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# ETHEREUM NETWORK

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***Abstract:*** The Ethereum network is an open-source and decentralized blockchain platform that enables developers to create smart contracts and decentralized applications (dapps). It was launched in 2015 and offers a more flexible development environment and a wider range of features compared to the original blockchain concept. Ether, the network's native cryptocurrency, powers the network, and the Ethereum Virtual Machine (EVM) enables developers to deploy and run dapps on a secure, immutable, and transparent network. In addition, the Ethereum network supports custom token creation, which can be used for financial applications and asset tokenization. However, like other blockchain platforms, the Ethereum network faces scalability and security challenges, which are being addressed through ongoing upgrades such as Ethereum 2.0. Ultimately, the innovative blockchain technology of the Ethereum network has the potential to transform various industries.

***IndexTerms – Ethereum, Design, Smart contract, Application.***

## 1. INTRODUCTION

Ethereum is a decentralized blockchain platform that has gained widespread usage and acclaim since its inception in 2015. Its main objective is to provide a programmable infrastructure for building decentralized applications (dApps) and executing smart contracts. Ethereum stands out from other blockchain platforms due to its unique characteristics, such as a Turing-complete programming language and an in-built system for creating and trading digital assets known as tokens. These capabilities empower developers to develop and deploy a broad spectrum of applications, including decentralized finance (DeFi) applications, games, and marketplaces.

The Ethereum network is supported by a decentralized network of computers and nodes that communicate and validate transactions. Ether (ETH), the platform's native cryptocurrency, is utilized to pay transaction costs and incentivize network validators.

Apart from its inventive features, Ethereum is also famous for its dynamic and engaged developer community, which has contributed to the network's expansion and adoption. Consequently, Ethereum has become a significant player in the blockchain industry and is projected to play an increasingly crucial role in the future of decentralized technology.

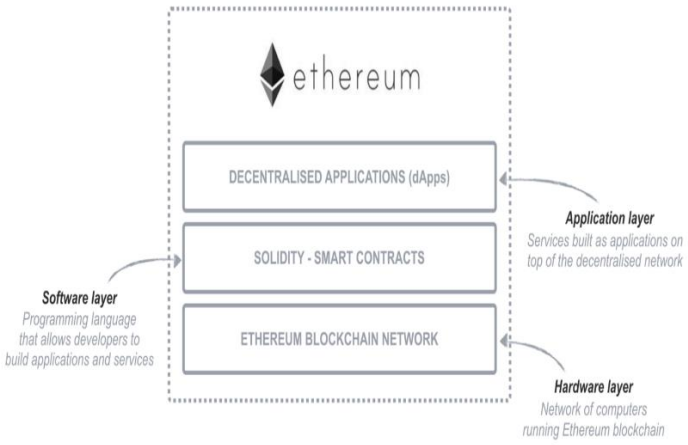


Figure 1: Layers of Ethereum

**Ethereum** is a decentralized, open-source blockchain platform that enables the creation of smart contracts and decentralized applications (dapps). It was launched in 2015 as a continuation of the original blockchain concept but with a wider range of capabilities and a more flexible development environment. The Ethereum network operates on the Ethereum Virtual Machine (EVM) and is powered by Ether, the native cryptocurrency of the network. The fundamental SC language is the low-level bytecode language and ETH network provides a virtual machine (i.e. Ethereum virtual machine, EVM) which executes such code [1]. The

platform allows developers to build and deploy decentralized applications that run on a tamper-proof, secure, and transparent network. Ethereum also supports the creation of custom tokens, enabling the development of tokenized assets and financial applications.
Ethereum has several distinctive features, including:

- Decentralized Nature: It operates on a network of nodes that are not controlled by a central authority, making it a decentralized platform.
- Smart Contract Capabilities: Ethereum enables developers to create and implement self-executing contracts that have the terms of the agreement between buyer and seller encoded in code.
- Dapp Development: The platform provides an environment for building and operating tamper-proof and transparent decentralized applications (dapps).
- Token Creation: The network supports the creation of custom tokens, allowing for the development of tokenized assets and financial applications.
- Ethereum Virtual Machine: The EVM acts as a sandbox environment for executing smart contracts and dapps, providing security and reliability.
- Ether Cryptocurrency: Ether is the primary cryptocurrency of the Ethereum network, used to pay for transactions and computational resources required to run smart contracts.
- Open-Source Platform: Ethereum is an open-source platform, inviting developers to contribute to its advancement and innovation.

