UNIT V

BLOCKCHAIN APPLICATIONS

SMART CONTRACTS

A Smart Contract (or cryptocontract) is a computer program that directly and automatically controls the transfer of digital assets between the parties under certain conditions. A smart contract works in the same way as a traditional contract while also automatically enforcing the contract. Smart contracts are programs that execute exactly as they are set up(coded, programmed) by their creators. Just like a traditional contract is enforceable by law, smart contracts are enforceable by code.

- The bitcoin network was the first to use some sort of smart contract by using them to transfer value from one person to another.
- The smart contract involved employs basic conditions like checking if the amount of value to transfer is actually available in the sender account.
- Later, the Ethereum platform emerged which was considered more powerful, precisely because the developers/programmers could make custom contracts in a Turing-complete language.
- It is to be noted that the contracts written in the case of the bitcoin network were written in a Turing-incomplete language, restricting the potential of smart contracts implementation in the bitcoin network.
- There are some common smart contract platforms like Ethereum, Solana, Polkadot, Hyperledger fabric, etc.

History:

In 1994, **Nick Szabo**, a legal scholar, and a cryptographer recognized the application of a decentralized ledger for smart contracts. He theorized that these contracts could be written in code which can be stored and replicated on the system and supervised by the network of computers that constitute the blockchain. These smart contracts could also help in transferring digital assets between the parties under certain conditions.

Features of Smart Contracts

The following are some essential characteristics of a smart contract:

1. **Distributed:** Everyone on the network is guaranteed to have a copy of all the conditions of the smart contract and they cannot be changed by one of the parties. A smart contract is replicated and distributed by all the nodes connected to the network.
2. **Deterministic:** Smart contracts can only perform functions for which they are designed only when the required conditions are met. The final outcome will not vary, no matter who executes the smart contract.
3. **Immutable:** Once deployed smart contract cannot be changed, it can only be removed as long as the functionality is implemented previously.
4. **Autonomy:** There is no third party involved. The contract is made by you and shared between the parties. No intermediaries are involved which minimizes bullying and grants full authority to the dealing parties. Also, the smart contract is maintained and executed by all the nodes on the network, thus removing all the controlling power from any one party's hand.
5. **Customizable:** Smart contracts have the ability for modification or we can say customization before being launched to do what the user wants it to do.
6. **Transparent:** Smart contracts are always stored on a public distributed ledger called blockchain due to which the code is visible to everyone, whether or not they are participants in the smart contract.

7. **Trustless:** These are not required by third parties to verify the integrity of the process or to check whether the required conditions are met.
8. **Self-verifying:** These are self-verifying due to automated possibilities.
9. **Self-enforcing:** These are self-enforcing when the conditions and rules are met at all stages.

Capabilities of Smart Contracts

1. **Accuracy:** Smart contracts are accurate to the limit a programmer has accurately coded them for execution.
2. **Automation:** Smart contracts can automate the tasks/ processes that are done manually.
3. **Speed:** Smart contracts use software code to automate tasks, thereby reducing the time it takes to maneuver through all the human interaction-related processes. Because everything is coded, the time taken to do all the work is the time taken for the code in the smart contract to execute.
4. **Backup:** Every node in the blockchain maintains the shared ledger, providing probably the best backup facility.
5. **Security:** Cryptography can make sure that the assets are safe and sound. Even if someone breaks the encryption, the hacker will have to modify all the blocks that come after the block which has been modified. Please note that this is a highly difficult and computation-intensive task and is practically impossible for a small or medium-sized organization to do.
6. **Savings:** Smart contracts save money as they eliminate the presence of intermediaries in the process. Also, the money spent on the paperwork is minimal to zero.
7. **Manages information:** Smart contract manages users' agreement, and stores information about an application like domain registration, membership records, etc.
8. **Multi-signature accounts:** Smart contracts support multi-signature accounts to distribute funds as soon as all the parties involved confirm the agreement.

Types of Smart Contracts

1. Smart Legal Contract:

There are legal guarantees for smart contracts. They follow the format seen in contracts: "If this occurs, then this will occur." Legal smart contracts provide more openness between contracting entities than traditional documents because they are stored on blockchain and cannot be altered. Contracts are executed by the parties using digital signatures. If certain conditions are met, such as paying a debt when a predetermined date is reached, smart legal contracts may operate on their own. If stakeholders don't comply, there may be serious legal ramifications.

2. Decentralized Autonomous Organizations (DAOs):

DAOs are democratic organisations with voting powers granted by a smart contract. A decentralised autonomous organisation, or DAO, is a blockchain-based entity with a shared goal under collective governance. There is no such thing as an executive or president. Instead, the organization's operations and the distribution of assets are governed by blockchain-based principles that are incorporated into the contract's code. One example of this kind of smart contract is VitaDAO, which uses technology to power a community dedicated to scientific inquiry.

3. Application Logic Contracts:

Application-based code that usually keeps up with multiple other blockchain contracts makes up application logic contracts, or ALCs. It permits device-to-device interactions such as blockchain integration and the Internet of Things. These are signed between

computers and other contracts rather than between people or organisations like other kinds of smart contracts.

How Do Smart Contracts Work?

A smart contract is just a digital contract with the security coding of the blockchain.

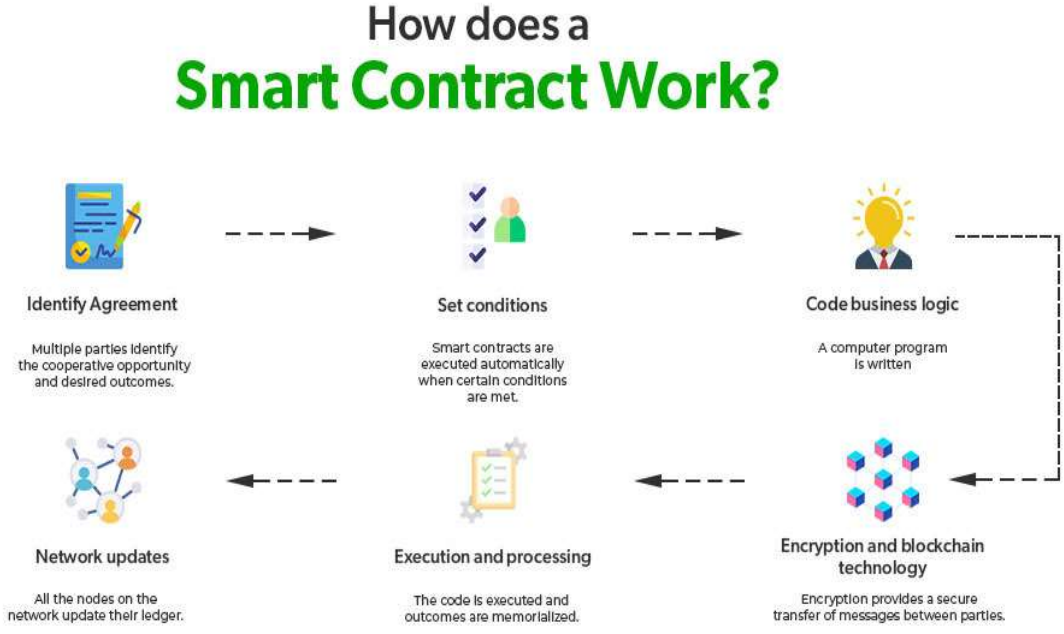
- It has details and permissions written in code that require an exact sequence of events to take place to trigger the agreement of the terms mentioned in the smart contract.
- It can also include the time constraints that can introduce deadlines in the contract.
- Every smart contract has its address in the blockchain. The contract can be interacted with by using its address presuming the contract has been broadcasted on the network.

