons. A lower minimum required spending on certain assets is also beneficial from a risk perspective as investors can more easily invest across different asset types.

Increased Liquidity

Fractionalisation of tokenised-assets makes illiquid investments more liquid. Assets like Real Estate, art or intellectual property, which previously were expensive, scarce or inaccessible, have suddenly become easier to access and distribute. In theory assets can be fractionalised into an infinite amount of tokens from which ownership is tracked on the blockchain. This dynamic leads to increased liquidity in the following ways:

1. Creation of new publicly traded markets of assets which were previously traded on a bespoke basis (OTC)
2. Lower barriers to entry for investors – increased flow in asset markets (compressing Bid/Ask)
3. Easier transfer of asset ownership on DLT – increasing velocity of market.
4. Assets can be divided in to much smaller units – increasing fluidity of market supply

Exhibit 56: Fractionalisation of assets



Source: Morgan Stanley Research

All of this should lead to increased democratisation of finance as illiquid and previously inaccessible assets become more investible. This allows a wider variety of investors to access different asset classes, irrespective of the available capital. In doing so the "tail-end" of investors get activated.

Examples of Tokenisation

DLT x Real Estate

Real Estate is seen as one of the most dynamic segments of the global economy. Despite this the average investor has few options to express any kind of view through investment products. Direct equity and REITS are available. Returns on direct investment in commercial real estate can be significant, but very few investors have the financial means and thus the access to do so. Tokenisation of real estate removes a lot of these hurdles. It makes real estate assets more liquid as it opens up the market to a broader investor group.

DLT x Collectibles

Tokenisation of collectibles has been around for some time. However with the increased adoption of DLT technology and better access for individual investors to marketplaces and exchanges we are seeing a surge in the popularity of fractionalising collectibles. Collectibles, which can be classified as alternative assets, have been seeing a significant increase in trading activity in recent years. Inherently the market of collectible trading has some inefficiencies, like poor transparency, potential asset destruction during trades. The lack of liquidity and high and increasing asset prices are also barriers to entry for many. By fractionalising the collectibles and putting them on chain, it is possible for investors gaining exposure to potential price appreciation of the asset by buying just a small part of it.

C. Immutable

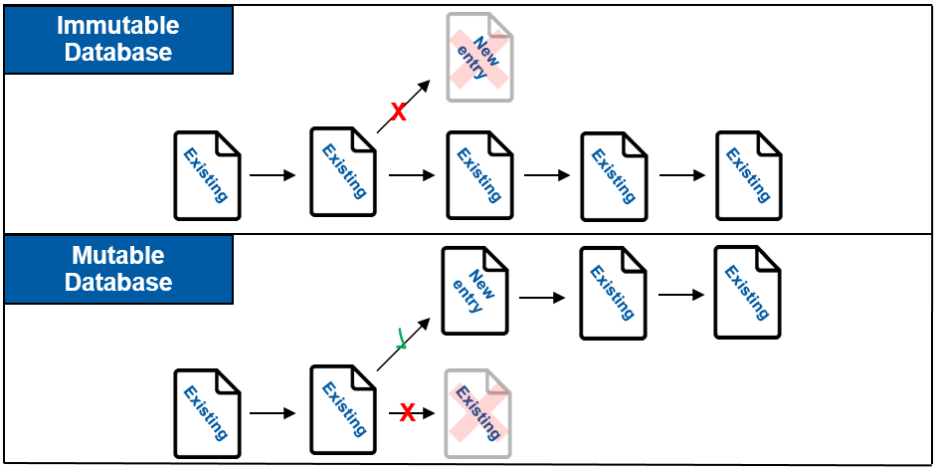
Immutability - the ability for the database to remain permanent, not capable of or susceptible to change. Past transactions cannot be altered.

