



Introduction to Ethereum

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Ether is the second largest cryptocurrency by market capitalisation behind bitcoin. Its current market cap stands at \$223 billion, representing approximately 18% of the total cryptocurrency market¹.

Conceived in 2013 and created in 2015, the blockchain network Ethereum has grown in innovation and utility. Different from Bitcoin’s primary function as a peer-to-peer electronic cash system and anti-fiat asset that could act as a hedge in another banking crisis, Ethereum invents a new world of peer-to-peer applications.

Before we dive into details, it’s important to distinguish ether (ETH) from Ethereum. Ether refers to the cryptocurrency used on the Ethereum blockchain. Ethereum refers to the blockchain network.

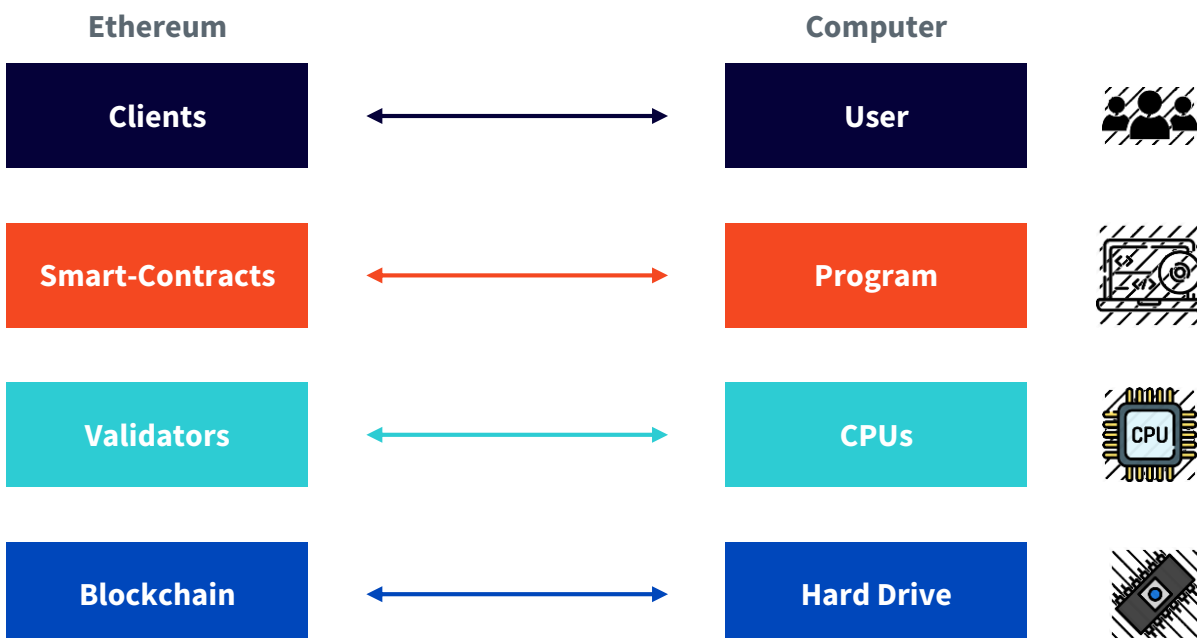
What is Ethereum?

Ethereum is a modular and programmable blockchain that handles applications without relying on a centralised counterparty.

The platform is built on the public, open-source, decentralised and cryptographic blockchain technology. It powers decentralized applications (dApps) that are supported by smart contracts.

With its collective computing power on the distributed network (the Ethereum Virtual Machine), Ethereum executes peer-to-peer transactions to realise automatic, conditional transfer of value and information, including money, voting rights, and property.

Ethereum can be compared to a ‘world computer’ on a blockchain where the underlying blockchain technology is the virtual machine’s hard drive, smart contracts are programs, validators² are central processing units (CPUs), and users pay with ETH to use this ‘computer’.