The idea behind smart contracts is pretty simple. They are executed on a basis of simple logic, IF-THEN for example:

- **IF** you send object A, **THEN** the sum (of money, in cryptocurrency) will be transferred to you.
- **IF** you transfer a certain amount of digital assets (cryptocurrency, for example, ether, bitcoin), **THEN** the A object will be transferred to you.
- **IF** I finish the work, **THEN** the digital assets mentioned in the contract will be transferred to me.

Note: The WHEN constraint can be added to include the time factor in the smart contracts. It can be seen that these smart contracts help set conditions that have to be fulfilled for the terms of the contract agreement to be executed. There is no limit on how much IF or THEN you can include in your intelligent contract.

Smart Contract Working



- **Identify Agreement:** Multiple parties identify the cooperative opportunity and desired outcomes and agreements could include business processes, asset swaps, etc.
- **Set conditions:** Smart contracts could be initiated by parties themselves or when certain conditions are met like financial market indices, events like GPS locations, etc.

- **Code business logic:** A computer program is written that will be executed automatically when the conditional parameters are met.
- **Encryption and blockchain technology:** Encryption provides secure authentication and transfer of messages between parties relating to smart contracts.
- **Execution and processing:** In blockchain iteration, whenever consensus is reached between the parties regarding authentication and verification then the code is executed and the outcomes are memorialized for compliance and verification.
- **Network updates:** After smart contracts are executed, all the nodes on the network update their ledger to reflect the new state. Once the record is posted and verified on the blockchain network, it cannot be modified, it is in append mode only.

Applications of Smart Contracts

1. **Real Estate:** Reduce money paid to the middleman and distribute between the parties actually involved. For example, a smart contract to transfer ownership of an apartment once a certain amount of resources have been transferred to the seller's account(or wallet).
2. **Vehicle ownership:** A smart contract can be deployed in a blockchain that keeps track of vehicle maintenance and ownership. The smart contract can, for example, enforce vehicle maintenance service every six months; failure of which will lead to suspension of driving license.
3. **Music Industry:** The music industry could record the ownership of music in a blockchain. A smart contract can be embedded in the blockchain and royalties can be credited to the owner's account when the song is used for commercial purposes. It can also work in resolving ownership disputes.
4. **Government elections:** Once the votes are logged in the blockchain, it would be very hard to decrypt the voter address and modify the vote leading to more confidence against the ill practices.
5. **Management:** The blockchain application in management can streamline and automate many decisions that are taken late or deferred. Every decision is transparent and available to any party who has the authority(an application on the private blockchain). For example, a smart contract can be deployed to trigger the supply of raw materials when 10 tonnes of plastic bags are produced.
6. **Healthcare:** Automating healthcare payment processes using smart contracts can prevent fraud. Every treatment is registered on the ledger and in the end, the smart contract can calculate the sum of all the transactions. The patient can't be discharged from the hospital until the bill has been paid and can be coded in the smart contract.

Example Use cases:

1. Smart contracts provide utility to other contracts. For example, consider a smart contract that transfers funds to party A after 10 days. After 10 days, the above-mentioned smart contract will execute another smart contract which checks if the required funds are available at the source account(let's say party B).
2. They facilitate the implementation of 'multi-signature' accounts, in which the assets are transferred only when a certain percentage of people agree to do so
3. Smart contracts can map legal obligations into an automated process.
4. If smart contracts are implemented correctly, can provide a greater degree of contractual security.

Advantages of Smart Contracts

1. **Recordkeeping:** All contract transactions are stored in chronological order in the blockchain and can be accessed along with the complete audit trail. However, the parties involved can be secured cryptographically for full privacy.
2. **Autonomy:** There are direct dealings between parties. Smart contracts remove the need for intermediaries and allow for transparent, direct relationships with customers.
3. **Reduce fraud:** Fraudulent activity detection and reduction. Smart contracts are stored in the blockchain. Forcefully modifying the blockchain is very difficult as it's computation-intensive. Also, a violation of the smart contract can be detected by the nodes in the network and such a violation attempt is marked invalid and not stored in the blockchain.
4. **Fault-tolerance:** Since no single person or entity is in control of the digital assets, one-party domination and situation of one part backing out do not happen as the platform is decentralized and so even if one node detaches itself from the network, the contract remains intact.
5. **Enhanced trust:** Business agreements are automatically executed and enforced. Plus, these agreements are immutable and therefore unbreakable and undeniable.
6. **Cost-efficiency:** The application of smart contracts eliminates the need for intermediaries(brokers, lawyers, notaries, witnesses, etc.) leading to reduced costs. Also eliminates paperwork leading to paper saving and money-saving.

Challenges of Smart Contracts

1. **No regulations:** A lack of international regulations focusing on blockchain technology(and related technology like smart contracts, mining, and use cases like cryptocurrency) makes these technologies difficult to oversee.
2. **Difficult to implement:** Smart contracts are also complicated to implement because it's still a relatively new concept and research is still going on to understand the smart contract and its implications fully.
3. **Immutable:** They are practically immutable. Whenever there is a change that has to be incorporated into the contract, a new contract has to be made and implemented in the blockchain.
4. **Alignment:** Smart contracts can speed the execution of the process that span multiple parties irrespective of the fact whether the smart contracts are in alignment with all the parties' intention and understanding.

TRUFFLE DESIGN AND ISSUE

Truffle is a world-class development environment, testing framework and asset pipeline for blockchains using the Ethereum Virtual Machine (EVM), aiming to make life as a developer easier.

Truffle is widely considered the most popular tool for blockchain application development with over 1.5 million lifetime downloads. Truffle supports developers across the full lifecycle of their projects, whether they are looking to build on Ethereum, Hyperledger, Quorum, or one of an ever-growing list of other supported platforms. Paired with Ganache, a personal blockchain, and Drizzle, a front-end dApp development kit, the full Truffle suite of tools promises to be an end-to-end dApp development platform.

- Built-in smart contract compilation, linking, deployment and binary management.
- Automated contract testing for rapid development.
- Scriptable, extensible deployment & migrations framework.
- Network management for deploying to any number of public & private networks.
- Package management with EthPM & NPM, using the ERC190 standard.

- Interactive console for direct contract communication.
- Configurable build pipeline with support for tight integration.
- External script runner that executes scripts within a Truffle environment.

Truffle Boxes

Helpful boilerplates that allow you to focus on what makes your dapp unique. In addition to Truffle, Truffle Boxes can contain other helpful modules, Solidity contracts & libraries, front-end views and more; all the way up to complete example Dapps.

Drizzle Boxes

A collection of front-end libraries that make writing d'App front-ends easier and more predictable. Truffle takes care of synchronizing your contract data, transaction data and more.

