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AAA
AA
A
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D

Hedera Hashgraph

Rating Report

Positive Outlook

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ANALYSTS

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EXECUTIVE SUMMARY

Advantages

① The core team has strong technical and management experience.

② Highly innovative consensus mechanism design; theoretically it can solve the TPS bottleneck found in most existing competing projects.

③ A strong funding history; the project has raised USD 160 million across three rounds of financing.

④ Developer-friendly: the developer code quality is generally sound with no major issues or bugs.

⑤ The project has strong partnerships which include a large number of global leading corporations.

Challenges

① Currently, the decentralization level of the Hedera project is low with only approximately 10 operational nodes.

② The actual running TPS is low (only 2.6).

③ A relatively high threshold needed to qualify as a consensus node.

④ The consensus mechanism still lacks large-scale and practical testing.

⑤ The unlock rate for new tokens is quite slow and may result in liquidity risk.

⑥ The project is still immature in terms of development progress and faces fierce market competition. In addition, the project also faces future challenges in the expansion of its ecosystem.

Outlook

Hedera Hashgraph is a high quality project compared to most public chain competitors evaluated by TokenInsight. With its unique Hashgraph DLT, the project is designed differently from most typical projects on the current market. Currently, the major challenges for Hedera Hashgraph are to accelerate the level of decentralization can continue to build out is ecosystem and partners. More specifically, it will need to attract developers to build on its ecosystem and quickly shrink the gap between the promised network performance that it promotes, and the actual performance of the project right now.

Conclusion

In conclusion, TokenInsight gives Hedera Hashgraph a rating of BB, with a positive outlook ahead.

Team

Project

Ecosystem

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01. MULTIDIMENSIONAL EVALUATION

Primary Indicators	Secondary Indicators	Comments
Team	CTO	Strong technical background and experience.
	CEO	Technical and management background; more than 20 years of experience.
	Advisors	Just a general counsel for now.
	Partners	Strong partners from several countries and industries.
Project	Decentralization	Current decentralization level is still low (only around 10 nodes)
	Consensus Mechanism	Innovative mechanism design, but more time is needed to prove its qualification for use in larger scale applications.
	Developers Friendly	Hedera-supported SDKs provide a friendly environment for developers.
	Code Quality	High quality code with no serious bugs or issues.
	Roadmap	Recently released a phased roadmap.
	Project Governance	Decentralized Governance. However, there are only 10 official members out of 39 at the moment and the lack of additional members will affect the level of project decentralization.
Ecosystem	Community	Highly monitored by the public in comparison to other projects.
	Quantity of DApp online	26
	Token Allocations	Token distribution is still too centralized. Tokens are released slowly.
	Token Economics	Further use-cases needed for token utilization.

02. PROJECT ANALYSIS

2.1 Introduction

" *The innovative Hashgraph structure gives Hedera the possibility to solve many bottlenecks in the application of existing distributed ledger technology.*

Hedera HashGraph aims to create an open, distributed, and progressively decentralized network. Unlike most blockchain projects, Hedera does not adopt the traditional 'chain of blocks' structure (those that uses an encryption algorithm to generate blocks at regular intervals and links them together to form a continuous chain) found in most projects.

Instead, the database structure adopted by the Hedera project is designed through a DAG (Directed Acyclic Graph). It connects blocks (termed 'Events' in Hedera) generated by different nodes in the project network to form a distributed hashgraph, using 'Gossip about gossip' and 'Virtual Voting' mechanisms to achieve a general consensus across the entire network.

Theoretically, this allows Hedera to process transactions initiated by its users within the network in parallel. Although this means different nodes maintain different hashgraphs (for a limited period of time), the efficiency of collecting, recording, and confirming a transaction is greatly increased. Based on this underlying design, Hedera provides digital asset services, smart contracts, file storage, and consensus services to support the development of upper-layer applications.

At present, Hedera Hashgraph has finished the internal testing phase of its network and the open access version is now officially accessible to the public. Developers can now build applications using the platform and begin testing applications. Although the Hedera Hashgraph project can theoretically resolve the performance bottlenecks found in current blockchain projects while ensuring network security, discussions about its relatively centralized structure and whether the actual performance of the network can reach the levels predicted by testing are still ongoing. TokenInsight will further carry out in-depth analysis regarding to this issue.

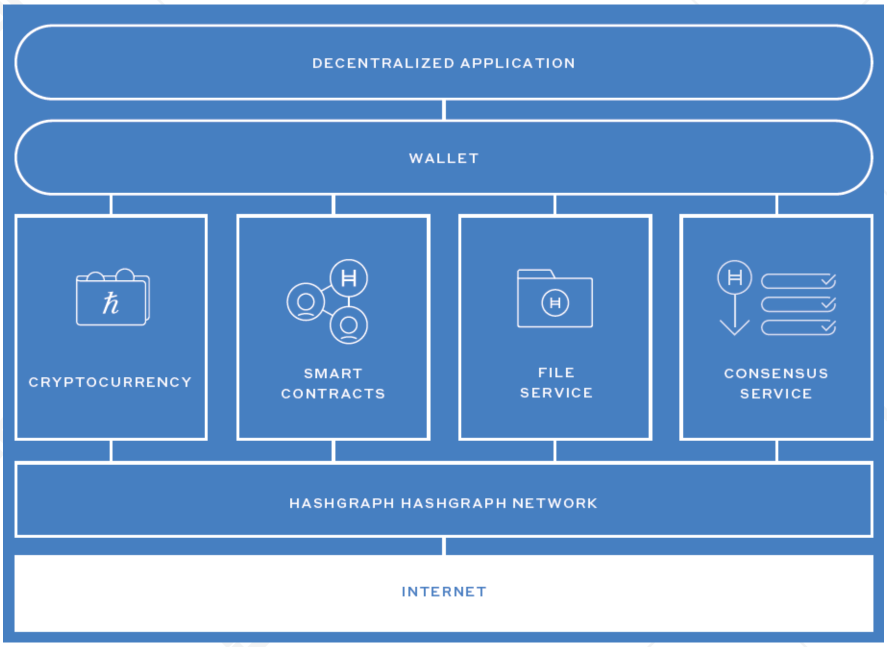
2.2 Project Framework and Technology

2.2.1 Network Structure

> "*The protocol layer is the core of Hedera's innovation and attempts to effectively use the limited resources of its network layer. The overall ecosystem development will depend on the health of its service layer.*

Hedera Hashgraph's ecosystem framework and structure can be divided into three parts from bottom to top: the network layer; the protocol layer; and the service layer (or application layer).

Figure 2-1 Hedera HashGraph network structure
Source: Hedera Hashgraph White Paper



- Network layer: P2P network nodes.
- Protocol layer: Hedera's core innovation; an asynchronous Byzantine that provides network consensus and security protocol.
- Service layer: The application layer uses the infrastructure provided by the lower layers to support a variety of applications.

The network layer is the lowest layer of the Hedera structure. The core resources of the network layer are the bandwidth of each node (used to communicate with other nodes) and its computing power (for correctness when validating transactions). In order to ensure the smooth flow of transactions through the network layer, Hedera has bandwidth and hardware requirements for consensus nodes. As a result, the participation cost for ordinary users to participate in maintaining the network ledger is high.

In the consensus layer, Hedera tries to utilize the limited resources of the network layer as efficiently as possible. The virtual voting mechanism is key to this. By omitting the voting and verification processes in the consensus stage, Hedara hope that the demand on network bandwidth can be reduced.

The service layer, acting as a front end, is the most user-facing layer and is crucial for development. The development of the service layer ecosystem depends mainly on the number of developers. The development costs for developers need to be as low as possible and incentives need to be offered such as general programming languages, standard module selection for development, and a safe and easy-to-use test environment.