### 1.1 History

In 2013, Vitalik Buterin proposed Ethereum, a blockchain platform that could handle more complex applications beyond digital currency transactions. The Ethereum Foundation was then created in July 2014 to develop the platform. While similar to Bitcoin, Ethereum allows for the development and execution of decentralized applications or dapps, which are not controlled by any single entity. The Ethereum network was officially launched in 2015 and has since become the second-largest blockchain platform in terms of market capitalization. The Decentralized Autonomous Organization (DAO) hack in 2016 was a significant event in Ethereum's history that resulted in a hard fork in the network, creating two separate chains: Ethereum (ETH) and Ethereum Classic (ETC).

Ethereum has continued to evolve and grow over the years, with the launch of Ethereum 2.0 in December 2020 being a major milestone. Ethereum 2.0 introduces a number of improvements, including increased scalability, security, and energy efficiency. The new network is designed to handle a much larger number of transactions, making it possible for developers to build even more complex and sophisticated dapps.

Overall, since its inception in 2013, Ethereum has undergone significant development and expansion. While originally intended to serve as a digital currency platform, Ethereum has transformed into a flexible and robust decentralized network that accommodates a broad range of applications. The launch of Ethereum 2.0 is a recent milestone that is likely to fuel further innovation and growth in the Ethereum ecosystem.

## 2. DESIGN

The design of the Ethereum network is focused on creating a decentralized, open-source blockchain platform that can support the development of decentralized applications (dApps) and smart contracts. To achieve this goal, the Ethereum network was built with several key features, such as a Turing-complete programming language and a built-in system for creating and trading digital assets known as tokens.

One of the primary design goals of the Ethereum network is to provide a high degree of flexibility to developers. This flexibility is achieved through the use of smart contracts, which can be programmed to execute a wide range of tasks and can interact with other smart contracts and decentralized applications on the network.

The Ethereum network is also designed to be secure and resistant to attacks. To achieve this, the network uses a decentralized network of computers and nodes to validate transactions and secure the network. The use of a consensus mechanism, such as Proof of Work or Proof of Stake, helps to ensure that the network is operating as intended and that transactions are valid.

Overall, the design of the Ethereum network is focused on providing a flexible and secure platform for the development of decentralized applications and the execution of smart contracts. This has helped to make Ethereum one of the most widely used and innovative blockchain networks in the world.

### 2.1 Ether

Ether (ETH) is the cryptocurrency of the Ethereum network, which serves as the currency or fuel that powers transactions and computational tasks. Unlike Bitcoin, which mainly functions as a digital currency, Ether's primary purpose is to be a medium of exchange for decentralized applications and smart contracts on the Ethereum platform.

The value of Ether is determined by the principles of supply and demand in the market and can be bought and sold on various cryptocurrency exchanges. It is primarily used to pay for transaction fees and computational services within the Ethereum network. The fees for these services can vary depending on the current demand for resources.

Holding Ether provides access to decentralized applications and smart contracts built on the Ethereum platform, as well as voting rights for proposed upgrades to the network. This allows Ether holders to have a say in the future development of the platform.

In conclusion, Ether is an essential part of the Ethereum network and plays a crucial role in its operation and growth. As the network and its applications continue to expand and become more widely adopted, the value and use cases for Ether are expected to grow.