Kaleido Boxes

Pre-integrated to work with Kaleido. Stand up your full encompassed d'App in minutes. Kaleido does all of the heavy lifting to secure connection.

How Does It Work

Truffle is the most popular development tooling for Ethereum programmers. Easily deploy smart contracts and communicate with their underlying state without heavy client side programming. An especially useful library for the testing and iteration of Ethereum smart contracts.

Connecting with Truffle

Kaleido environments are provisioned with two pre-configured Truffle boxes for the easy construction and deployment of a basic decentralized application. Truffle is a particularly useful development framework, as it abstracts away many of the web3 and Ethereum complexities that typically exist with blockchain app development and allows for rapid lightweight testing and iteration. This is a great way to get started without needing deep expertise around client libraries and JSON/RPC APIs.

The first box truffle-kaleido-box compiles and instantiates the simple storage smart contract. Simple storage uses a single global variable – storedData – specified as an unsigned integer and a single method – set – for state updates.

It is accompanied by the drizzle-kaleido-box which extends the initial library with a React and Redux front end for secure interaction with your Kaleido environment.

How It Enables Better Business

Truffle Suite provides a development environment, testing framework, and asset pipeline for blockchain applications, simplifying the process of developing, testing, and deploying smart contracts.

In a business context, Truffle enables better blockchain integration by:

Streamlining Development: Truffle simplifies the process of writing smart contracts in Solidity, reducing development time and effort.

Facilitating Testing and Deployment: It ensures smart contracts are robust and secure before deployment with built-in testing frameworks and deployment mechanisms.

Enhancing Productivity: Its integrated development environment (IDE) and user-friendly interfaces improve developers' productivity, allowing businesses to focus on innovation and value creation.

Supporting Multiple Blockchains: Truffle supports Ethereum, Quorum, and other EVM-compatible blockchains, offering flexibility in choosing the most suitable blockchain platform for business needs.

DAPPS

Decentralized apps are digital applications or programs that are based on Blockchain and fundamentally different from normal applications. Unlike normal applications that run on

centralized servers that belong to the company which owns them, dApps run on a **decentralized peer-to-peer (P2P) network** that is based on Blockchain.

What are Decentralized Apps (dApps)?

Decentralized applications or dApps are distributed, decentralized open-source software applications that run on a decentralized peer-to-peer network. Imagine the Twitter application that you have on your phone. You can post anything you want on Twitter but ultimately it's controlled by a single company that can delete your tweets if they violate community guidelines or some other reason. But if there was a Twitter-type dApp, then it would be decentralized and not owned by any one person. If you posted something there, nobody would be able to delete it including its creators.

Multiple people can create content and consume content on these applications that is free of any control and interference from one person. Below are some of the requirements of dApps:

1. **Open Source:** dApps should be open source and its codebase should be freely available for all. Any changes in the structure or working of the app should only be taken with the agreement of the majority.
2. **Decentralized:** dApps should be decentralized with all the information and operations stored on a public and decentralized Blockchain which would ensure security and transparency.
3. **Incentive:** dApps should offer some sort of incentive to their users in the form of cryptographic tokens. These are a sort of liquid assets and they provide incentives for users to support the Blockchain dApp ecosystem.
4. **Protocol:** dApps should have a particular protocol to demonstrate proof of value. This means showing the value of a particular process in a way that can be easily verified by others.

How Do dApps Work?

A dApp has a backend code running on a decentralized peer-to-peer network. It can also have a frontend code and a user interface that can be written in any language just as it is done for normal applications. The front end can be hosted on any decentralized server like IPFS. dApps work in a manner similar to normal applications except for the few differences that are discussed below:

The dApp working has the following features:

- **Decentralized:** A dApp operates on Ethereum which is an open public decentralized platform.
- **Deterministic:** dApps perform the same function irrespective of the environment in which they are executed.
- **Turing complete:** dApps can perform any action given the required resources.
- **Isolated:** dApps are executed in an Ethereum Virtual Machine which is a virtual environment that ensures that even if there is a bug in the smart contract, it won't hamper the normal functioning of the blockchain network.

Most Common Platforms For Creating dApps

There are many Blockchain platforms created by various companies. While the most popular and commonly heard one is Bitcoin, there are many others that are used to create dApps. These Blockchain platforms are further used as a base to create dApps. So let's see some of these now:

1. **Ethereum:** Ethereum is the most popular decentralized, open-source blockchain in the world currently. It is used as the base for many Blockchain projects, including more than 2500 dApps. In fact, Ethereum is only second to Bitcoin in terms of its market value. Ethereum also has a native cryptocurrency known as

BTH which is their version of Bitcoin. All in all, this is an excellent option for creating a dApp although it's a bit expensive.

2. **NEO:** NEO is also a decentralized, open-source blockchain that aims to create a smart economy. It is also called the Chinese Ethereum and provides better options for scalability in dApps as compared to other Blockchain platforms. NEO is currently less popular than Ethereum with only about 100 dApps built using this technology. It's also quite expensive and can even charge higher fees than Ethereum in some cases.
3. **TRON:** TRON is a comparatively new Blockchain platform as compared to Ethereum or NEO. However, it's quite popular and may even become a competitor to Ethereum in the future. TRON is particularly famous for gaming applications and gambling sites. There are around 1500 dApps created using this platform which makes it an excellent choice.

Popular dApps

Below are some of the popular dApps:

1. **CryptoKitties:** CryptoKitties is a fun app that is used for entertainment. You can buy kitties on the app using cryptocurrency and then breed and sell them at a profit. Apparently, cute cats are popular everywhere, even on Blockchain because CryptoKitties was once responsible for 10% of Ethereum transactions daily.
2. **OpenSea:** Open Sea is a dApp that encourages interaction between various games based on Blockchain. Gamers can exchange their collectibles from any cryptocurrency-based game on OpenSea. Currently, this dApp supports collectibles from Ethereum only, but they plan to expand in the future.
3. **WINk:** WINk is the most popular dApp for gambling-based games in the market. It included everything from poker to dice games to sports betting. WINk is based on the TRON platform and the winners in betting get WIN tokens which can then be exchanged for BTT which is a sort of cryptocurrency like Bitcoin.
4. **IPSE:** IPSE or InterPlanetary Search Engine is actually a search engine with Blockchain as its base. IPSE is based on the EOS blockchain and it uses the InterPlanetary File System (IPFS) which is an improvement over HTTP on the internet. A big advantage of IPSE over other conventional search engines is that it guarantees security and privacy on the internet.
5. **Blockchain Cuties:** For anyone interested in CryptoKitties, Blockchain Cuties is a great option. It allows you to focus on multiple cue animals like puppies, bear cubs, lizards, etc. apart from kitties. Blockchain Cuties is a dApp that is accessible using multiple Blockchain platforms like Ethereum, NEO, TRON, etc., unlike CryptoKitties which favors Ethereum only.

Advantages of dApps

The following are some of the advantages of dApps:

1. **Fault tolerance:** As dApps work on a decentralized platform, if a single node is working the network will be still; available but the performance will be severely downgraded.
2. **Privacy:** Users don't need to submit real-world identity or any personal information to use any app-specific functionality.
3. **Data integrity:** Data stored on the blockchain is immutable and tamper-proof due to the use of consensus algorithms. Hackers cannot forge transactions and the data stored on the blockchain is resistant to change.

