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Blockchain technology basics

Key takeaways

- Blockchain is an innovative way to record and share information without needing a central entity or company.
- Blockchain is literally a "chain of blocks," secured by cryptography and group agreement, making it reliable for keeping honest records.[1]

Blockchain is a simple yet powerful way to keep records digitally. It's like a shared notebook that many people can write in, but once something is written, it cannot be changed or erased. This technology was first implemented in 2008 by someone (or a group) using the name Satoshi Nakamoto to support bitcoin, the first native blockchain digital asset.

The key idea is that the blockchain is decentralized, so that no single person, company, or government controls it. Instead, it is run by a group of computers — called nodes — that work together. In public networks like Bitcoin and Ethereum, anyone can set up and own a node by downloading the software and connecting to the network. These nodes are spread out all over the world and check each other's work in an effort to make sure everything is fair and accurate. This setup builds trust because everyone can see the records, and it's hard for anyone to tamper with them.

Blockchain gets its name from how it stores information — in "blocks" that are linked together like a "chain." Each block holds details about a transaction, such as one person sending bitcoin to another person. The chain grows as new blocks are added, creating a permanent history that's secure from tampering as the "blocks" are cryptographically linked, making any alternation detectable and requiring enormous computational power to rewrite the entire chain.

How blockchain works

Think of blockchain as a chain of locked boxes. Each box (a block) contains a list of events or transactions, plus some extra details to help keep it secure.

1. What is blockchain, McKinsey & Company. June 6, 2024.

When someone wants to add new information, like "Person A sends 5 units of a digital asset to Person B," it's grouped with other similar items into a new block. Every block has three main parts:[2]

- **The data**: This is the actual information, like the transaction data.
- **A timestamp**: This is just the date and time when the block was made, like a postmark on a letter.
- **A hash**: This is a special code, like a unique fingerprint[3]. It's created using math rules (called cryptography) that turn the block's contents into a short string of letters and numbers. If you change even one tiny thing in the block, the hash changes completely.

What makes the chain durable is that each new block includes the hash from the previous block. So, Block 2 has Block 1's hash inside it, Block 3 has Block 2's, and so on. If someone tries to change something in an old block, all the hashes after it would break, and everyone would notice.

Generally, transactions are added to a temporary pool[4] and, when enough transactions build up, a new block is created to bundle them together. To add a new block, the network must agree on it. This agreement is called consensus. It's like a group vote to make sure the information is correct. The consensus can be achieved in ways that differ across blockchains:

- **Proof of work (PoW)**: This is used on the Bitcoin platform. Computers (nodes) race to solve a hard math puzzle. The first one to solve it gets to add the block and earns a reward. It's like mining for gold — it takes a lot of energy and computer power, but it helps keep the system secure because tampering would cost too much. To tamper with an established PoW network like Bitcoin would require someone to control more than half of the network's computational power. Currently, this would require massive amounts of specialized hardware and consume enormous amounts of electricity. [5]
- **Proof of stake (PoS)**: This is used on the Ethereum platform[6]. Security of the network is achieved through a system where people pledge their own digital assets as collateral to participate. This deters malicious behavior because any attempt to tamper with the blockchain records — such as approving invalid transactions — results in "slashing." That means part or all the malicious actors stake is forfeited as a penalty, making attacks economically unviable as controlling the network requires acquiring a majority of the staked coins, which in established networks would be prohibitively expensive.[7] To encourage people to pledge collateral to secure the system, the network distributes rewards. Rewards are distributed by pseudo-randomly selecting participants based on the size of their pledge, with larger commitment increasing selection chances[8]. The Ethereum participant chosen to propose and validate a new "block" of transactions earns transaction fees and newly minted digital assets as an incentive for maintaining network integrity.[9]

Here is a step-by-step process:

1. Someone starts a transaction and sends it to the network.

2. Structure and Components of a blockchain, bytefederal. Novermber 10, 2025.
3. What is a blockchain, McKinsey & Company. June 6, 2024.
4. Memory Pool, learnmeabitcoin.com. August 30, 2025.
5. Why Does Bitcoin Mining Use Energy, River Learn. November 10, 2025.
6. Proof-of-stake, Ethereum.org. October 21, 2025.
7. Why Does Bitcoin Mining Use Energy, River Learn. November 10, 2025.
8. Proof-of-stake, Ethereum.org. October 21, 2025.
9. Proof-of-stake, Ethereum.org. October 21, 2025.