One of the core properties of the DLT is that it stores data in a decentralised way. After all DLT is a zero-trust network that relies on multiple parties validating data in case of

any change. Once consensus on the transactions is reached and the data is updated on the ledger, it cannot be retroactively changed by anyone on the network. Immutability is not something found in traditional databases, where information can be amended or deleted. This has significant benefits for organisations that decide to integrate DLT:

- **Data Integrity** – a DLT database can guarantee the entire transaction history. Since the inception of the database all transactions that joined the ledger up to the present can be traced back. If there is an attempt to change existing data, it will be visible on chain.
- **Audit** – Immutability should help to simplify audit trails. DLT's provide the ability to have the complete, unquestionable history of transactions and the state of the ledger. This is most useful for organisations that have strict oversight from regulators or other stakeholders and often have audits.
- **Efficiency** - Through immutability a complete and correct record of history is maintained on the ledger. At any point in time a company can look at and see what the state of the ledger was. The ability to look at the data saved in the database in this new way is efficient, and conducting analysis of the data in this structure can also lead to new insights.

Exhibit 57: Immutable vs Mutable Database



Source: Morgan Stanley Research

Examples of Immutability

DLT x Financial Transactions

Immutability enables more secure transactions. This is why DLT is finding use cases in the financial industry to increase security and prevent fraudulent financial transactions. By delivering an unalterable audit trail through its higher standards of data validity, DLT increases the integrity and traceability of transactions.

DLT x Identity Theft Prevention

With the increasing penetration of the internet, the requirement for personally identifiable information (PII) to access specific services is also increasing. The majority of organisations are currently forced to collect and guard their own user data. This comes

with the additional (and often unsolicited) responsibility to have infrastructure and protection in place to securely store this data. All the personal data is sitting in "silos" scattered across the web. With data breaches and the cost linked to those on the rise, organsations are looking to DLT as a possible answer. Solutions like self-sovereign identity (SSI), in which DLT gets leveraged to allow individuals to control which data can be accessed by third parties, are on the rise. These solutions should reduce the unintended sharing of sensitive personal data.

D. Operational Efficiency & Cost Savings

The use of DLT increases efficiency as it reduces inaccuracy during the creation and maintenance of the database. Due to the decentralised nature in which the DLT is operated, the need for administrative overhead costs is also lower. DLT benefits operations in two ways:

- **Increased efficiency** – For some use cases, the use of DLT removes a lot of the requirements for employees or others to update and maintain any database, which often is an operational burden. Due to it being automated, the database and the ledger are updated as soon as consensus is reached. The transaction time for some actions can be finalised within seconds where they previously could take hours or even days. Depending on the requirements, other operational tasks can be replaced by the zero-trust based ledger.

- **Reduced cost** – The automation of the ledger reduces the need for manual work and therefore labour and other costs associated with maintaining the database. The use of smart contracts can also reduce costs. For example, services such as drafting contracts or performing accounting audits can be enhanced or partially replaced by smart contracts.

Examples of Operational Efficiency & Cost Savings

DLT x Insurance

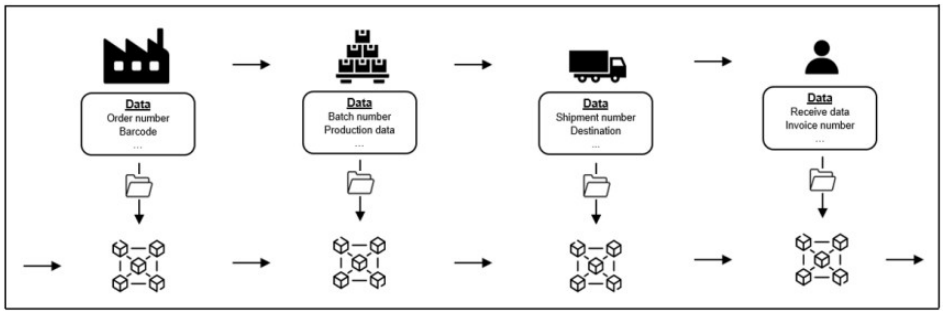
In the insurance industry, smart contracts are a powerful tool to increase operational efficiency across the value chain. "Smart contracts" are digitally signed agreements where the contract's rules, which are coded within, execute and enforce some or all terms of the agreement.