4. **Flexible platform:** The Ethereum platform provides a flexible environment for easy development of dApps.
5. **Verifiable behavior:** Smart contracts can be analyzed and are guaranteed to execute in predictable ways without a need from monitoring or involvement from a central authority.

Disadvantages of dApps

The following are some of the drawbacks of dApps:

1. **Performance Overhead:** There is a lot of performance overhead to achieve the level of security, transparency, and integrity that Ethereum desires. Even the proof-of-work takes a lot of time and computational resources.
2. **Maintenance:** dApps are hard to maintain, debug and update, as the code or data published to the blockchain are hard to modify and all bug fixes require consensus from all the peers on the network which is in most cases hard to achieve in a timely manner.
3. **Scalability:** Decentralized networks are hard to scale than centralized networks.
4. **User experience:** It is quite hard for the developers to design a user-friendly dApp as it requires users to use the public and private keys for login instead of the username and password that is being used in centralized applications.
5. **Centralization:** Developing user-friendly, developer-friendly applications on top of Ethereum may end up developing a centralized service. Centralization may eliminate all the good features of the blockchain over the traditional model.
6. **Network Congestion:** There is an issue of network congestion while using a dApp as one dApp uses too many computational resources, and the entire network gets backed up. If the number of transactions coming in is more than the 10-15 transactions that are being processed in a second then unconfirmed transactions will pile up.

NFT

A non-fungible token (NFT) is a unique cryptographic asset used to create and authenticate ownership of digital assets. NFTs are used with cartoons, music, film and video clips, JPEGs, postcards, sports trading cards, and virtual real estate and pets. NFTs provide a secure record stamped with a unique identifying code that's stored on blockchain.

In contrast to stocks, bonds and other traditional investments, NFTs are considered an alternative investment that isn't fungible, or replaceable, with a similar item. NFTs are similar to rare collectibles. Demand for them increased in 2020 and grew dramatically in 2021. This drove up the price of digital artworks, with celebrities, content creators, auction houses and others participating in the market.

How do NFTs work?

Blockchain technology establishes ownership of the NFT. Blockchain acts as a decentralized ledger, enabling NFTs to be authenticated publicly. The technology uses a digital signature to prove who owns the work and that it is original. An NFT buyer doesn't own a piece of art to hang on a wall, but rather a digital image of that artwork and digital certificate of authentication.

The NFT buyer does not own the copyright or trademark of the item. Although there may also be numerous versions of it on the internet, NFT buyers have an original in the virtual world. Royalties can be programmed into the token, enabling artists to collect a portion of sales in the future.

The one-of-a-kind qualities of NFTs make them non-fungible. This contrasts with fungible assets, such as Bitcoin and other cryptocurrencies, dollar bills, gold bars and stock, that are worth a specific amount and are interchangeable. Although one dollar bill can be exchanged for another dollar bill or one bitcoin can easily be swapped for another, that is not the case with NFTs.

NFTs are generally nondivisible. The basic unit of the NFT is the token, which usually cannot be divided into smaller denominations, as a dollar might be divided into 10 dimes. However, fractional ownership of NFTs has been recently introduced by some platforms, such as Fractional. Fractional ownership allows an NFT to be divided into smaller NFTs, which can be sold to multiple buyers.

Additionally, NFTs are immutable. They can't be altered once they have been encoded using blockchain technology. The originality and legitimacy of the item are validated through the blockchain in which it is stored.

NFTs are created using blockchain technology, a complex but secure way of verifying digital transactions. Learn about the five steps for verifying and executing transactions using blockchain technology.

Why are NFTs important?

The surge in popularity of NFTs is a result of their "improved ease of onboarding, speculative nature as both a collectible and investment, and grassroots communities developed around the products," explained Justin Herzig, co-founder of Own the Moment NFT, which provides content, tools and analytics on NFTs.

NFTs let individuals buy and sell digital assets in new ways. They help artists and other content creators display their skills digitally and provide the ability to securely value, buy and exchange digital art using a digital ledger. Using NFTs, new and previously decentralized actors can develop innovative value exchanges to build new market structures.NFTs are just one of the several types of virtual assets created on blockchain.

NFTs are a significant form of alternative investment that appeals to buyers' personal interests and passions, Herzig said. With NFTs, retail investors will be able to invest in things they have a personal connection with, as well as things that provide financial and utility value. The NFT buyer hopes the value of the token increases with time, similar to all investments. Just like their fungible cousins, NFTs are subject to shifts in supply and demand. According

to Grand View Research, the NFT market was valued at $20.44 billion in 2022 and is expected to grow to $211.72 billion by 2030.

Benefits of NFTs

Digital artists, other creators and collectors obtain various advantages from NFTs. Some of the most important benefits are the following:

- **Direct monetization.** NFTs let digital artists monetize their work by selling it on online marketplaces like Niio without the need of galleries, auctions houses or other intermediaries.
- **Immutable ownership and authenticity.** NFTs enable owners to prove immutable ownership and authenticity of a digital asset. Unique NFT metadata verifies its origin, ownership and transaction history. This ensures that the ownership of an NFT can be easily verified and authenticated through blockchain technology, providing a sense of security and confidence in owners.
- **Royalties.** NFTs let artists program royalties into their work, ensuring they receive a percentage of future sales when it is resold on secondary markets. This feature enables artists to benefit from the increasing value of their creations, even after the initial sale. Moreover, royalties serve as an incentive for collectors to support artists and contribute to the overall growth of the NFT ecosystem.
- **Fractional ownership and accessible investing.** NFTs allow fractional ownership, enabling multiple individuals to collectively own a digital asset. Fractional ownership enables broader participation and investment in high-value assets, providing access to individual collectors who might otherwise be unable to afford one. This democratization of ownership expands the possibilities for both artists and collectors in the NFT space.
- **Enhanced interactivity and utility.** NFTs can go beyond static digital files and incorporate interactive elements, giving collectors a unique and immersive experience. For example, some NFTs grant access to exclusive events, experiences, or digital items or content related to the artwork or collectible. This can help boost customer loyalty.

What are uses and examples of NFTs?

An early use of NFTs was a game launched in 2017 called CryptoKitties, in which users could trade and sell virtual kittens. In 2021, NFTs that sparked attention included Twitter CEO Jack Dorsey's first-ever tweet and work by Beeple, the professional name used by artist Mike Winkelmann, who sold his piece "Everydays: the First 5000 Days" for $69 million.

NFTs are being used to sell a range of virtual collectibles and assets, including the following:

- National Basketball Association virtual trading cards.
- Digital sneakers from Nike.
- Trading cards featuring personal memorabilia from actor William Shatner.
- A full studio album by rock band Kings of Leon.
- The original Nyan Cat meme.
- Collectible virtual characters called CryptoPunks.
- A variety of GIFs and images commissioned by Taco Bell, with proceeds going toward the restaurant chain's charity organization.
- Virtual real estate in Decentraland, a 3D virtual reality (VR) platform.
- Tokenized real-world assets, such as real estate.

Today, the primary owners and collectors of NFTs are enthusiasts with a strong interest in a domain or project. However, NFTs are expected to become mainstream and attract retail investors eventually as the products and technology improve.