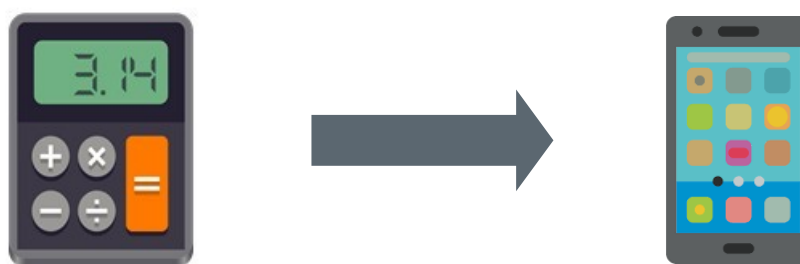
1. CoinGecko, 24 April 2023.

2. A validator is a participant in a proof-of-stake blockchain who’s responsible for validating new transactions and maintaining network security.

Solving the problem

Ethereum's invention was inspired by Bitcoin.

Bitcoin established the foundation for decentralised blockchain technology but its functionality has been limited to peer-to-peer electronic cash transfers. Ethereum expands Bitcoin's functionality to programmable applications. Essentially, Ethereum aims to create a decentralised network to run various applications. To borrow its founder Vitalik Buterin's metaphor: "Bitcoin is like a calculator, but Ethereum wants to become a smart phone running many applications"³.



This decentralised network automates decisions and transactions reducing the need for a trusted central party. It lowers the need for intermediaries, reduces arbitration costs, prevents fraud, and minimises mistakes.

How does Ethereum work?

Smart contracts

At the core of Ethereum are smart contracts.

Smart contracts are pieces of code or programs that tell the blockchain what to do. Nick Szabo, the developer behind them, has often compared smart contracts to codes behind vending machines.

A smart contract is executed when triggered by a transaction. In the example of a vending machine, the smart contract is triggered when a user inserts a coin into the vending machine. Once it's triggered, the action is executed based on 'if ... then...' conditions embedded in the smart contract code.

In the same way, pressing a combination of buttons on a vending machine releases a bottle of water. The specific product that gets dropped in the vending machine is the outcome of the smart contract. An equivalent on the Ethereum network could be a value transfer of ETH to another account or a transaction that triggers another smart contract.

A smart contract abides by a predefined set of rules that allow it to automatically execute code in the same way on every Ethereum node on the network. This eliminates the need for a third party to carry out the code execution on behalf of the users, making the system decentralised. The system empowers coders to create a wide range of applications layering together different smart contracts.

3. Vitalik mentioned this metaphor during a speech he gave on 10 October 2016, 'Ethereum in 25 Minutes.'

In a decentralised insurance application, for example, members can purchase insurance directly on the application with the network's native token. A pool of money is established aggregating insurance payments from all members. When a disaster hits, payouts will be made to impacted members without the need to go through the traditional insurance industry's cumbersome reimbursement process. Crop insurance, for example, could automatically pay out if droughts or flooding are reported in the area by government agencies.

Gas

Fees need to be paid in ETH to validators in order to facilitate transactions and execute smart contracts. This fee is called gas. Gas price is often a small fraction of ETH, which is denoted in the unit of Gwei (10^9 Gwei = 1 ETH).

Gas is essential in sustaining the Ethereum network. It incentivises validators to stake their ETH, help process and verify transactions, and secure the Ethereum blockchain for a monetary reward. The amount of gas needed in a transaction is dependent on the network congestion at the time of transaction, the demand for transaction validations, and the number of validators participating in the process. When the network is congested and the demand for transaction validations is high, the gas price is also high and vice versa. The planned Proto-Danksharding⁴ upgrade is expected to alleviate the congestion experienced on the Ethereum network.