The insurance sector was quick to explore the potential benefits of the technology. The Blockchain Insurance Industry Initiative (B3i) was launched in October 2016. The founders were 13 leading insurance companies, such as Allianz, Generali, Zurich and Munich RE. The initial set-up of the venture was to explore if DLT could be used to automate and streamline the process of paying claims. Today, six years later, the process has been very successful. Over time, other parts of insurance and reinsurance have been added to the project, and it has now automated the full lifecycle of a reinsurance contract and continues to expand. Currently ~43% of live enterprise blockchains that have been successfully launched have been initiated by the financial and insurance sector.

DLT x Enterprise Resource Planning

For many companies the Enterprise Resource Planning (ERP) system is deeply ingrained in the business. It serves as a backbone for many as it processes large amounts of business critical data. The ERP often contains data like the organisational structure, supply chain data and accounting journals. Through the DLT the transaction time and required manual effort can be significantly reduced, cutting overall operational and overhead costs for the company. Companies like Walmart and AB Inbev have already openly communicated that they have integrated blockchain and DLT into their ERP and supply chain.

Exhibit 58: Blockchain in Supply Chain



Source: Morgan Stanley Research

What are the challenges for Tokenisation and Adoption?

A. Regulation

Regulatory entities globally are expressing increasing appetite to regulate the blockchain technology and cryptocurrency. These entities are in later stages of exploration of the technology's potential but in reality there is little concrete already in place. Some countries and regulators are moving quicker than others in their efforts to get a framework in place. However due to the borderless nature of blockchain technology it is hard to rely on much without common regulation across jurisdictions. A supranational framework is required to avoid exploitation and regulatory arbitrage.

To address this, it seems like one of three different approaches is being used:

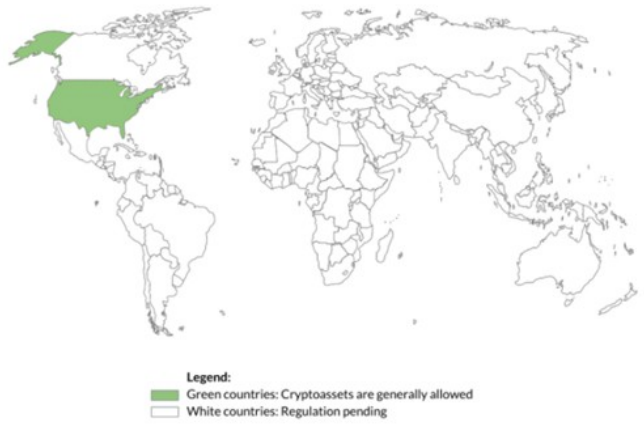
1. Installing new, tailored frameworks for tokenised assets & on-chain assets
2. Defining new roles for new actors that participate in these markets
3. Redefining existing regulatory framework to address DLT and blockchain specific risks.

The lack of such a framework is holding back the rate of adoption as institutions and investors are facing having difficulties in fully embracing the trend towards digital assets. A framework is needed that clearly specifies digital assets and the implications of the regulation without much room for ambiguity. If the tokenisation of assets wants to become a mainstream practice, it needs to ensure that the system is trustworthy. It needs to operate with a certain degree of integrity that reassures users. We believe that a stronger regulatory framework is one of the prerequisites.

One of the key challenges is to create a framework in which the key value proposition of tokenised assets is not compromised. Despite increasing focus from regulators we are yet to see a comprehensive regulatory framework for this new asset class. If and when the regulation arrives, it will remain to be seen if tokenisation still manages to democratise finance and asset ownership. If the regulation ends up being complex it could crowd out non-sophisticated investors as they could have trouble navigating regulatory requirements. Some of the cost and efficiency benefits might also be lost if regulation becomes too heavy or strict.