### 2.2 Accounts

An Ethereum network account refers to a unique identifier, similar to a bank account, that holds a balance of Ether and has the ability to send and receive transactions. The network has two types of accounts:

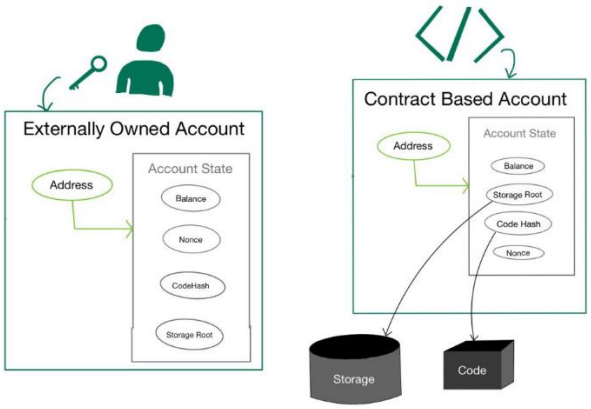


Figure 2: Types of Accounts

External accounts controlled by private keys and smart contract accounts controlled by code.

External accounts, controlled by a private key, are used for human-to-human transactions. These can be created by users and managed using wallet software or a cryptocurrency exchange.

Smart contract accounts are self-executing contracts with terms written in code. These accounts are managed automatically by the Ethereum network and programmed to perform specific actions based on conditions.

Both account types play a crucial role in the network's functioning, allowing secure storage and transfer of Ether, as well as executing decentralized applications and smart contracts. Ensuring the security of an account requires proper storage of the private key and protecting it from unauthorized access.

### 2.3 Ethereum Virtual Machine

The Ethereum Virtual Machine (EVM) is a software environment that executes smart contracts on the Ethereum network. It acts as a runtime environment for decentralized applications and provides a secure and isolated environment for executing contracts.

The EVM allows developers to create and deploy smart contracts without the need for a central authority, as all code is executed in a decentralized manner. This ensures that the outcome of the contract is predictable and cannot be altered by any single entity

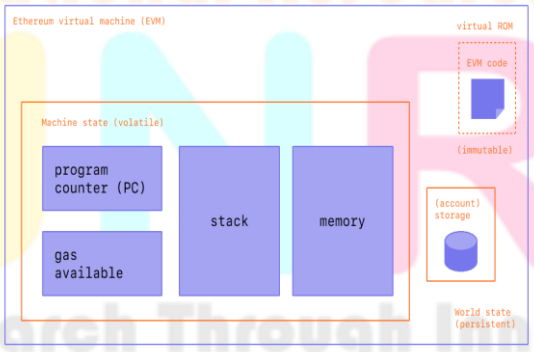


Figure 3: EVM

The EVM also acts as a sandbox, providing a secure and isolated environment for the execution of contracts. The execution engine remains quite inefficient, and so is certainly unsuitable for creating any kind of complex applications at the script level [2]. This protects the Ethereum network from malicious code, as well as from security breaches and vulnerabilities.

Additionally, the EVM is designed to be platform agnostic, meaning that it can run on any computer or device with an Ethereum client installed. This allows for a high degree of compatibility and scalability, making it easier for developers to create and deploy decentralized applications on the Ethereum network.

Overall, the EVM is a key component of the Ethereum network, providing a secure and decentralized environment for the execution of smart contracts and decentralized applications.

## 3. SMART CONTRACT

The concept of a smart contract was first introduced by computer scientist Nick Szabo in 1994. It is an automated computer program that enforces the terms of a contract between two or more parties and has become a fundamental feature of many blockchain platforms, including Ethereum.

The main objective of smart contracts is to eliminate intermediaries in transactions, such as brokers or lawyers, by offering a transparent, secure, and automated way to execute agreements. It acts as a software agent or delegate of the party that employed it with the intention that it fulfills certain obligations, exercises rights and may take control of assets within a distributed ledger in an automated way [3]. These contracts are built using programming languages and can execute automatically when specific conditions are met.

Smart contracts can operate independently, without human intervention, once they are deployed to a blockchain network. This makes them particularly useful for tasks such as supply chain management, financial transactions, and digital identity verification.

Smart contracts can streamline business processes, reduce transaction costs, and increase transparency and security. As blockchain technology evolves, the use cases for smart contracts are expected to expand, making them an increasingly important component the digital economy.