Applications

Ethereum's applications take advantage of blockchain technology's decentralised and immutable nature. Code and applications can be created and contributed to the network by anyone without tampering with the system's security. The purpose of applications ranges widely. Here are a few important examples:

- + **Decentralized Finance (DeFi):** DeFi aims to build an open and global financial system that can be accessed by anyone with an internet connection. Unlike the traditional trust-based, centralised finance industry, DeFi is trust-minimised, meaning that the system's operation doesn't rely on any single entity but is owned by its users. This decentralised structure enables the network to be accessible on demand by anyone. The network is also transparent, faster and cheaper than the centralised trust-based system. The decentralised network connects peer-to-peer supply and demand eliminating the need for intermediaries. Users can borrow, lend, invest, trade, earn interest, buy insurance and transfer money in a decentralised manner.
- + **Decentralized Autonomous Organizations (DAOs):** A DAO refers to an organisation without a third party that's established for a common purpose. This organisation operates and collaborates through a shared, defined and automated protocol to ensure all group members' voices are heard and the decision-making process is transparent. Each DAO has an embedded treasury where the funds are stored and the funds are spent according to member votes.

4. Proto-Danksharding is a way to scale Ethereum so it can handle more transactions at a lower cost by using layer 2 solutions.

One of the early examples of a DAO is a decentralised venture capital fund named “The DAO”. Launched in 2016, members could purchase DAO tokens to gain voting rights on investment proposals. If a project became profitable, members would be given a return according to their stakes. Although the DAO was an innovative idea, it failed due to a bug in its smart contract code that allowed hackers to steal a portion of its funds. This led to a decision to implement a hard fork on the Ethereum network creating a branch called Ethereum Classic. Other examples of a DAO have continued to operate successfully, such as MakerDAO which enables the generation of Dai, a decentralised stablecoin.

- + **Non-fungible tokens (NFTs):** NFTs are data records on the blockchain which make the underlying assets immutable and differentiated. They range from digital assets such as photos, audios, videos, shares and certificates, to physical assets such as properties and paintings.

Since digital files are easy to replicate, having a non-fungible token that proves ownership is important. When an NFT is bought the owner gains an unchangeable ownership record. The appeal of an NFT for a digital asset lies in the sense of scarcity it creates, improving the asset’s collectable value. For an artist selling the asset, NFTs allow for a direct distribution of their work without a third-party platform, enabling them to better protect their copyrights and meaningfully increase profits.

For an NFT backed by physical assets, tokenization provides proof of digital ownership and preserves the uniqueness of the item. Since late 2022 tokenization of real-world physical assets has become increasingly popular.

What’s next for Ethereum?

The main characteristic of the Ethereum blockchain is its constant upgrades and continuous development.

In September 2022 Ethereum moved from proof-of-work consensus mechanism to proof-of-stake in an upgrade known as ‘The Merge’. This changed the way transactions are processed and validated, and the way the Ethereum network is secured. Although the proof-of-stake Beacon Chain⁵ was originally introduced in December 2020, it wasn't possible to withdraw staked ETH or the accumulated rewards until April 2023.

One of the main advantages of moving to the proof-of-stake mechanism was the significant energy savings the network achieved from this transition. Instead of relying on miners with energy-intensive equipment to solve complex mathematical problems, validators lock their ETH tokens in a smart contract to validate transactions and secure the network, and receive new ETH tokens as a reward.

The next major improvement on Ethereum will increase the network's capacity. Instead of implementing ‘sharding’ by splitting the network into smaller ‘shards’ and increasing space that way, the focus among developers seems to be on Proto-Danksharding which aims to improve capacity by working with layer 2 scalability solutions.

5. Beacon Chain is the original proof-of-stake blockchain which ran in parallel to the proof-of-work blockchain until The Merge.

Layer 2 scalability networks move a bunch of transactions off-chain, roll them up and combine them back into a single transaction that's secured on the layer 1 blockchain, benefitting from its robustness and security. This process represents most of the cost of layer 2 scalability solutions, but is essential for reconstructing transactions on the base blockchain if there's an issue on layer 2.

To this end, developers are working on a solution where a temporary increase in data storage would be added for layer 2 networks on Ethereum. This would enable the network to handle more transactions at a fraction of the cost of the current setup.

Conclusion

The Ethereum network is a decentralised modular and programmable blockchain. It continues to be the most widely adopted smart contract platform by app developers. The blockchain keeps evolving and upgrading, and provides an exciting platform to create decentralized applications, eliminate centralised counterparties, and provide faster, more cost-effective solutions for the finance applications of the future.

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