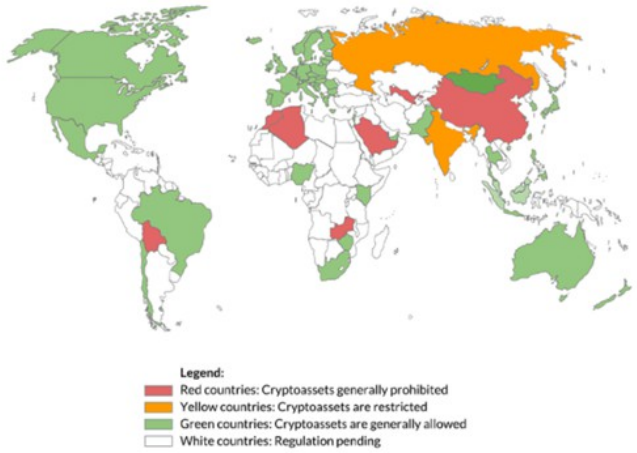
On the other hand there is also a big opportunity for legislators who are quick and nimble in addressing regulatory requirements. As companies are increasingly becoming more global, currently they can do regulatory arbitrage between frameworks to find exposure to those who are most supportive. This means that geographies with regulators who take a more welcoming stance towards the technology could experience significant growth and innovation as they become an attractive hub for projects and companies.

Exhibit 59: Crypto Regulation in 2015



Source: Elliptic

Exhibit 60: Crypto Regulation in 2021



Source: Elliptic

B. Infrastructure

This is easily one of the biggest challenges. Trustworthy, high quality and accessible infrastructure is an important prerequisite for adoption. Sound infrastructure will also drive adoption across the entire spectrum of potential users.

a. Organisations

While the benefits of moving assets on chain is obvious, it requires companies and organisations to develop their own DLT or blockchain infrastructure. High up-front development costs in the form of R&D and Capex create an opportunity cost that can slow adoption. In our view this remains one of the largest challenges of widespread adoption.

b. Individuals

Today anyone can tokenise an asset if they have a basic knowledge of coding or web3 protocols. Tokenisation needs to be made accessible for everyone if it wants to grow into the next wave of adoption as the space goes mainstream. Apps, web portals and frictionless UI/UX are needed to pull the incremental new user in. While this sounds like a straightforward job, as this is something that has been done before with web2, in reality this is a massive undertaking.

Below are some of the infrastructure requirements

- Blockchain – You actually need a chain
- Data Storage – need to store data that has been substracted from the blockchain
- Interface – either on an app or through web interface
- User authentication & administration
- Private key storage capacity – requires high integrity to fend of hacks and security breaches

Besides the infrastructure required on the data storage and application side there is also infrastructure required from individuals who wish to use tokenisation services. The value proposition to tokenise assets and put them on chain is only viable if the asset owner can interact seamlessly with the ledger. Access to the internet is one of the largest prerequisites.

C. Lack of Standardisation

Given the decentralised nature of DLT, which ultimately is the technology that supports tokenisation, there is a lack of standardisation of tokenisation practices. Developers, investors and other stakeholders can advocate different approaches to tokenisation.

Potential new adopters of tokenisation technology have already signalled the desire for more cohesive and transparent practices. There are some practices from chains like Ethereum (with ERC), Solana (with SPL) and Algorand (with ASA) that aim to homogenise tokens and guide developers through the process of doing so. Despite this there is still no universal approach to tokenisation. The most likely reason for this is that the implementation of a homogenous framework most likely means central oversight. A lot of developers have expressed concern that central oversight in tokenisation practices could decrease the culture of collaboration, which is still heavily driven by trial and error.