How do smart contract works:


Figure 4: Smart Contract Working

### 3.1 Trust And Contract

The concept of trust and contract is central to the functioning of the modern business world. Trust refers to the belief or confidence in the reliability and integrity of a person or organization. Contracts, on the other hand, are legal agreements between two or more parties that outline the terms and conditions of a particular transaction.

In a business context, trust plays a vital role in establishing and sustaining relationships with stakeholders, suppliers, and customers. Trust enables parties to collaborate and conduct transactions with assurance that the agreed-upon terms will be upheld. Contracts provide a framework for defining the terms of a transaction, including the rights and responsibilities of each party. They also provide a legal mechanism for resolving disputes and enforcing the terms of the agreement.

When trust and contract are combined, they create a powerful combination that helps to build and maintain relationships and ensures that transactions are carried out fairly and effectively. This is particularly important in complex business relationships, where there may be a significant amount of money or valuable assets involved. Trust and contract are important components of the modern business world, and they play a crucial role in facilitating transactions and maintaining relationships between parties.

### 3.2 A Digital Vending Machine

A digital vending machine refers to an automated system that facilitates the purchase of goods or services through a digital interface such as a computer, mobile device, or a dedicated vending machine terminal. The aim is to simplify the buying process by eliminating the need for physical money, and instead utilizing digital payment methods like credit cards, debit cards, mobile payments, and digital currencies.

The system operates in real-time, processing transactions quickly and dispensing the purchased item or service immediately. Digital vending machines are widely utilized across different industries, from food and beverage to retail, and entertainment, and they offer several benefits over traditional vending machines. For example, they enable businesses to accept multiple payment methods, monitor sales and inventory, and provide a more efficient and convenient buying experience for customers.

Digital vending machines play a crucial role in the shift towards digital transformation and the growing adoption of digital technologies in various industries. They provide a cost-effective and user-friendly solution that benefits both businesses and consumers.

#### 3.2.1 Automation Execution

Automated execution involves the use of technology to automate repetitive and routine tasks, freeing up time and resources for other activities. Tasks such as data entry, data analysis, and workflow management can be automated. Benefits of automation include increased efficiency, reduced errors, improved accuracy, and standardization. Automated processes are typically faster, more reliable, and can operate 24/7, enabling organizations to scale and grow effectively.

Moreover, automation can help reduce costs by minimizing the need for manual labor and the number of staff required to complete tasks. Automation allows organizations to collect and analyze large amounts of data, providing valuable insights that can be used to make business decisions and improve overall performance.

However, automation requires careful planning and implementation, as well as a clear understanding of the processes and systems involved. Organizations must also consider the impact of automation on their workforce and take steps to support their employees through the transition. Despite these challenges, automation is a powerful tool for organizations looking to streamline their processes, improve their operations, and drive growth and success.

### 3.2.2 Prediction Outcome

The prediction of outcomes refers to the process of estimating the future result of a particular event or scenario based on available data and information. This can be done through various techniques such as statistical analysis, machine learning, or artificial intelligence.

In a digital vending machine context, prediction outcomes can refer to the estimation of customer purchasing patterns and behaviors. This information can then be used by vending machine operators to optimize the machine's inventory and improve customer satisfaction.

For example, by analyzing customer data, vending machine operators may be able to predict the most popular items at certain times of day or in certain locations. This information can then be used to ensure that the machine is stocked with the right items, reducing the risk of stockouts and improving customer satisfaction.

In addition to improving customer satisfaction, accurate prediction of outcomes can also help vending machine operators improve their business operations by reducing waste and increasing efficiency. By understanding customer behavior and purchasing patterns, operators can make data-driven decisions to optimize their supply chain and increase profitability. Overall, the prediction of outcomes is an important tool for businesses, particularly in the context of digital vending machines, as it can help optimize operations and improve customer satisfaction.

### 3.2.3 Public Record

A public record in a digital vending machine refers to information that is stored in the machine's database and is available to the public for inspection and use. This can include information about the items or services offered by the machine, the prices of these items or services, the machine's transaction history, and other relevant details.