In addition, Hedera utilizes a mirror network which serves as a read-only copy of the Hedera main network. Nodes on the mirror network can read data from the main network at any time, but they cannot submit transactions or modify the information on the mainnet. This provides users with most of the functions of the mainnet, but uses significantly less resources on the mainnet. The mirror network can be used to develop applications that depend on the trusted data of the mainnet without taxing the network.

2.2.2 Technical Characteristics

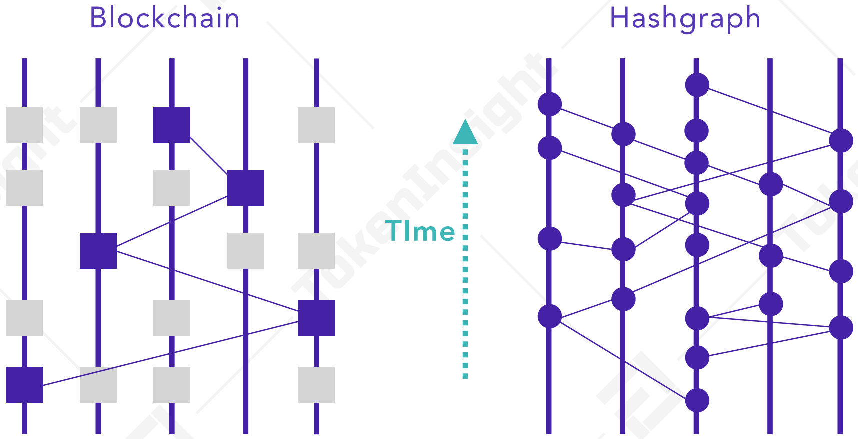
2.2.2.1 Hashgraph

> " *In order to obtain a unified global transaction speed, traditional blockchains discard blocks generated by other nodes willingly. This one of the core reasons for the performance bottleneck of single-chain distributed ledgers.*

The figure below shows the difference in how information is recorded between the Hash diagram structure used by Hedera and the traditional blockchain structure.

Figure 2-2 Distributed ledger structures Comparison

Source: TokenInsight



Each vertical line represents a node, and each square or circle of the vertical line represents a block generated by the node (referred to as an Event in Hashgraph).

On a standard blockchain, in order to obtain a shared global ledger, there is only one winner each round (the purple square in the figure); other gray blocks are still valid blocks, but these blocks are discarded and certain nodes may not be compensated with rewards because of to issues such as slow network speeds, or problems during the broadcasting process. Transactions from those blocks are not confirmed, and are returned to the pool (Mempool) to wait for the next round.

In Hashgraph, by comparison, blocks produced by multiple nodes at the same time (or round) are retained. Hashgraph is able to achieve a higher system speed and efficiency by allowing multiple nodes to maintain one global ledger while at the same time allowing each of them to contribute transactions each round. The main challenge with this lies in how to ensure that multiple nodes can confirm the transaction of processed orders from multiple blocks while keeping the communication cost low.

The key to doing this lies in the innovations of the Hashgraph consensus mechanism. Specifically, there are two technological innovations: the 'Gossip about gossip' and 'Virtual Voting' mechanisms.

2.2.2.2 Gossip about gossip

> " *The Gossip about gossip mechanism helps different nodes collect and broadcast transactions to other peers randomly. The nodes then depict the hashgraph of his/her own local hashgraph, and this is pruned through a virtual voting mechanism to obtain a unified global hashgraph (global ledger)*

In a standard Gossip protocol, nodes in a distributed system randomly broadcast messages by themselves and do not contain any information about the history of that message.

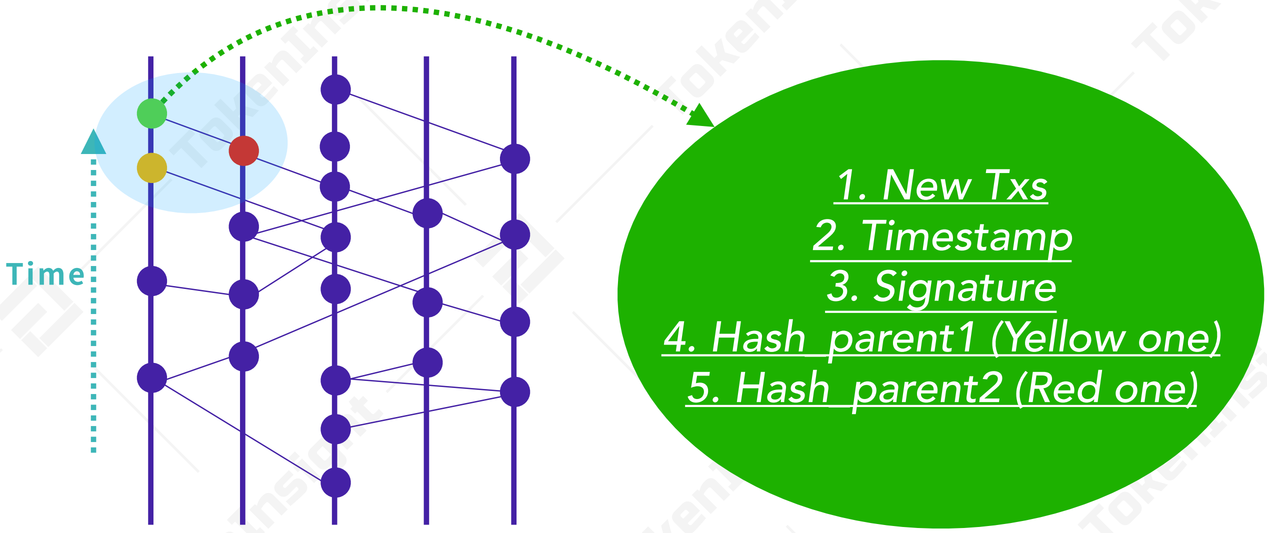
However, this is changed in Hashgraph. In addition to randomly sending messages to other nodes, in Hashgraph, the history of how the message themselves are spread is also gossiped, hence the name Gossip about gossip.

Figure 2-3 Hashgraph Block Structure

Source: TokenInsight

There are no actual 'blocks' in the Hashgraph. Instead, they are defined as "Events". However, for ease of understanding, the term "blocks" will be used in this report to refer to "events" in order to better understand the Hedera project.

Figure 2-4 Hashgraph's Block Structure
Source: TokenInsight



In the figure above, the latest green block located in the first column contains a new transaction, timestamp, and signature. Additionally, the green block also contains two hash values inherited from the yellow block and the red block. This structure ensures that all new blocks are descendants of old blocks, and that the relationship between different blocks are clearly defined and recorded.

In this way, all nodes can depict their own local hashgraph via the 'Gossip about gossip' protocol. In the ideal situation, the local hashgraph depicted by most nodes will be very similar.

Over time, the local hashgraphs of different nodes should gradually converge. Ultimately, when the hashgraph of different nodes' contain the same block, the block will have exactly the same two parent blocks across the nodes.

This is reflected in the above figure. As the green block is broadcast to other nodes, any nodes that contain the green block in its local hashgraph will also contain the values for both the yellow and red block as well. Across these nodes there will be a block with the same inheritance relationship (hash values of yellow and red blocks in the green block).

Subsequently, by virtual voting, the respective hashgraphs are synchronized to obtain a global hashgraph (global ledger).