How are NFTs created?

NFTs are created using smart contracts. Smart contract code is incorporated into the token when it's created or minted. Stored on blockchain, the smart contract determines the NFT's qualities, such as ownership and transferability.

The smart contract is autonomous, containing the terms and conditions of an agreement directly within the lines of code. Each NFT is linked to a single token that is stored in a smart contract, which runs on top of the distributed ledger to provide proof of ownership and verifiable originality. Even though there are other copies of the same content, only one person can own the particular token that authenticates ownership of the NFT.

Smart contracts are a crucial feature of blockchain technology. While many NFTs reside on the Ethereum blockchain, some are based on other blockchain technologies, such as Tron and Neo. Blockchain also helps ensure that NFTs remain secure.

While NFTs gain popularity, market participants and observers are becoming increasingly aware of the impact that NFTs have on the environment. The use of blockchain generates greenhouse gases, which have a significant effect on the world's carbon footprint.

How are NFTs bought and sold?

As demand for NFTs grows, new marketplaces continue to surface. Popular marketplaces for creators to sell NFTs include the following:

- AtomicMarket.
- BakerySwap.
- Enjin.
- Foundation.

- KnownOrigin.
- Myth Market.
- OpenSea.
- Portion.
- Rarible.
- SuperRare.

The following outlines the steps involved in buying and selling NFTs:

1. Set up a digital wallet, and buy cryptocurrency, such as ether, using an app, such as Coinbase, MetaMask or Robinhood.
2. Connect the digital wallet to an NFT marketplace.
3. Mint or list the NFT for sale, or start bidding on or purchasing pieces of content. Users can auction bids or purchase outright, depending on the seller and marketplace.

NFT scams

There are several scams in the NFT space to be aware of, including the following:

- **Phishing scams.** Phishing scams involve deceptive links or pop-ups that trick users into revealing sensitive information or transferring funds to fraudulent accounts. NFT phishers create fake marketplaces or accounts on social media, tricking users into giving them their private keys under the guise of making payments for nonexistent NFTs. To avoid falling for phishing scams, it's crucial to verify the authenticity of websites and double-check the URLs before entering any personal information or making transactions. Keeping keys private is an important way to avoid NFT cons.
- **Counterfeit NFTs.** Counterfeit NFTs involve scammers selling other people's work as their own original creations. Fraudulent NFTs appear identical to genuine pieces of digital collectibles or art, making it challenging for collectors to distinguish between authentic and counterfeit tokens. To mitigate the risk of purchasing counterfeit NFTs, users should conduct research, verify the reputation and authenticity of the artist, and buy from reputable marketplaces and verified sources.
- **Pump-and-dump schemes.** These schemes are deceptive practices involving the artificial inflation of an NFT's price through coordinated marketing efforts, often driven by influential individuals or groups. Pump and dumpers drive the price of an NFT to a peak and then liquidate their holdings, causing the value to plummet

and leaving other investors with substantial losses. Users should conduct thorough, independent research and assess the long-term value of an NFT, refraining from making impulsive investments based on hype.

- **Free mint scams.** Free mint scams involve scammers enticing users to participate in deceptive mints, promising exclusive NFTs or rewards. However, instead of receiving the promised NFT, victims inadvertently sign away control of their wallets or provide access to their private keys, resulting in unauthorized access to their funds or assets. To protect against free mint scams, it's crucial to use caution when engaging in NFT minting processes and verify the legitimacy and security of the platforms or projects involved.

The future of NFTs

The principles of supply and demand apply to the NFT marketplace. As with any investment, buyers should be cautious and watch closely as the market evolves.

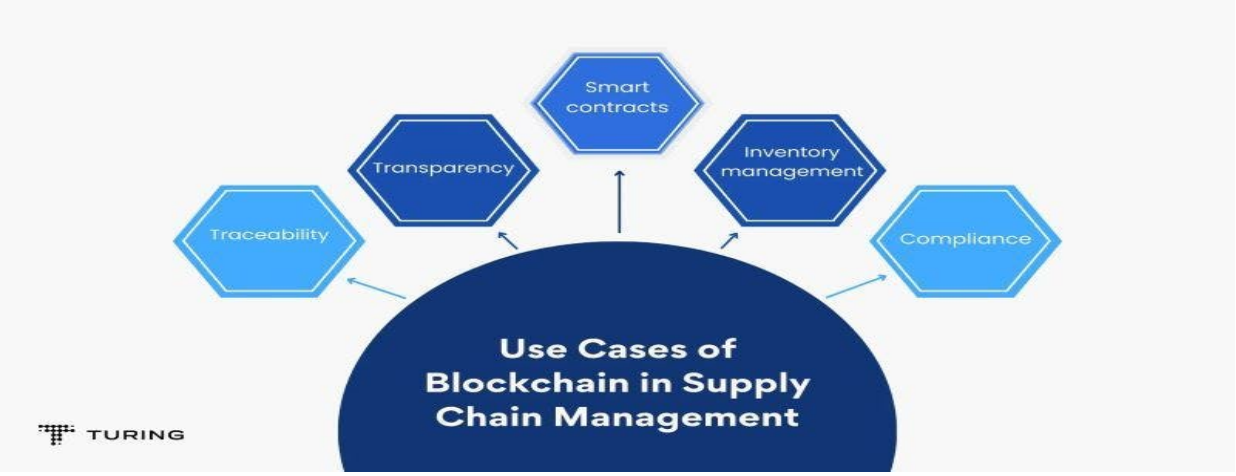
"An NFT is only as valuable as what others are willing to pay for it," Herzig said. "NFTs that can build a deep connection with collectors and investors have shown an increased likelihood of having long-term staying power."

Collectors and investors should view previous and similar sales on established marketplaces to understand NFT value. NFTs' long-term viability will depend on how their utility value is perceived. Like with other collectables, this will happen once owners view NFTs as uniquely valuable experiences or features. NFT communities will develop and grow, helping to maintain prices and markets; this will increase trust in their long-term survival.

NFTs are also linked to future uses in the metaverse, the VR world and healthcare. Because NFTs can prove immutable ownership of an asset, they could be used to protect patient data in healthcare. Other potential uses include proving digital ownership in the metaverse and other VR worlds. Retailers have begun using NFTs to sell digital products in the metaverse and prove ownership of digital deeds.

BLOCKCHAIN APPLICATIONS IN SUPPLY CHAIN MANAGEMENT

Blockchain use cases in supply chain management



The prominent use cases of blockchain for supply chain management include:

1. Traceability

Traceability is one of blockchain's most compelling use cases in supply chain management. Blockchain empowers businesses to create an immutable ledger of every product's journey, from its origin to its final destination. With blockchain's transparent and tamper-proof record-keeping, companies can trace the movement of goods with unparalleled accuracy.

The high level of traceability enhances accountability and serves as a critical tool for product recalls and quality assurance. The consumers also gain deeper insight into the origins of the products they purchase, fostering trust and strong relationships with the companies.

2. Transparency

Transparency is a significant use case of blockchain for supply chain management. Traditional supply chains often suffer from a lack of visibility and trust among participants. Blockchain technology addresses this challenge by providing a decentralized and immutable ledger that all stakeholders can access and verify.