Public records in digital vending machines are used to provide transparency and accountability in the vending machine industry. For example, these records can help track the sales and usage of vending machines, as well as monitor the quality and availability of the items or services they offer.

Moreover, public records can also be used by researchers and data analysts to study consumer behavior and preferences, as well as to identify trends and patterns in vending machine usage. They can also be used by regulators to enforce industry standards and ensure that vending machines are operating in a safe and secure manner. Public records play a crucial role in the operation and management of digital vending machines, providing valuable insights and information for businesses, consumers, and regulators alike.

### 3.2.4 Privacy Protection

A digital vending machine that prioritizes the privacy of its users is crucial to build and maintain trust. The machine should take steps to protect personal and financial information from unauthorized access or misuse. Encryption and secure communication protocols can be used during transactions to ensure sensitive information is kept confidential.

Users should have the option to opt-out of data collection and analysis for marketing purposes. The digital vending machine should also have proper disposal methods for personal and financial information.

Transparency is also an important aspect of privacy protection. The machine should clearly explain its privacy policies and provide users with easy access to their personal and financial information. This promotes responsible data practices and helps build trust with users. Privacy protection is vital to the success of digital vending machines. It ensures users feel secure when making purchases and enables the continued growth and innovation in the digital vending industry.

### 3.2.5 Visible Terms

Visible terms refers to the terms and conditions, policies, and agreements that are clearly visible and accessible to the user. These terms should outline the rights and responsibilities of both the user and the provider, such as the use of personal information, payment and refund policies, and any other relevant terms.

In the context of a digital vending machine, visible terms can be displayed on the machine's screen, in the user's account, or on the vendor's website. It is important for users to be able to easily access and understand these terms before making a purchase, as they provide important information about the transaction and protect both parties involved.

Having visible terms is important for maintaining trust and transparency between the user and the vendor, as well as for ensuring legal compliance. It is also a way for vendors to clearly communicate their policies and establish expectations for the user.

## 4. APPLICATIONS

### 4.1 Token System

Token systems that are based on blockchain technology have a wide range of potential uses. These can include serving as digital currencies representing tangible assets like USD or gold, or representing company stocks or smart property. Token systems can also be used as secure, unalterable coupons, or simply as point systems for incentivization purposes. The implementation of a token system on Ethereum is relatively straightforward and only requires the implementation of specific logic into a smart contract.

The core principle behind a token system is to enable a database with a single operation. This operation subtracts X units from one party (A) and transfers X units to another party (B). The transaction is approved by party A and is only executed if party A has at least X units prior to the transaction.

The basic code for implementing a token system in Serpent looks as follows:

```
def send(to, value):
  if self.storage[msg.sender] >= value:
    self.storage[msg.sender] = self.storage[msg.sender] - value
    self.storage[to] = self.storage[to] + value
```

Token systems based on blockchain technology have vast potential applications and are easy to implement. This versatility and ease of use make them a promising tool for a variety of industries, from finance to gaming and beyond.

### 4.2 Financial Derivatives and Stable-value Currencies

Financial derivatives are an important aspect of financial markets, providing a way for investors to hedge their risks and manage their portfolios. With the rise of blockchain technology, the creation of financial derivatives through smart contracts has become increasingly possible and accessible.

Using smart contracts for financial derivatives provides a significant advantage by automating the process of executing trades and settling transactions, resulting in reduced need for intermediaries, lower risk of fraud and errors. It also leads to faster settlement times, lower transaction costs and greater accessibility to a wider range of investors.

One of the challenges of implementing financial derivatives on the blockchain is the need for reference to external price tickers. This requires a data feed contract maintained by a trusted third-party, which provides the latest prices for various assets. This data feed contract must be designed so that it can be easily updated and accessed by other smart contracts.

Despite these challenges, they provide significant benefits. They introduce greater transparency and efficiency in financial markets, creating new opportunities for portfolio and risk management. With the advancement of technology, the financial derivatives market will likely see more smart contract applications.