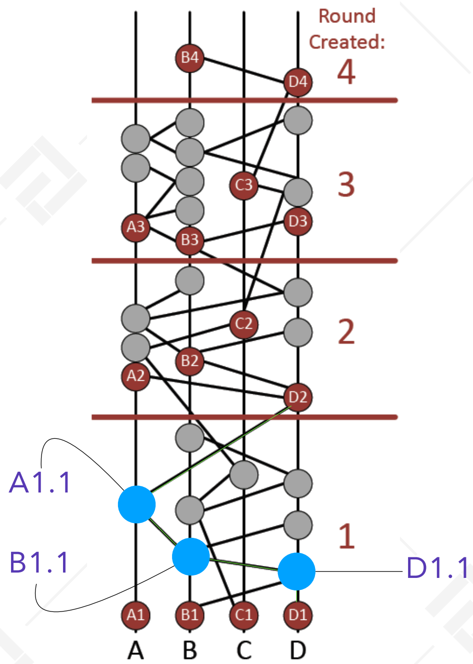
2.2.2.3 Virtual Voting

" *'I know how you will vote, so you don't need to vote at all - TokenInsight'. This principle greatly reduces the overall bandwidth and usage of the network; and determines the processing order for new transactions within each block.*

2.2.2.3.1 Round Creation and Determination

Figure 2-5 Hashgraph Round Creation

Source: SWIRLDS TECH REPORT



The first step in Hashgraph's virtual voting system is to determine the Round Created (R) value. After determining the round created value, the transaction processing occurs in ascending order; round R will be before R+1.

In each round, the first block created by any node is called a **Witness**. As shown in the above figure, A2, B2, C2, and D2 are Witnesses for the second round.

Determining if a block is in round R or round R+1 is dependent on whether or not the block can navigate and travel through the **majority** of the nodes, as well as trace back to the **majority** of the **Witnesses** in the previous round (round R). If this condition is true, the block is located in the next round (R+1). Otherwise it is included in the current round (R).

The D2 block in the above figure, can be traced back to D1 using the green path in the figure above. This path passes through three nodes of A B D (n=4, majority nodes (2n/3) >= 3). D2 contains the hash value of A1.1 (and also the block directly below D2); and A1.1 contains the hash value of B1.1 (and also A1); and continues until it finds D1.1, which contains the hash value of D1.

In the above process D2 can ***Strongly See*** D1.

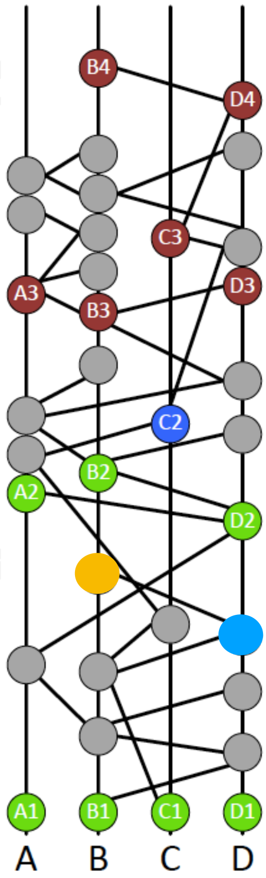
In the same way, D2 also ***Strongly See*** B1, C1. (Note: D2 does not **Strongly See** to A1, because the path: D2-A1.1-A1, only two nodes of A D, less than 3.)

The number of ***Witnesses*** in the first round that D2 can ***Strongly See*** is 3, which is the majority. As a result, the round created of D2 is 2.

2.2.2.3.2 Identifying Famous Witness Blocks

After determining the round number of blocks, the next step is to decide the block processing order for blocks with same round number. However, before that, we need to identify the ***Famous Witnesses***.

Figure 2-6 Determination of Hashgraph's Famous Witnesses
Source: SWIRLDS TECH REPORT



The requirement for a ***Witness*** to be ***Famous Witness*** is lower than the requirement for deciding a block's round number. A witness is ***Famous*** if it can ***see*** the ***majority Witnesses*** for the next round:

For each witness (A2, B2, C2, and D2 in the figure left), it checks whether these witnesses can trace a path to the majority of the witnesses of next round (three of A3, B3, C3, and D3). In addition, it should be noted at this time that there is no need for A2, B2, C2, and D2 to be ***Strongly Seen*** by them.

Therefore, it can be found that A2, B2, and D2 are ***famous witnesses***, and **C2 is not**. C2 can only be traced up to C3, and it cannot be traced to A3, B3, and D3. The final confirmation of the ***Famous Witness*** is determined by the next round of voting (the third round), and the voting result is collected by the following round (the fourth round).

2.2.2.3.3 Determining the Consensus Timestamp of Blocks in the Same Round

Once the famous witness blocks have been identified, the network can begin to decide the block consensus timestamps in the same round. Since the blocks that are famous witnesses in the second round are only A2, B2, and D2, it is only necessary to consider the timestamps of these three nodes, which are A, B and D.

Take the blue block in the figure above as an example. The specific method is as follows:

1. A: Find the earliest block created by A that can be traced up to A2 and can also be traced back to the blue block (determining it can be traced back to itself). Here, this block is A2 itself.
2. B: Find the earliest block created by B that can be traced up to B2 and can also be traced back to the blue block. Here, this block is the yellow block.
3. D: Find the earliest block created by D that can be traced up to D2 and can also be traced back to the blue block. Here, this block is D2.

The consensus timestamp of the blue block is determined by taking the median of the 3 timestamps collected from the yellow block, block A2, and block D2 received from the blue block. If the number of famous witnesses results in an even number, the two median timestamps are used to determine the outcome. Any further ties are broken by sorting the signatures of the participating nodes.

2.2.2.4 Summary

In general, as the core of the Hedera Hashgraph asynchronous Byzantine algorithm consensus mechanism, the 'Gossip about gossip' and 'Virtual Voting' mechanisms are relatively complex. This makes them difficult to understand, especially for the section on 'Virtual Voting'. However, the key points are:

- Construct local hashgraphs for each node through the 'Gossip about gossip' protocol.
- Use the ***Witnesses*** and the ***Strongly See*** mechanisms to divide the blocks generated by many nodes into different rounds.
- In each round, use ***Famous Witnesses*** to determine the consensus timestamps of different blocks.
- Finally, the processing order of many blocks generated by different nodes is determined.

Since the hashgraph obtained by using the 'Gossip about gossip' protocol converges, the shapes of different hashgraphs from different nodes tend to be identical. In addition, the subsequent public method for deciding the timestamps of any block helps different nodes to calculate the same result. Therefore, nodes do not actually need to vote during the voting process. This results in a virtual vote, which best expressed by the phrase 'I know how you would vote, so you don't need to vote at all – TokenInsight.'

2.2.3 TokenInsight Analysis

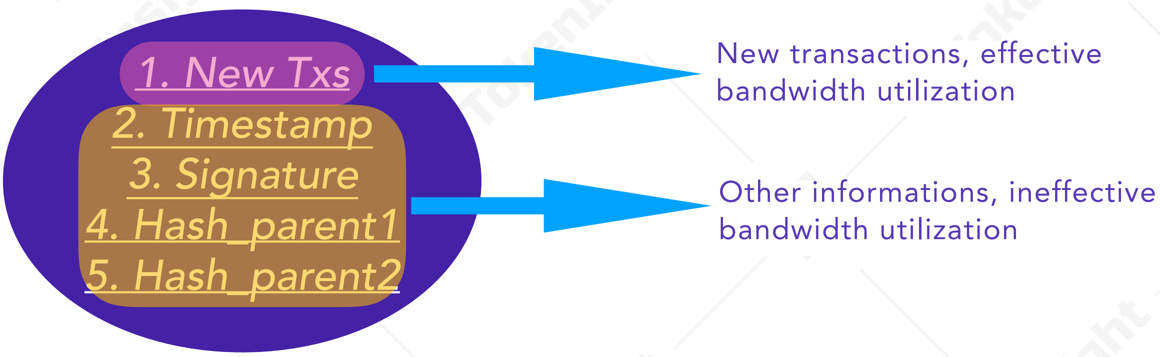
" *The larger the size of the new transactions in a block, the more efficient the network bandwidth utilization.*

For any block, only the new transaction information in the block has any real utility in updating the global state of Hedera's network. As a result, resources should be focused on this information to improve the efficiency of the overall network.