Every transaction recorded on the blockchain is transparent and cannot be altered, ensuring a single source of truth for all involved parties. This transparency enables real-time tracking of goods, from raw materials to the end product, allowing businesses to identify bottlenecks, inefficiencies, and potential areas for improvement.

3. Smart contracts

Smart contracts represent a transformative use case of blockchain technology in supply chain management. Smart contracts are self-executing agreements with predefined rules and conditions encoded on the blockchain. These contracts automate and streamline various supply chain processes, such as procurement, payments, and compliance.

By leveraging blockchain's decentralized and transparent nature, smart contracts eliminate the need for intermediaries, reduce administrative costs, and minimize the risk of errors or disputes.

For instance, when a shipment reaches a specific location, the smart contract can automatically trigger the payment to the supplier. This automation improves efficiency and enhances accountability among supply chain participants, ensuring fulfillment of contractual obligations.

4. Inventory management

Inventory management represents a crucial use case for blockchain technology in supply chain management. Traditional inventory management systems often suffer from inefficiencies, inaccuracies, and a lack of real-time visibility. Blockchain addresses these challenges by providing a secure and transparent ledger that tracks the movement and status of inventory items across the supply chain.

Through IoT devices and sensors, real-time data can be recorded on the blockchain, allowing stakeholders to accurately monitor inventory levels, locations, and conditions. This transparency reduces the risk of overstocking or stockouts and helps to optimize supply chain operations.

5. Compliance

With its immutable and transparent nature, blockchain provides a reliable and auditable record of all transactions and activities throughout the supply chain. This data enables businesses to demonstrate compliance with various regulations, standards, and certifications.

By securely storing and sharing data on the blockchain, supply chain participants can easily verify the authenticity and integrity of documents, such as certificates of origin, quality inspections, and regulatory compliance records.

Blockchain also facilitates the automation of compliance processes through smart contracts, ensuring that all parties adhere to predefined rules and regulations. By leveraging blockchain for compliance, businesses can mitigate risks, improve regulatory reporting, and enhance trust among stakeholders in the supply chain ecosystem.

Blockchain offers tangible benefits to businesses across different sectors and is emerging as a critical lever in streamlining supply chain operations. Blockchain builds on top of existing systems and provides significant value for businesses by increasing efficiency, enhancing trust, and building a more robust collaboration between various stakeholders involved in supply chain operations.

Let us explore the strategic benefits offered by blockchain for supply chain management.

1. Increased efficiency

The traditional supply chains often involve multiple intermediaries, manual record-keeping, and time-consuming reconciliations. Blockchain technology streamlines these operations by creating a decentralized, transparent ledger that all parties can access in real time. This process eliminates the need for intermediaries, reduces the risk of errors, and expedites transaction processes.

Blockchain offers self-executing smart contracts with predefined rules to automate supply chain operations. These contracts enable automatic compliance verification, facilitate seamless payment settlements, and trigger actions based on predefined conditions.

For instance, when a shipment reaches a specific location, payment can be triggered automatically, reducing delays and administrative overhead.

2. Reduced risk

The risks associated with the supply chain mainly originate from 4 channels - sourcing, transportation, processing, and distribution. With blockchain, businesses can track and verify every step of the supply chain process, from sourcing to distribution, in a secure and decentralized manner.

This transparency helps identify potential risks and vulnerabilities, such as counterfeit products, unauthorized modifications, or delays in transportation.

By recording transactions on a distributed ledger, blockchain ensures that all participants have access to the same information, eliminating information discrepancy and reducing the risk of fraud. The immutability of blockchain data prevents tampering or unauthorized changes, providing a reliable and auditable record of every transaction.

3. Enhanced trust

A supply chain typically consists of multiple stakeholders, processes, and transactions. Trust is critical for establishing efficient operations and a sustainable delivery stream. Traditional supply chains often suffer from information disparity, where participants have limited visibility into the activities and transactions of others, leading to inefficiencies and potential fraud.

With blockchain, each transaction is time-stamped and linked to previous transactions, creating an immutable audit trail that can be verified by all parties involved. By having a shared and tamper-proof record of transactions, blockchain technology enables increased trust among supply chain participants.

4. Improved collaboration

A traditional supply chain involves multiple parties, such as manufacturers, suppliers, distributors, retailers, and customers, each with its own systems and databases. This fragmentation often leads to inefficiencies, delays, and a lack of collaboration among the participants. With blockchain, all participants access a shared ledger that records and verifies every transaction or event in real time.

By enabling secure and transparent data sharing, blockchain facilitates better stakeholder coordination and communication. This collaboration allows effective tracking of goods, efficient inventory management, and demand forecasting, leading to improved efficiency and reduced costs.

Challenges in implementing blockchain for supply chain management

While blockchain offers multiple benefits in different industries, there are several challenges and considerations in its implementation for supply chain operations that need to be tackled effectively. The prominent challenges associated with implementing blockchain for supply chain management are as follows:

1. Scalability

Several scalability considerations in implementing blockchain for supply chain operations include high-speed connectivity, processing power, storage capacity, and energy consumption. Traditional blockchains use proof-of-work (PoW), which requires significant computational power and time to validate transactions. This technique can result in slower processing of transactions and limits scalability.

Another scalability challenge is the storage and processing requirements of blockchain data. Each transaction is recorded on every node in the network, leading to a large amount of data storage. As the supply chain grows and more transactions occur, the storage and processing demands increase exponentially. The increase in demand can strain the network's resources and hinder scalability.

Various solutions are being considered to mitigate these challenges, including sharding or layer-two protocols that aim to improve scalability by dividing the network into smaller parts or processing transactions off the main chain. Ultimately, companies must accurately forecast their network usage and requirements to deploy the most efficient blockchain solution for their specific supply chain needs.

2. Regulatory compliance

The decentralized nature of blockchain technology raises concerns regarding legal compliance. Different countries and regions have varying regulations and standards for data protection, intellectual property rights, and cross-border transactions. Implementing blockchain in a supply chain requires careful consideration of these regulations to ensure compliance.

One key aspect is the General Data Protection Regulation (GDPR) in the European Union, which governs the collection, storage, and personal data processing. Blockchain's immutability and transparency can conflict with GDPR's data protection principles.

Organizations must find ways to reconcile these requirements, such as implementing privacy-enhancing techniques like zero-knowledge proofs or off-chain storage of sensitive data.

Collaboration between blockchain developers, supply chain stakeholders, and regulatory bodies is crucial to address these challenges. Establishing industry standards and guidelines for blockchain implementation can help navigate the complex regulatory landscape and ensure compliance.

Additionally, compliance with import/export regulations, trade sanctions, and product certifications must be integrated into the blockchain system to ensure transparency.

3. Interoperability

As blockchain adoption becomes more mainstream, there must be a universal agreement on interoperability standards for ensuring global alignment. Each blockchain network may have its unique structure, consensus mechanism, and smart contract language, making it difficult to establish a standard protocol for data exchange. Additionally, the scalability and performance of blockchain networks can vary, further complicating interoperability efforts.