While different tokenisation standards should suggest a difference in programmatic outcome, this is not the case. Despite the technological differences and standards between distributed ledgers the core value proposition of a token as a unit of value that can change ownership and is registered on the ledger is still a feature that is present across different token standards. So the value proposition between standards currently remains relatively equal. The question is whether or not this will persist as the standards change through new propositions and updates.

D. Audit & Custodianship requirements of tokenised asset

At its core, blockchain and distributed ledgers are used to record transactions. Digital currency and other scarce assets with a digital underlying asset generally function very well on chain. It becomes trickier when the tokenisation of assets requires off-chain validation, authentication and confirmation. Once tokenised, there are also questions around custodianship of the underlying that need to be answered.

There is a school of thought that says DLT only makes sense in a digital-only world because of the audit and custodian requirements. The reality is that service companies are already offering these type of auditing and custodian services. However it is a challenge and remains to be seen if these services can uphold the integrity and avoid exploitation as tokenisation become more widely used across different industries and asset types.

Audit

When tokenising an asset with the purpose of transferring ownership through trading the token, the underlying asset needs to be verified. The security token needs to reflect the underlying asset and its value correctly. For some assets like commodities, gems, and

metals, tokenisation is straightforward as the market value gives a good indication of the intrinsic value of the asset. It is more difficult when tokenising assets like art and buildings.

In cases of increased complexity, an accountant, consulting firm or law firm is often required to assess and confirm the state of the asset and its characteristics as well as confirm if the minted token is reflective of the underlying asset.

A certain degree of control over the asset also needs to be proven. In most cases the ownership of the tokenised asset also assumes ownership and control over the underlying asset. Before an asset can be tokenised it needs to be demonstrated and verified that the party minting the token indeed has control over the asset.

So far we have mainly addressed tangible assets. Tokenising intangible assets is more difficult as proof of control over intangible assets like Intellectual property, carbon credits and others can be opaque. Establishment of control over the intangible asset before minting is even more important in this case.

Custodianship

Once the token is minted, the asset needs to be safeguarded to guarantee the state of the asset remains reflective of the token. Custodians who can look after insurance, regulation, ownership validation etc. are often required for more complex assets. Custodianship of tokenised assets can be a regulatory requirement for some assets, however the regulations are not yet clear. Requirements for custodianship also influence how attractive and useful it actually is to tokenise an asset.

As tokenisation services become more popular, the requirement for regulation also increases. The broad adoption and use cases for tokenisation of assets will in part be decided by the future regulatory framework and the additional requirements that need to be fulfilled to tokenise assets and trade them.

Glossary

Blockchain: A network of computers ("nodes") that keep an incorruptible, open and common record of transactions / data without the need of a central authority. Open and public blockchains are transparent (anyone can view them), permissionless (anyone can use them), and censorship-resistant (no-one can stop them). Yet, they can be slow because new blocks are added upon consensus, which is the process by which the nodes verify new transactions and add to the blockchain. This is achieved by solving a mathematical problem, via computational efforts.

Burning: Permanently removing tokens or coins from circulation, reducing the overall supply of this token or coin.

Chain Explorers: They allow users to see different details of past transactions, including the amount transacted, the source, the destination and the status of the transaction.

Coin: A digital asset that sits on its native blockchain. It serves as a means of exchange within the ecosystem of its blockchain.

Consensus Mechanism: A set of rules embedded in a blockchain to consolidate the decisions of users who are aiming to find agreement on the state of the ledger (database) and the potential changes to it. The set of rules can vary depending on the blockchain.

dApps: A decentralised application is an application that runs on distributed ledger technology.

Digital Wallet: In the context of Web3 this means a wallet that enables self-custody and interactions with Web3-based applications or dApps.

Distributed Ledger Technology (DLT): A technology that allows data to be stored and kept up to date across multiple entities. Data on the ledger is only carried out when consensus between multiple record keepers is achieved. Once stored, the data is immutable.