This means that the system effectiveness of the Hashgraph network can be improved when the portion of new transactions on the network becomes larger, or if the information from the "less significant" portions are very small.

Figure 2-7 Hashgraph's block structure

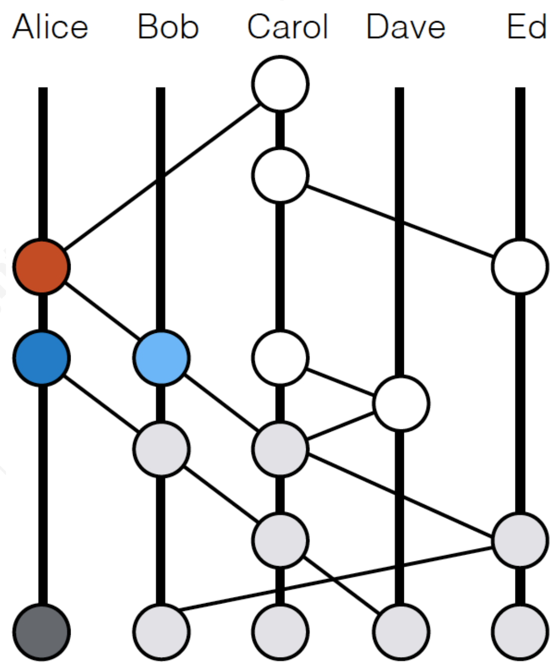
Source: TokenInsight



1. For the information about bandwidth utilization, please refer to Hashgraph's Medium.

> *Invalid broadcasts in 'Gossip about gossip' will occupy the bandwidth and resources of nodes.*

Figure 2-7 Hashgraph and 'block' structure
Source: Hedera Hashgraph White Paper



The figure above shows an invalid broadcast of Alice's red block to Carol's block on the top.

In this example, the broadcast is invalid because Carol does not receive the two parent blocks (represented by the deep blue and light blue blocks) information for the red block. In the Gossip protocol, Alice randomly broadcasts its current block to other nodes, and this process consumes Alice's bandwidth. From Alice's perspective, if the sent block cannot be recorded by the recipient (putting the hash value into its own block), Alice's bandwidth resources are wasted.

> *Virtual voting does not require actual communication between nodes, greatly reducing communication complexity.*

In most Byzantine consensus systems, the usual steps are:

1. The node generates a block and broadcasts to other nodes.
2. Other nodes will validate the communication after receiving it.
3. Another round of communication is required to confirm the block by signing signatures.
4. Update the ledger.

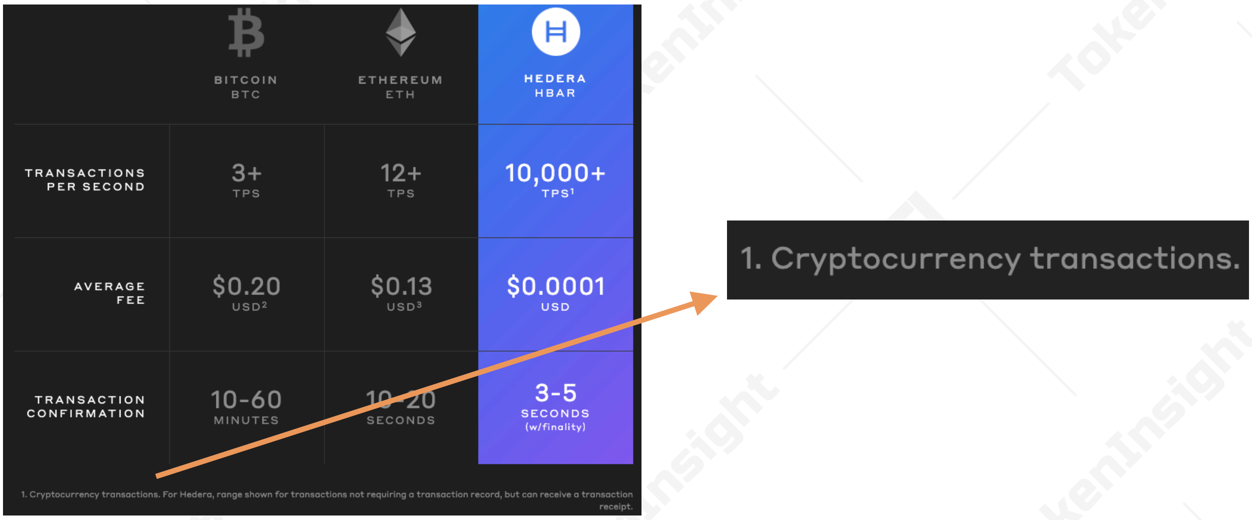
Each round of such a process requires communication between nodes. The process of validation consumes a network's resources but does not contribute much to updating the global ledger. Only the new transactions are crucial to the update.

Hashgraph is able to save much of its network bandwidth at this stage through its virtual voting mechanism. In the overall process of the consensus mechanism, only the Gossip about gossip step needs nodes to communicate with other nodes. This reduces the communication complexity compared to most Byzantine consensus mechanisms.

> *Although, theoretically this innovation of the consensus mechanism can bring a significant increase in performance, the actual performance in the long-term remains to be seen.*

Figure 2-9 Hedera Hashgraph 10,000 TPS

Source: Hedera Hashgraph



	BITCOIN BTC	ETHEREUM ETH	HEDERA HBAR
TRANSACTIONS PER SECOND	3+ TPS	12+ TPS	10,000+ TPS[1]
AVERAGE FEE	$0.20 USD[2]	$0.13 USD[3]	$0.0001 USD
TRANSACTION CONFIRMATION	10-60 MINUTES	10-20 SECONDS	3-5 SECONDS (w/finality)

1. Cryptocurrency transactions. For Hedera, range shown for transactions not requiring a transaction record, but can receive a transaction receipt.

According to Hedera Hashgraph's official website, its performance can reach 10,000 TPS. However, this figure refers to cryptocurrency transactions. Smart contract processing is much more complicated in both transaction data size and processing complexity. As the proportion of smart contract transactions increase, the network TPS will inevitably fall. The data presented for this regard has not been publicly published by Hedera Hashgraph.

In addition, as an infrastructure for the development of DApps, the future of Hedera Hashgraph's ecosystem aims to contain a large number of applications for service users. More applications means the complexity of transactions in the network will increase, which affects the actual performance of Hedera Hashgraph. In this regard, Hedera Hashgraph needs to be more transparent and work to increase its developer community and user base.

> *The high entry requirements for consensus nodes affects the degree of decentralization of the network.*

According to TokenInsight, the overall requirement of hardware and network bandwidth for joining the Hedera Hashgraph network as a consensus node is higher than most public chains in the current market. Most ordinary users can't use their own computers or laptops to become consensus node validators.

2.3 Governance and Other Features

" *The governance model is similar to Libra's approach, with governance members holding equal rights*

In terms of governance, Hedera Hashgraph has established a Governance Council with a maximum of 39 members. As the founder, the Hedera project team has the right to nominate candidates for membership in the Governance Council. However, in terms of specific governance, the Hedera project team has the same rights as other committee members and does not have special privileges.