There must be universal consensus and interoperable standards to ensure compatibility across multiple blockchain platforms, applications, and ecosystems. This consensus will streamline cross-communication and verify end-to-end operations across the supply chain networks.

Currently, some workarounds in the form of bridges use a combination of "off-chain" relayers and smart contracts. However, this solution has some drawbacks, like high costs and resource-intensive computations. Industry-wide collaboration and standardization efforts are necessary to address these challenges.

BLOCKCHAIN APPLICATIONS IN LOGISTICS

Achieving excellence in logistics requires many partners to collaborate and constantly optimize the flow of physical goods as well as the complex flow of information and financial transactions. It is therefore quite obvious that the potential of blockchain technology can be fully exploited in the management of logistics supply chains.

The blockchain provides all parties involved in the supply chain with unrestricted insight into all transactions. Information about the status or location of a good is available in real time, and all relevant documents and shipping data can be accessed at any time. No one is excluded from information, as it is impossible for information to be shared covertly, so some participants may not have access to it.

In the supply chain, every transaction can be secured via the blockchain. Whether, for example, a good actually originates from a certain area can be traced step by step via the blockchain right back to the first entry. Once entered as a block in the chain, a transaction can no longer be modified – everyone can rely on this.

In addition, payment transactions can also be processed efficiently via the blockchain. Digital contracts integrated into the blockchain – so-called smart contracts – contain all contract details. When the necessary conditions are met, financial transactions are initiated automatically. Blockchain can also support the automation of processes in other areas, such as warehouse technology and load planning, through greater data security. More automation means more efficiency.

Blockchain and Logistics: Use Cases

Examples of blockchain logistics already in practice or currently being evaluated include:

- Blockchains for international container logistics to automate global trade through data transparency and security. A transcontinental transport by ship requires numerous steps and coordination. Reliable documentation in the blockchain simplifies the process.
- Blockchains for digital and automated customs clearance. All information is available at all times to all parties involved (consignor, consignee, logistics service provider, customs authorities) and is updated in real time.
- Blockchains to maintain food freshness and safety across the entire supply chain.
- Blockchains for sustainability to ensure a high standard of sustainability by means of transparent traceability.

Blockchain Technology at DHL

To fully realize the potential of blockchain technology for logistics, Deutsche Post DHL Group has allocated a budget of 100 million euros for the implementation of blockchain applications by 2025. Ongoing blockchain projects include the global delivery of spare parts to the car manufacturer Nissan. In the area of cross-border e-commerce, DHL is also cooperating with online retailers in test series to optimize goods traffic in this segment with the help of blockchain technologies.

As for DHL Freight, it is actively involved in projects exploring the use of blockchain technology through its subsidiary, customs service provider Gerlach Customs. In this context, DHL is participating in the Open Customs Blockchain working group, which is supported by the Open Logistics Foundation and coordinated by the Fraunhofer Institute for Material Flow and Logistics. The common goal of all parties involved: the end-to-end integration of customs and logistics processes in foreign trade using blockchain technology to make cross-border processes tamper-proof, trustworthy, and efficient.

Customs clearance is highly regulated and characterized by divergent rules and requirements of the respective countries. The authenticity of the circulating information and data is sometimes difficult to verify for authorities and other stakeholders. To achieve deeper integration and interconnection of digital customs proceedings, it is of foremost importance to strengthen trust in the data provided. Blockchain technology is ideal for this. Existing regional solutions are proving the practicability of blockchains in customs. The Open Customs Blockchain working group now aims to implement blockchain technology on a broad scale. To this end, partner customs organizations are currently being sought to implement this solution in their respective countries.

BLOCKCHAIN APPLICATIONS IN SMART CITIES

Among the cities with municipal blockchain-based initiatives, it is worth noting Dubai, which, **with an investment of US$300,000 million, aspires to become the first city in the world to integrate blockchain into all its services by 2020.** The following are examples of the use of this technology for urban management:

Security

Blockchain improves the protection of the personal data collected.

Energy

Smart blockchain-based contracts make it easier for solar-powered households to automatically trade surplus electricity with other members of the grid.

Mobility

Government departments can know which citizens use their cars daily and offer them discounts and advantages to encourage them to take public transport.

Waste

Blockchain can provide the public and the waste collection service with real-time information on containers so that they can always know whether they are full or empty.

Participation

Blockchain platforms guarantee the security, reliability, transparency and anonymity of public consultations, such as elections, surveys, referendums, etc.

In addition, blockchain technology can benefit other services, such as **water resource management, air quality control or park and garden care.**

Countries and cities with blockchain governments.

SEE INFOGRAPHIC: Countries and cities with blockchain governments [PDF]External link, opens in new window.

PLATFORMS FOR SMART CITIES

Smart cities need appropriate and highly compatible technological ecosystems to be functional and develop successfully. Otherwise they will become isolated, with systems that are unable to communicate with each other because they speak different languages. Today there are several platforms that act as a framework for smart cities:

- **United for Smart Sustainable Cities (U4SSC):** this UN initiative aims to become the platform that drives information and communication technologies (ICTs) towards smart and sustainable cities. Is also the parent of the Blockchain4Cities working group.
- **Fiware:** the European Union (EU) is behind this free software platform that provides tools and a suitable ecosystem to developers of online applications and services. Although Fiware was not designed to specifically support smart cities, it is capable of ensuring interoperability between them.
- **DownTown:** is one of the systems best adapted to smart cities. This platform has some 13,000 to 20,000 domains in smart cities around the world (including London and Dallas), with the first experiment in access to local restaurants.

BLOCKCHAIN APPLICATIONS IN FINANCE AND BANKING, INSURANCE

The **Ethereum blockchain** enables more open, inclusive, and secure business networks, shared operating models, more efficient processes, reduced costs, and new products and services in banking and finance. It enables digital securities to be issued within shorter periods of time, at lower unit costs, with greater levels of customization. Digital financial instruments may thus be tailored to investor demands, expanding the market for investors, decreasing costs for issuers, and reducing counterparty risk. Over the last five years, the technology has matured for enterprise-grade use demonstrating the following benefits:

- **Security**: Its distributed consensus based architecture eliminates single points of failure and reduces the need for data intermediaries such as transfer agents, messaging

system operators and inefficient monopolistic utilities. Ethereum also enables implementation of secure application code designed to be tamper-proof against fraud and malicious third parties — making it virtually impossible to hack or manipulate.

- **Transparency**: It employs mutualized standards, protocols, and shared processes, acting as a single shared source of truth for network participants
- **Trust**: Its transparent and immutable ledger makes it easy for different parties in a business network to collaborate, manage data, and reach agreements
- **Programmability**: It supports the creation and execution of smart contracts — tamper proof, deterministic software that automates business logic – creating increased trust and efficiency
- **Privacy**: It provides market-leading tools for granular data privacy across every layer of the software stack, allowing selective sharing of data in business networks. This dramatically improves transparency, trust and efficiency while maintaining privacy and confidentiality.
- **High-Performance**: It's private and hybrid networks are engineered to sustain hundreds of transactions per second and periodic surges in network activity
- **Scalability**: It supports interoperability between private and public chains, offering each enterprise solution the global reach, tremendous resilience, and high integrity of the mainnet

According to a **report by Jupiter Research**, blockchain deployments will enable banks to realize savings on cross-border settlement transactions of up to $27 billion by the end of 2030, reducing costs by more than 11%. Ethereum specifically has already demonstrated disruptive economics, creating over 10x cost advantages against incumbent technologies. Financial institutions acknowledge that distributed ledger technology will save billions of dollars for banks and major financial institutions over the next decade.