Enterprise Blockchain: A permissioned blockchain that is used by one or more corporations, mainly with the objective to streamline business processes by sharing recorded financial transactions and data on the ledger.

ERC-721: The standard that describes how non-fungible tokens (NFTs) are created on the Ethereum (EVM) compatible blockchains.

Fork: A permanent split in a blockchain from which going forward two separate chains autonomously operate. This is usually the result of disagreement in the community about the future developments.

Fungible: This means that the coins or tokens are interchangeable for one another and so are not unique. One bitcoin can be traded for another bitcoin as they are perfectly identical and interchangeable.

Immutability: The inability of the database (partially or in full) to be deleted or amended. Once on the database it remains there.

Metadata: In context of NFTs, the Metadata is unique, token-specific data that is used to locate data that is not stored on the chain. Each ERC-721 token contains a metadata string with data that defines what the NFT actually represents off-chain. The reason for this is that currently the entire Ethereum ledger is ~1.05 TB of storage. If NFTs were to be stored directly on the blockchain, the ledger would very quickly become very large in size, given high quality images already take up 2-20 MB of storage each.

Minting: Creating a new cryptocurrency, NFT or other crypto-related asset. The process typically involves creating a new block and recording the information onto the blockchain.

NFT:: A non-fungible token is a token that is characterised by its unique nature. The token is unique and not interchangeable.

Node: A computer that is connected to other computers and which supports a distributed ledger network by helping to validate transactions.

Non-fungible: Meaning something is unique and can't be replaced with something else.

Off-chain: "not on the blockchain/distributed ledger"

On-chain: "on the blockchain/distributed ledger"

Oracles: These are data feeds that allow information from sources off the blockchain, such as the current price of a stock or a fiat currency, to be integrated into DeFi services.

Peer-to-peer (P2P): A state of communication in which peers can interact and transact directly without the requirement for an intermediary or third party to perform any kind of verification process.

Permissioned Blockchain: A distributed ledger that is not publicly accessible. It can only be accessed by users with permission.

Permissionless Blockchain: A distributed ledger that is publicly accessible. No prior permission is required for users to access it.

Security Token: A token that represents (a fraction of) ownership of a tangible or intangible asset.

Smart Contract: A contract based upon a programmable and predefined set of rules/requirements that automatically executes certain actions based on whether or not those requirements are fulfilled.

Token: A digital asset that can represent (i) a unit of value of a blockchain-based organisation that unlocks a service or (ii) an electronic certificate indicating ownership of a tangible or intangible asset. Tokens are used by projects that operate on top of the distributed ledger.

Tokenisation: The process of creating a digital copy (token) of an asset and putting it on the distributed ledger.

Turing Complete: In the context of blockchain, it refers to a machine that given enough time and memory along with the necessary instructions can solve any computational problem, no matter how complex.

Utility Token: A crypto token that serves some use case within a specific ecosystem. It allows the user to perform certain actions or access certain services within the ecosystem.

Validators: A party that is responsible for verifying transactions on the blockchain. Once verified it is added to the ledger. How the verification happens depends on the blockchain and its consensus mechanism.

Research Reports

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Cryptocurrency: It's all about the money (supply)
Cryptocurrency: Buying a Coffee with Crypto

Corporate & Investment Banks: Climate, Crypto, and Competing in This Cycle
Decentralised Finance (DeFi): An Alternative Financial System?
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	COVERAGE UNIVERSE		INVESTMENT BANKING CLIENTS (IBC)			OTHER MATERIAL INVESTMENT SERVICES CLIENTS (MISC)	
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Equal-weight/Hold	**1564**	**44%**	**373**	**44%**	**24%**	**705**	**45%**
Not-Rated/Hold	**0**	**0%**	**0**	**0%**	**0%**	**0**	**0%**
Underweight/Sell	**564**	**16%**	**95**	**11%**	**17%**	**219**	**14%**
TOTAL	**3,552**		**842**			**1550**	

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