In addition, when selecting members of the Governance Council, Hedera prefers large, leading, and geographically distributed companies or organizations. The reason for this is that it can reduce the possibility of members of the Governance Council from collaborating (difficulty and different interests). This ensure that the Governance Council remains fair and promotes long-term stability and healthy development.

" *Uses Ethereum's Smart Contract Language, Solidity*

Hedera uses the same language as Ethereum for smart contract development, which is developer-friendly and reduces development costs to deploy Ethereum applications on Hedera.

In addition to the smart contract language, Hedera also provides complete development documentation, SDKs, and other tools; all of which are powerful ways to attract developers to help build and grow the ecosystem.

" *PoS and Staking*

The results given by node voting in Hedera's consensus mechanism is determined according to the number of HBAR tokens owned by nodes. Hedera supports Staking to motivate users to join in the consensus process, and uses token participation in the voting process to ensure network security.

Hedera also supports joining the voting process through proxies. Staking rewards are shared equally between holders and proxy nodes. This is similar to many projects. The key difference is that staking in Hedera does not require token holders to lock in the liquidity of their tokens; the tokens can be transferred out at any time and withdrawn from the voting process.

The convenience brought by not locking tokens helps to motivate holders to participate in staking. In turn, the increased tokens in the PoS consensus mechanism ensures higher security. However, without locking and punishment mechanisms in place, there is a lower barrier for misbehavior by users, and there is a risk that users will vote dishonestly.

2.4 Development Plan and Current Stage

> *The core goal of future development is decentralization.*

The core of Hedera Hashgraph's development plan is to gradually increase the degree of decentralization moving forward.

The development of Hedera Hashgraph is divided into four phases:

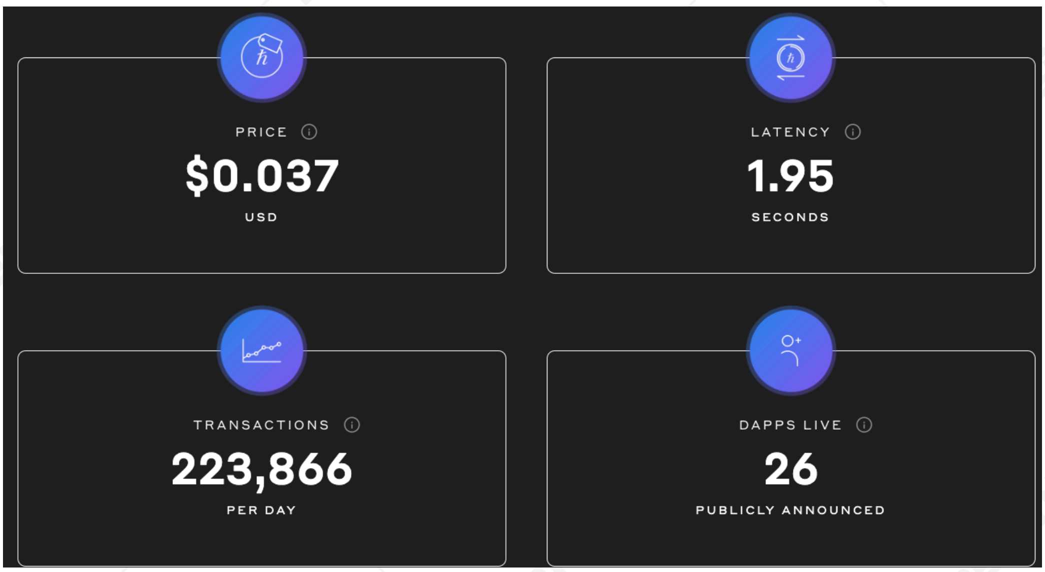
- Allocating the HBAR tokens temporarily held by the Council into the ecosystem;
- Attracting more trusted consensus nodes to join the system, increasing the decentralization of the network;
- Gradually allowing anonymous nodes to join the network and become consensus nodes, further increasing the degree of decentralization on the network;
- Realizing the decentralization of HBAR distribution and the system.

Currently, the Hedera Hashgraph mainnet handles 223,866 transactions per day, and the converted TPS of Hedera Hashgraph is about 2.6. The average transaction latency (the time the transaction was finally confirmed) is approximately 1.9 seconds.

This data currently is wildly different from the advertised 10,000 TPS on Hedera's website. Part of the reason is that Hedera Hashgraph has a much shorter launch time and is less popular than others (Bitcoin, Ethereum, EOS). As a result, its user base is currently small.

In addition, as can be seen later in the Economic Analysis section, Hedera Hashgraph is extremely strict in controlling the circulating of HBAR, and the number of short-term HBAR holders is also small. This may be one of the reasons why the development of its ecosystem is relatively slow.

Figure 2-10 Hedera Hashgraph mainnet status (2019.09.25)
Source: Hedera Hashgraph Official Website



2.5 Code Analysis

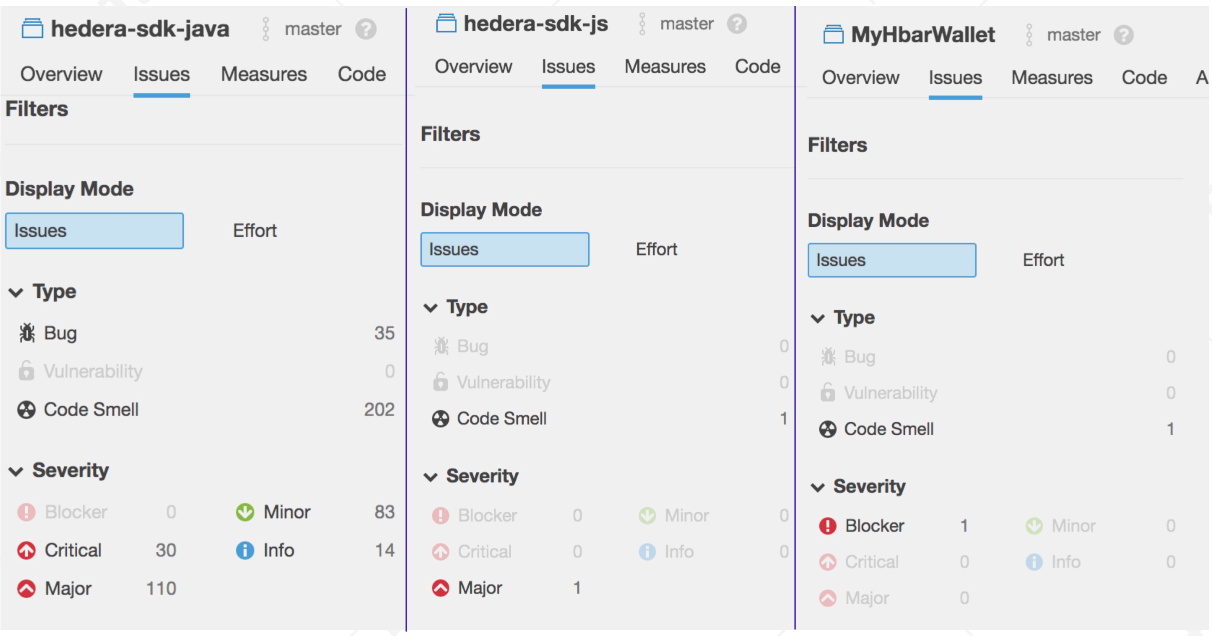
" *The overall quality of the code is high.*

TokenInsight analyzed the code of Hedera Hashgraph (https://github.com/hedera). Overall, the Hedera's open source code is relatively complete, providing the implementation language, algorithms, demos, mainstream language SDKs, and APIs.