### 4.3 Non-Fungible Tokens (NFT)

NFTs, also known as Non-Fungible Tokens, are digital assets that are stored securely using blockchain technology. Unlike traditional digital assets, each NFT is unique and cannot be exchanged for another token, making them one-of-a-kind. This enables individuals to securely own and manage their digital assets in a decentralized manner.

These tokens have a range of applications, from digital art and music to video games and collectibles. For instance, a digital artist could sell a unique piece of artwork as an NFT, and a collector could own and showcase it in their digital collection. Similarly, a musician could release a limited edition album as an NFT, providing fans a new and innovative way to own a piece of the artist's work.

NFTs bring scarcity and authenticity to the digital world. Their unique nature ensures that the value of an item is not diluted by an oversupply of similar items, and blockchain technology secures the ownership and authenticity of digital items. This makes NFTs a valuable tool in the fight against counterfeits and fraud. NFTs represent a promising advancement in the blockchain industry and offer a secure and decentralized way for individuals to own and control unique digital assets.

### 4.4 Decentralized Finance

Decentralized Finance (DeFi) refers to a financial system built on top of blockchain technology that operates without the need for intermediaries such as banks or traditional financial institutions. Instead, DeFi relies on decentralized networks, smart contracts, and blockchain technology to provide financial services.

One of the key benefits of DeFi is increased accessibility. By utilizing blockchain technology, DeFi can provide financial services to people who may not have access to traditional financial institutions, such as those in developing countries or those with low credit scores. Additionally, DeFi operates on a global scale, allowing users from around the world to participate in its financial services.

Another benefit of DeFi is its security and transparency. Transactions on a blockchain are immutable and visible to anyone on the network, making it difficult for bad actors to manipulate the system. This increased security can help reduce the risk of fraud and other malicious activities.

The decentralized finance (DeFi) sector is rapidly expanding within the blockchain industry, providing a novel approach to offering financial services in a more accessible and decentralized manner. This development has the potential to disrupt the conventional financial industry and create new opportunities for individuals globally.

## 5. ETHEREUM 2.0

Ethereum 2.0, also referred to as Serenity, is an upgraded version of the Ethereum network created to tackle the scalability and security issues that the current Ethereum network faces. Ethereum 2.0 introduces the staking concept, which enables users to earn rewards by locking up their Ethereum to help secure the network. This eliminates the current proof-of-work consensus mechanism, which consumes resources and exacerbates the Ethereum network's scalability problems.

In addition to staking, Ethereum 2.0 will also introduce sharding, which allows the network to process transactions in parallel, increasing its overall transaction throughput.

Another major change in Ethereum 2.0 is the shift from the current Ethereum Virtual Machine (EVM) to the new Ethereum 2.0 Virtual Machine (Ewasm), which is designed to be more efficient and secure.

The Ethereum network is anticipated to undergo significant improvement in terms of scalability and security with the introduction of Ethereum 2.0, rendering it more appropriate for the expanding requirements of decentralized applications and DeFi use cases. Therefore, Ethereum 2.0 can be regarded as a noteworthy advancement for the Ethereum network, as it endeavors to tackle some of the scalability and security obstacles encountered by the present network and establish a more scalable and secure future for decentralized applications and DeFi.

## 6. CONCLUSION

Ethereum is a decentralized blockchain platform that provides a programmable environment for creating decentralized applications (dApps) and executing smart contracts. Decentralized applications are often described as trustless or peer-to-peer with the distinguishing characteristic that there is no single server or entity controlling it like in a client–server model [4]. It distinguishes itself from other blockchain platforms by featuring a Turing-complete programming language and a built-in system for creating and trading digital assets known as tokens.

Ethereum is undergoing a significant upgrade with the introduction of Ethereum 2.0, also known as ETH 2.0. This upgrade aims to tackle scalability and security challenges and implements important changes, including the switch to Proof-of-Stake consensus mechanism and an increase in maximum block size.

Ethereum is a crucial player in the blockchain industry and continues to shape the future of decentralized technology. The launch of ETH 2.0 is a considerable step for the Ethereum network and is expected to have a considerable impact on the broader blockchain community.

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