2. Computers (nodes) perform an initial check on the transaction to see if it is valid — for example, does the sender have enough of the digital asset to send?
3. Valid transactions are bundled into a block, and a new hash is generated.
4. Computers (nodes) use consensus (like PoW or PoS) to validate the block. While the individual transactions have already gone through an initial check, a final consensus or agreement is needed to avoid discrepancies and provide a consistent record. This can take several minutes or be completed quickly based on the network.[10]
5. The block is added to the chain, and every computer (node) updates its copy of the notebook.

Because copies are shared across the blockchain network of computers, if one computer goes down, another keeps going. And since the blockchain is locked with hashes, it is very hard to fake or change past records.[11]

Key characteristics of blockchain

We believe blockchain is innovative because of a few important features.

- **Decentralization***:* No one entity maintains blockchain making it more difficult for a bad actor(s) to take create fraudulent activities on a blockchain.
- **Transparency**: The whole blockchain is open to the public, like a public bulletin board. But users can stay somewhat private — users use codes (called addresses) instead of names.
- **Security**: The math behind hashes and the group checks makes it tough to hack.[12] To infiltrate the blockchain system, you would need more than half of the network's power (blockchains rely on consensus to consider what is valid; majority rules), which is very expensive and impractical for big blockchains.
- **Immutability**: This means that once data is recorded in a block and added to the chain, it cannot be altered or deleted without detection.[13] This is a key characteristic because it helps build trust and reliability in the system, making blockchain a consideration for applications like secure transactions, audits, and verifiable histories where integrity is paramount.
- **Efficiency**: Blockchain can help cut out the middleman — in this case intermediaries like payment processors or third-party processors who facilitate transactions, verify identities, or handle data between parties. This can help make things quicker and cheaper, though busy times can slow down the efficiency and speed of recording everyone's transactions.

Of course, blockchain technology is not perfect.

Potential disadvantages of blockchain

- **Scalability issues**: Some blockchain networks like Bitcoin process a limited number of transactions per second, that can lead to slow confirmation times and high fees during peak usage.[14]
- **High-energy consumption**: PoW blockchains require massive computational power for mining, consuming enormous amounts of electricity and contributing to environmental concerns like carbon emissions.[15]

10. Block Validation, Wall Street Mojo. November 6, 2023.
11. Bitcoin With No Internet: What Happens To Bitcoin If The Internet Goes Down?, Bitkan. September 2, 2024.
12. Can Bitcoin Be Hacked? River Learn. River.com.
13. What is a blockchain, McKinsey & Company. June 6, 2024.
14. The problem of scalability in the bitcoin network. Bitpanda.com
15. Bitcoin Energy Consumption Index. Digiconomist.

- **Regulatory uncertainty**: Governments worldwide have varying or unclear regulations on blockchain and digital assets, which can create legal risks.
- **Irreversibility of transactions**: Once confirmed, a transaction cannot be reversed, meaning errors or fraudulent transactions result in permanent losses without recourse, unlike traditional banking systems.[16]

Blockchain adoption is accelerating rapidly as a distributed ledger technology, with the total digital asset market capitalization having grown from around $776 billion in 2020 to over $3.6 trillion as of November 2025.[17] Over the next decade, this innovation holds the potential to transform industries by enabling secure, peer-to-peer transactions in finance, supply chain management, and healthcare while disrupting traditional models through enhanced efficiencies, transparency, and new opportunities for direct interactions among users – for example, large box stores can use blockchain to track food products through its supply chain for faster safety checks and recalls, delivery carriers improve package traceability and resolve shipping disputes more efficiently, and global shippers can apply it to global shipping logistics to reduce paperwork and speed up processes.

16. Why blockchain transactions are irreversible. Tokenmetrics.com
17. Coingecko.com, as of November 3, 2025.

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