According to the code history, the development of Hedera's code is active with frequent code submissions and updates. Regarding the code quality itself, based on the static code detection tool 'sonar', very few high-risk bugs were founded. However, a lot of 'Code Smell' was found. This may affect how easy it is for developers to create DApps on the network as well as the overall quality of the applications themselves.

Figure 2-11 Hedera GitHub code detection results (sdk-java, sdk-js, wallet)

Source: TokenInsight



2.6 Difficulties and Challenges

" *The decentralization process is difficult, and progress may be slow.*

Currently and in the near future, potential nodes need to be reviewed by Hedera, under the conditions trusted by Hedera, before they join the network as a participant.

As this process also includes the slow allocation of HBAR, it is very likely that this will be a relatively long process. In fact, for a long time, Hedra Hashgraph will behave not as a publicly distributed ledger, but more like a permission chain that requires a license.

" *Building an ecosystem is difficult, and the actual performance may not be as high as what is promoted.*

The promoted 10,000 TPS, according to Hedera Hashgraph, is only for simple token transactions. As smart contract transactions involved in the ecosystem increase, actual performance may not be as high as what has been publicly stated. In addition, although Hedera Hashgraph provides various tools for developers, the demand for developer talent in the blockchain field is extremely high. In turn, this increases the acquisition cost of talented developers and it may affect the growth of the ecosystem.

A shortage of developers leads to a lack of applications that actually serve users and which are required for the development of the entire ecosystem.

" *The allocation process of HBAR tokens is slow, and may cause the market to lose interest.*

The slow and cautious allocation of HBAR tokens is designed to avoid market speculation. However, if there are not many users holding the token, Hedera Hagraph may lose some market popularity. This is a significant risk at this stage where a large number of projects are trying to obtain users.

Summary

Overall, Hedera Hashgraph's innovations have contributed significantly to the industry, especially with its consensus mechanisms and structure. The project's ingenious design theoretically provides a great solution for the blockchain industry to solve problems such as safety, performance, and fairness. However, it will certainly face questions and scrutiny as it is not a completely open ecosystem.

To be successful, projects require excellent technology, strong team backgrounds, and other factors. While on their own they are not enough to guarantee success, Hedara has them and it gives them a solid foundation. Hedera Hashgraph is still in the very early stages of development; the next step focused on developing and growing the ecosystem.

03. INDUSTRY ANALYSIS

3.1 Public Blockchains

3.1.1 Industry Pain Points

> " *Public blockchains currently face problems with scalability, insufficient security and high usage cost for users.*

Underlying public blockchains are development platforms made up of various DApp and smart contract developers looking to establish and distribute applications. It is widely considered to be a critical aspect of the infrastructure for the overall blockchain industry.

Ethereum is one of the most important projects in the entire public blockchain sector. Its Turing complete development language offers the possibility of achieving complex functions through blockchain technology and expands the application scope of blockchains. However, there are also many limitations where Ethereum cannot provide more practical and standard functions. At present, most public blockchains face the following problems:

① Insufficient scalability. The actual TPS of Bitcoin is between 5 and 10, and that of Ethereum is between 5 and 15. Although the performance of EOS has been improved, the actual TPS at present is only between 30 and 80. The low TPS and slow transfer confirmation speeds of these public blockchains make it impossible for them to meet the requirements of large-scale business applications.

② Security and reliability need to be improved. Ethereum was launched in 2015 and several security vulnerabilities have been disclosed since its launch. The most far-reaching incident was the DAO Hack. Hackers stole 12 million ETH by exploiting vulnerabilities in its smart contracts, directly leading to the hard fork of the Ethereum network. The EOS project was launched in June 2018, and some security vulnerabilities have since been found related to the contract code and arbitrary numbers.

③ Costs are still too high. Transfers and transactions in the Ethereum network require payments in GAS fees. EOS application development requires EOS mortgages to acquire RAM, NET, CPU and other resources. This not only results in a high cost to developers, but also becomes a necessary threshold for users to enter its ecosystem.

④ Privacy protection on the blockchain is needed. At present, transfer records on public blockchains are kept in blockchains and are open to the outside world. Users can query the history of anyone on the blockchain through browsers, and there is a risk of data that compromises user privacy being leaked in some scenarios.

⑤ Governance mechanisms need improvement. The development of public blockchains is usually dominated by a group of developers. Community governance also needs to find a balance between on-chain and off-chain governance as well as centralized and decentralized governance.

3.1.2 Existing Solutions

In view of existing pain points surrounding public blockchains, many projects have innovated to try and solve these problems.

At present, the actual performance of public blockchains is far from the level of large-scale use. To tackle this, developers have provided various on-chain and off-chain solutions. Most of these solutions are still in the early proof-of-concept testing stages and have not been actually executed yet.

Figure 3-1 Solutions for Scalability

Type	Solution	Description	Representative Projects
Layer 1	Increase the block size	Increase the capacity of a single block	Bitcoin Cash
	Sharding	Allocate the workload of entire networks to each shard for parallel processing	QuarkChain, Zilliqa, and Hedera Hashgraph
	DAG	Directed acyclic graph, which changes the original chain results into a net structure	IOTA, Conflux, and Hedera Hashgraph
	Segregated witness	Remove unnecessary signature information from blocks	Bitcoin Cash
	Change the consensus mechanism	PoS, DPoS and other consensus algorithms	EOS, Tron, IOST, and Hedera Hashgraph
Layer 2	State channel	Establish two-way channels between different nodes	Lighting Network
	Sidechain	Transfer main chain assets to sidechains for better performance	Lisk
	Crosschain	Link various ecosystem chains from different blocks	ICON, Polkadot and Cosmos
	Off-chain computation	Perform off-chain processing of complex tasks, and then send the results back to the chain	DOS Network and ARPA

Source: TokenInsight

3.2 Competitor Analysis

" *The market is fiercely competitive, there is still a certain gap between Hedera Hashgraph and leading projects.*

Figure 3-2 Performance comparison between different projects (26-09-2019)

	Hedera	Ethereum	EOS	IOTA	Algorand
TPS	2.6	8-9	50-70	3-4	<1
Consensus Mechanism	Hashgraph(aBFT)	PoW	DPoS	Tangle	DPoS
Smart Contract Language	Solidity	Solidity	C++	Abra	Developing

Source: TokenInsight, Block Explorer

Competition in the public chain sector is fierce. The main competitors of Hedera Hashgraph include Ethereum, EOS, IOTA, Algorand, Conflux, Nervos and others.

At present, Ethereum, the most well-developed competitor in terms of ecosystem and the leading projects in the current market. It is also important to note that the project is currently in the process of upgrading its consensus mechanism from PoW to PoS. This is crucial for the future enhancement of Ethereum performance. Hedera supports Ethereum's EVM and Solidity programming languages for smart contracts. However, in terms of governance, Ethereum's network is much more decentralized and its founder continues to have great influence in providing this future development.

EOS, another strong competitor, has shown better progress than Hedera in developing its ecosystem. However, in terms of governance, the 21 super nodes are more centralized in number than the current 10/39 Hedera nodes. In addition, when selecting members, Hedera is relatively stricter about the requirements and trustworthiness of these members.

For the IOTA project, like Hedera Hashgraph, some innovations have been made in its consensus mechanism, and the structure of DAG has been also adopted. However, even after several years of development, the actual number of transactions on the network remains small.

As for Algorand, at present, it handles only a few thousand transactions per day. Algorand is similar to Hedera Hashgraph and is a product of academic research and practical integration.