How does the Digitization of Financial Instruments Impact Finance?

The digitization of financial instruments – comprising digital assets, smart contracts and programmable money – takes the benefits of blockchain further by forging unprecedented levels of connectivity and programmability between products, services, assets and holdings. These digitized instruments will redefine the processes of commercial and financial markets, creating a new paradigm where value is brought at every touch point. Digital financial instruments offer the following business benefits:

- **Authenticity and scarcity**: Digitization ensures data integrity, and enables asset provenance and full transaction history in a single shared source of truth
- **Programmable capabilities**: Code that addresses governance, compliance, data privacy, identity (KYC/AML attributes), system incentives and features that manage

stakeholder participation (for voting and other rights) — can be built into the assets themselves

- **Streamlined processes**: Heightened automation increases overall operational efficiency. It enables real-time settlement, audit and reporting; and it reduces processing times, the potential for error and delay, and the number of steps and intermediaries required to achieve the same levels of confidence in traditional processes
- **Economic benefits**: Automated, more efficient processes trigger reduced infrastructure costs, operation costs, and transaction costs
- **Market reactivity**: Digital securities allow greater customization than standardized securities, and can be issued within shorter timeframes. Issuers can create bespoke digital financial instruments directly matched to investor demand.
- **New products and markets**: Secure, scalable and rapid asset transfers, fractionalized ownership of real-world assets, tokenized micro-economies, and more

Together, these benefits result in more accountable transparent governance systems, more efficient business models, improved incentive alignment between stakeholders, greater liquidity, lower costs of capital, reduced counterparty risk, access to a broader investor and capital base, and access to all other digital financial instruments.

What are the Blockchain Use Cases in Financial Services?

- **Capital Markets**
  - Issuance
  - Sales and trading
  - Clearing and settlement
  - Post-trade services and infrastructure
  - Asset servicing
  - Custody
- **Asset Management**
  - Fund launch
  - Cap table management
  - Transfer agency in asset management
  - Fund administration
- **Payments and remittances**
  - Domestic retail payments
  - Domestic wholesale and securities settlement
  - Cross border payments
  - Tokenized fiat, stablecoins and cryptocurrency

- **Banking and Lending**
  - Credit prediction and credit scoring
  - Loan syndication, underwriting and disbursement
  - Asset collateralization
- **Trade Finance**
  - Letters of credit and bill of lading
  - Financing structures
- **Insurance**
  - Claims processing and disbursement
  - Parametrized contracts
  - Reinsurance markets

How does blockchain impact capital markets?

Capital markets refers to the pairing of issuers with demand for capital, to investors with corresponding risk and return profiles. Whether issuers be entrepreneurs, startups or large organizations, the process of raising capital can be challenging. Firms face increasingly stringent regulations, longer times to get to market, volatility from interest rates and liquidity risk. Particularly in emerging markets, they must navigate the lack of rigorous monitoring, thorough regulation and sufficient market infrastructure for issuing, settlement, clearing, and trading. Blockchain offers multiple benefits for several capital market use cases:

- Elimination of a single point of failure through decentralized utilities
- Facilitation of capital market activities streamlining processes, reducing costs and decreasing settlement times
- Digitization of processes and workflows, reducing operational risks of fraud, human error, and overall counterparty risk
- Digitization or tokenization of assets and financial instruments, making them programmable and much easier to manage and trade. In token form, they gain wider market access through increased connectivity and the possibility of fractionalized ownership. This results in increased liquidity and decreased cost of capital.

How does blockchain impact asset management?

Venture capital firms, private equity firms, real estate funds, and specialty markets are facing demands to improve liability risk management, adapt more dynamic decision-making structures, and address the increasing complexity of ever-changing regulations. Blockchain can effectively streamline asset and stakeholder management. It allows:

- Automated fund launch
- Seamless stakeholder engagement with digitized assets and services

- Digitization of portfolio and existing holdings for wider market access, liquidity and fractionalization
- Customizable built-in privacy settings for transaction confidentiality
- Voting and other shareholder rights and obligations programmed into digital assets, resulting in seamless user experience and reduced risks of human error
- Creation and enforcement of incentive mechanisms to promote participation and punish nefarious activity
- Improved governance and transparency for investors and stakeholders
- Efficient cap table management
- Automated fund administration
- Automated transfer agency in asset management

How does blockchain impact global payments and remittances?

Global payments and remittances today are executed by a number of intermediaries that exact tolls for their service. It takes 2 to 7 days and costs a global **average of 6.94% to send $200** between countries. This means that remittances are directly reduced by $48B through fees, intermediaries, and financial institutions. Blockchain can streamline payment and remittance processes, reducing settlement times and significantly reducing costs. It allows:

- Rapid and secure domestic retail payments
- Rapid and secure domestic wholesale and securities settlement
- Rapid and secure cross border payments
- Real-time gross settlement between central banks, commercial banks, and independent banks
- Digitized KYC/AML data and transaction history, reducing risks of fraud and enabling real-time authentication
- Automated regulatory oversight and auditing
- Multiple forms of payment enabled on blockchain: Tokenized fiat, **stablecoin**, and **cryptocurrency**

How does blockchain impact banking and lending?

Core banking comprises of transaction, loan, mortgage, and payment services. Many of these services depend on legacy processes of execution. For example, between information verification, credit scoring, loan processing and distribution of funds— it takes 30 to 60 days for individuals to secure a mortgage, and 60 to 90 days for small or medium enterprises to secure a business loan. Blockchain can streamline banking and lending services, reducing counterparty risk, and decreasing issuance and settlement times. It allows:

- Authenticated documentation and KYC/AML data, reducing operational risks and enabling real-time verification of financial documents

- Streamlined credit prediction and credit scoring markets, instantaneously informed by the collation of user activity and sanctioned data across a network
- Automated syndicate formation, underwriting, and disbursement of funds i.e. principal and interest payments, reducing cost, delay and friction of syndication
- Facilitated collateralization of assets because digitization enables real-time asset management, tracking, and enforcement of regulatory controls

How does blockchain impact trade finance?

Trade finance refers to the infrastructure, processes and funding that support international trade supply chains. The industry continues to rely on paper-based processes that are susceptible to security vulnerabilities. Individual transactions can take as long as 90-120 days in order to process letters of credit, verify documents, and establish trust among stakeholders. Blockchain can digitize the entire trade finance lifecycle with increased security and efficiency. It can enable more transparent governance, decreased processing times, lower capital requirements and reduced risks of fraud, human error, and overall counterparty risk. It allows:

- Digitized and authenticated documentation (i.e. letters of credit and bill of lading) and KYC/AML data with real-time verification of financial documents
- Asset digitization to enable faster settlement times
- Creation of more efficient financing structures through shared secure networks and digitized processes
- Creation of a consistent financing vehicle for the entire trade lifecycle, eliminating the legacy practice of negotiating independent finance vehicles for each stage of the trade