Blockchain | Can Scalability Solutions Unleash Blockchain Technology's Full Potential?

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Capacity limitations have so far prevented blockchain technology from realizing its potential, but the key to unlocking scalability is in sight--in the form of important compromises.

What is the scalability issue?

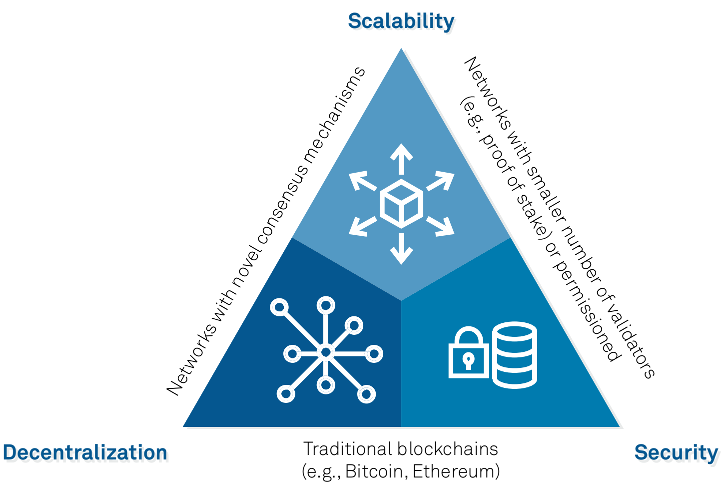
The transaction processing power of public blockchains is currently limited. Blockchain networks have limited capacity to handle large amounts of transaction data on their platforms. For example, the largest blockchains, the Bitcoin network and Ethereum, can process around five and 30 transactions per second (TPS), respectively. This compares with around 1,700 average TPS on Visa's network. This limited throughput is particularly problematic for high-transaction-volume use cases and enterprises that depend on high-performance legacy transaction processing systems. While blockchain solutions or distributed ledger technology (DLT) has clear benefits (for example, trustless transactions, improved security and privacy, visibility, and traceability), key blockchains such as Ethereum face inefficiencies, because their networks are rapidly growing and filling up with millions of users. The lack of scalability has resulted in higher costs, slower transaction speed, and the general dissatisfaction of many users.

Changing parameters is not necessarily the solution. A lot of constraints on the scalability of public blockchains come by design. For example, in the Bitcoin network, it takes about 10 minutes to generate one block, which consists of about 2,800 transactions. It would theoretically be possible to increase TPS by amending the parameters--that is, reducing the block generation time or increasing the block size. However, this would likely force out regular node operators due to higher storage, bandwidth, and processing requirements, which are critical for the security of proof-of-work (PoW) networks.

Blockchains face a trilemma between scalability, decentralization, and security. Traditionally, blockchains can only achieve two of these three properties simultaneously. Historically, the large public blockchains have prioritized decentralization and security over scalability, which is reflected by their low transaction volumes. Other blockchains take a different approach and sacrifice decentralization for better scalability.

Blockchains have to compromise on at least one of three properties: scalability, decentralization, or security

The Scalability Trilemma



Source: S&P Global Ratings.

Scalability issues on blockchains are holding back many applications. This became evident as the use of decentralized finance surged in summer 2020 and heavily congested the Ethereum network, which hosts the majority of applications. As a result, average transaction costs (measured in "gwei" or gas fees) have surged to $400+ on some days in 2021.

We expect more centralized versions of blockchain will be vehicles for efficiency gains rather than disruption

The current landscape

High-performance blockchains are more scalable but also more centralized. Referring to the scalability trilemma, one solution is to shift the tradeoff toward scalability. This approach is followed by multiple high-performance blockchains, such as Stellar and Solana, which have reported TPS of up to 3,000 and 50,000, respectively. The main difference between these and more decentralized blockchains lies in their consensus mechanism. For Solana, block information is distributed across a set of only 1,000 nodes, which produce and validate each block.

The industry is exploring highly divergent solutions to improve scalability, also in a highly decentralized setting. The most notable projects include Bitcoin's lightning network, Ethereum 2.0, and Ethereum L2s (layer 2). The details are very technical and include a variety of measures. For Ethereum 2.0, it is a direct upgrade of the current Ethereum 1.0 network to bring its consensus algorithm from PoW to proof-of-stake (PoS). This allegedly increases scalability to as much as 100,000 TPS. Ethereum 2.0 is already running alongside the Ethereum 1.0 mainnet in a testnet configuration for production deployment in early 2022.

Ethereum L2s are a second layer that is added on top of the mainnet blockchain, which executes the transaction outside the Ethereum mainnet but settles all transaction data back onto the Ethereum blockchain. It brings another 10x improvement in speed against the underlying Ethereum mainnet TPS. Ethereum L2's Arbitrum and Optimism are already in production and delivering the anticipated scalability. However, in order to ship, they have sacrificed decentralization in their early deployments.

Bitcoin's lightning network is a decentralized layer 2 that takes Bitcoin transactions offline and processes them directly between parties. This increases TPS by as much as 250 TPS per channel, but as part of the trilemma, appears to sacrifice security by not settling all transaction data to the Bitcoin blockchain and forcing non-DLT concepts such as watchtowers and payment channels.

PoW consensus algorithms are increasingly replaced by PoS. The original mechanism used by blockchains is PoW, which requires computers to compete against each other to process transactions and get rewards. This process is highly energy-intensive and time-consuming. For this reason, Ethereum's upgrade to version 2.0 will also see it transition to PoS, to support faster transactions and lower fees. With PoS, consensus is reached by using an algorithm that chooses a node to win a block of transactions, rather than the nodes competing to win the block by using large amounts of power.

The credit implications

Improvements in scalability can bring use cases to another level. We expect that both more and less decentralized blockchains will improve the scalability of their technology. Their use in mainstream applications will be the real test. Greater scalability is a precondition to many mainstream applications. However, jeopardizing security for the sake of higher scalability can undermine confidence in a particular blockchain and hurt the use case itself. Other types of DLT, such as directed acyclic graphs (DAG), address current scalability issues and offer lower transaction costs. A few protocols, such as Hedera Hashgraph or IOTA, use DAG solutions. We think DAG-based solutions could help in overcoming scalability issues.

We believe highly decentralized solutions are the main game-changers. The strength of highly decentralized blockchains lies in their resistance to centralized control through intermediaries. If successful, we expect solutions based on highly decentralized blockchains can be more disruptive to current intermediaries, particularly in the financial world, compared with those from more centralized platforms, which critics sometimes liken to cloud computing. We believe use cases based on more centralized platforms align more closely with the existing market infrastructure and allow players to increase efficiencies while generally avoiding being disintermediated.

However, there is a case for more centralized versions. Although decentralization can underpin a high level of security and accessibility, we believe the blockchain's other properties are not necessarily optimal for every use case. For example, abandoning the immutability of blockchains may allow easier alterations, which can be beneficial to certain applications (for example, credit card payments can be reversed for multiple weeks). For that reason, we expect more centralized versions of blockchains, often permissioned ones, will appeal to a broader area of applications. Those can be an efficient trigger to revamp legacy processes, while an identified intermediary and regulated access to blockchains fit more readily in existing regulatory frameworks.