04.
ECONOMIC ANALYSIS

The HBAR token issued in the Hedera Hashgraph ecosystem has a total supply of 50 billion. Initially, the vast majority of the tokens are locked into a common address managed by the Hedera Governing Council, and subsequently released into the ecosystem based on a set timeline. Considering the particulars of the above-mentioned PoS consensus mechanism, to ensure the safety of the Hedera network and reduce the speculative behavior of the secondary market, the HBAR release schedule will be very slow. At the end of 2019, it is expected that only 7% of the total supply will be released, and it is expected that by 2023, only 34% of the total supply will be released.

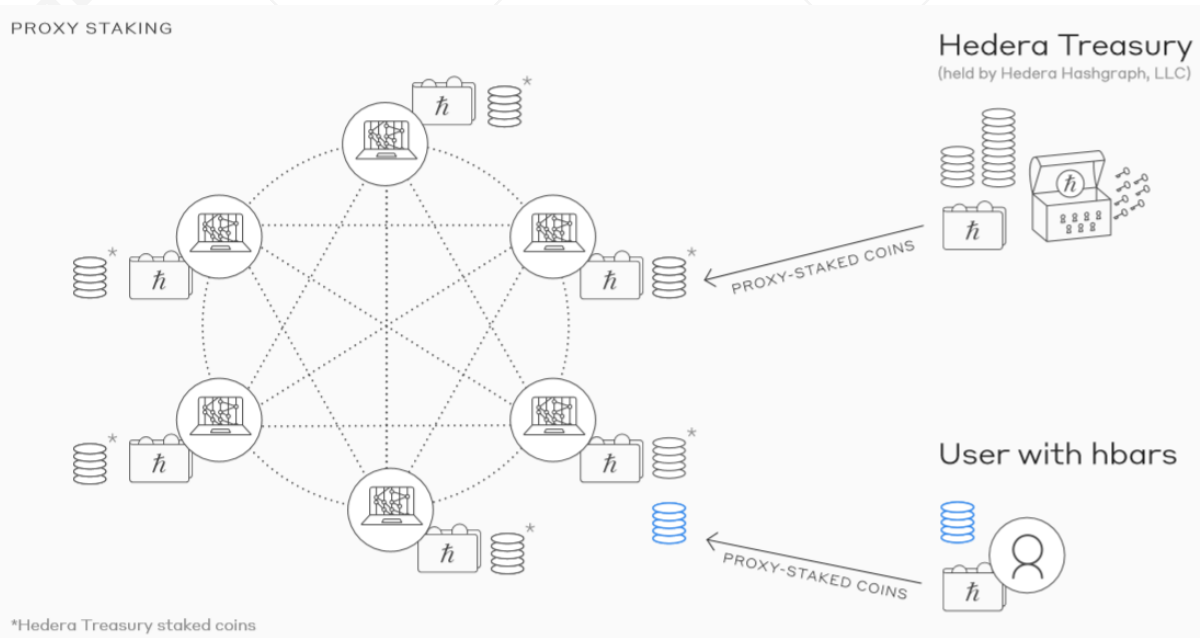
4.1 Token Usage

4.1.1 Voting

Hedera adopts the PoS consensus mechanism. However, the vote counting method of the virtual voting mechanism is not 'one node, one vote'. Instead it uses a 'one HBAR, one vote' method to increase the cost of any potential fork attacks. HBAR is used to protect the entire Hedera network though Hedera's PoS consensus mechanism. Users who don't want to operate a node independently, but own HBAR tokens can stake their own HBAR tokens on other nodes, and extra HBAR tokens will be rewarded to the nodes and those who stake their own HBAR tokens as an incentive.

Figure 4-1 Staking on Hedera Hashgraph

Source：HBAR Economics Paper

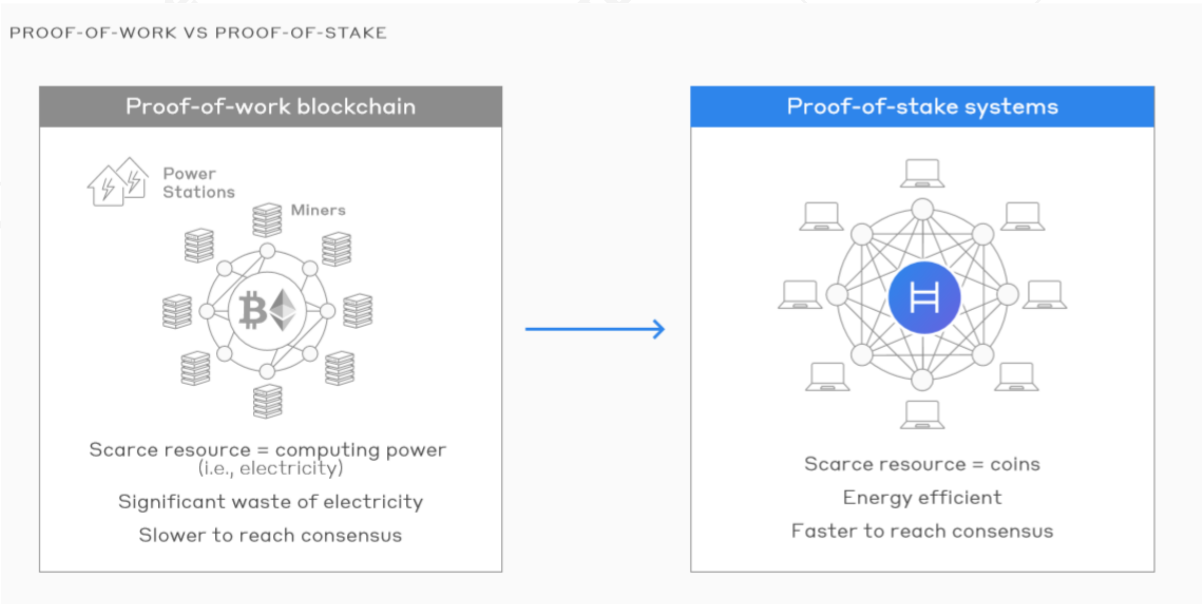


Each distributed ledger must have a limited, hard-to-obtain resource to ensure that the entire ledger is not vulnerable to tampering. For the Bitcoin and Ethereum networks, PoW consensus mechanisms are utilized; computing power is the limited resource for those networks. Having more computing processing power increases the probability that a user will add a new block to the ledger.

In the Hedera network, HBAR is the limited resource. In the virtual voting model, the vote counting method is not based on the number of nodes, but rather the number of staked tokens on the nodes itself. The slow release schedule for HBAR is designed to ensure that the main network node controlled by the Hedera Governance Council controls more than 66% of the total amount of available tokens for the first five years. This preserves the absolute voting power and enables them to maintain the ecosystem operation for this period.

Figure 4-2 Comparison of PoW and PoS

Source: HBAR Economics Paper



4.1.2 Payment medium

As a medium for value transmission, HBAR is used to pay and reward each role in the ecosystem to assist with ecosystem growth. Fees are expected to be paid by the end user and include application fees, network fees, node fees, and service fees.

4.2 Token Staking and Allocation

4.2.1 HBAR Allocations

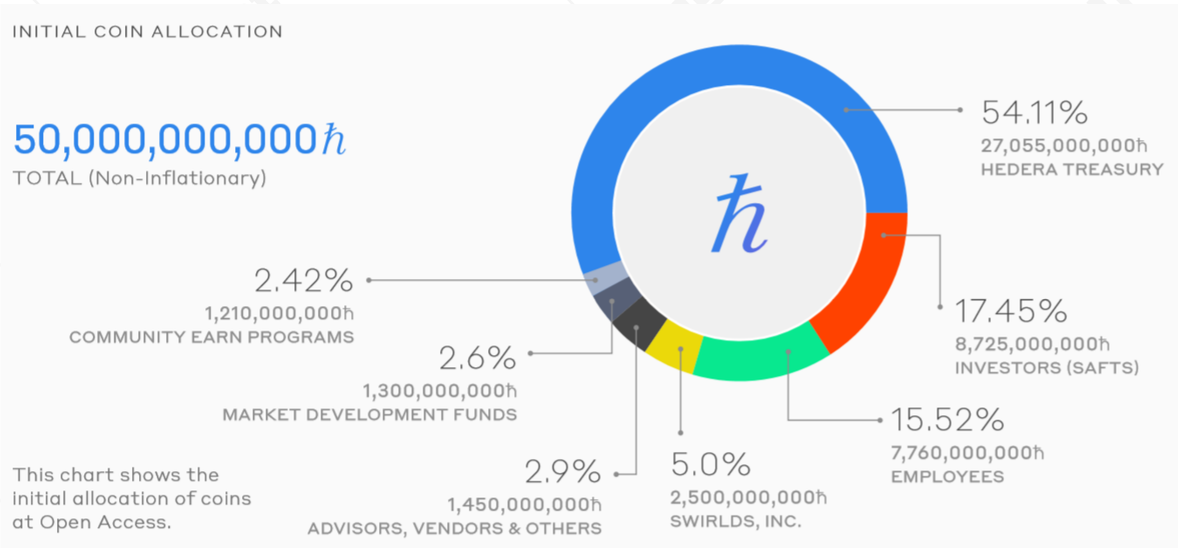
> *Most of the HBAR token are held by the Governance Council and the company.*

Hedera Hashgraph's open access mainnet launched in Sept 2019 and deposited a fixed supply of 50 billion HBAR tokens into the Hedera treasury account. Before open access, Hedera developed the current release mechanism based on four key considerations. These include regulatory compliance, security, decentralization, and the results from the initial sale of HBAR tokens.

According to documents published by the official website of Hedera, the distribution of HBAR tokens are shown in the following figure as of the launch of open access (September 17, 2019). Nearly 54% of HBAR tokens are locked in Hedera's treasury account. In second place is investors from three rounds of public offerings (closed sale) holding 17.45%. They are followed by project employees with 15.52%; Swirlds Inc. 5%; advisors; vendors and others with 2.9%; market development funds with 2.6%; and the community earn programs with 2.42%.

Figure 4-3 HBAR initial allocation

Source: HBAR Economics Paper



4.2.2 HBAR Release Schedule

Figure 4-4 HBAR 5 Years Release Schedule

Source： HBAR Economics Paper

FIRST 5 YEARS: COIN ALLOCATION AND RELEASE

Period	Seed SAFTs	SAFT 3	Hedera Team*	Community Earn Programs**	Advisors, Vendors & Others	Market Development Funds	Swirlds	Treasury	Incremental Supply	Total at end of period	% Circulating
Day 1 of Open Access	194,062,857	185,263,841	0	1,208,333,333	1,957,864	0	0	0	1,589,617,895	1,589,617,895	3.18%
Day 2 - Day 7	194,062,857	0	0	0	12,957,865	0	0	0	207,020,722	1,796,638,617	3.59%
Rest of 2019	658,221,234	273,510,244	381,806,450	0	135,277,192	7,297,952	60,000,000	450,000,000	1,966,113,072	3,762,751,689	7.53%
2020	2,076,801,486	322,018,909	1,680,957,394	0	280,153,579	88,902,294	122,717,936	431,279,328	5,002,830,926	8,765,582,615	17.53%
2021	1,956,904,787	48,508,723	439,526,433	0	114,622,450	145,200,650	299,369,682	479,929,740	3,484,062,465	12,249,645,080	24.50%
2022	1,450,322,972	48,508,723	490,577,959	0	75,811,488	145,200,650	168,146,581	479,929,740	2,858,498,113	15,108,143,193	30.22%
2023	693,987,432	48,508,717	1,156,170,025	0	168,033,196	251,562,259	226,955,235	981,609,047	3,526,825,911	18,634,969,104	37.27%

Table above shows allocation by type, along with anticipated release schedule from open access, expected to be September 16, 2019, through December 31st, 2023

* Includes current team tokens + budget for hiring through 2022

** 208.3mm hbar are in the process of being distributed to the community as part of Hedera's community testing program, 1bn is set aside for a committed earn program

HBAR has a detailed unlock plan for the first five years after the launch of the mainnet, followed by a 10-year schedule that starts in 2023 (until 2033). The total unlock cycle is 15 years.

The above figure shows the initial five-year HBAR unlock plan; it details the different release periods of the plan on the vertical axis, as well as the different holders on the horizontal axis. On the first day of the project's open access, 3.18% of the locked HBAR tokens were released. That number is expected to rise to 3.59% after a week of open access, and by the end of 2019 it should reach a further 7.53%.

From the perspective of participants such as investors, employees of the project, project advisors, and partners, the HBAR that is set aside for them is released over a six year period. The estimated HBAR tokens released for them in each year is detailed in columns 2, 3, 4, and 6 of the figure.

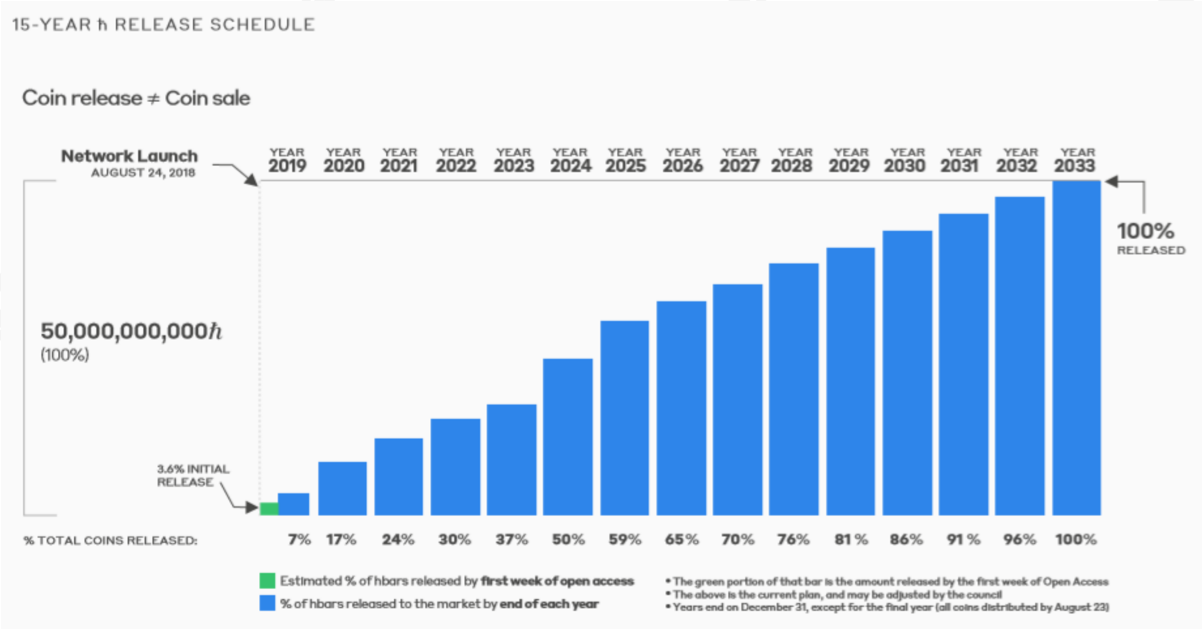
In addition, in order to protect investors, the Hedera Governance Council also stipulates that HBAR tokens owned by market development funds and the co-founder of the project will be locked until January 1, 2020. Furthermore, most of them will continue to be locked after 2020 and will not be released until Sept 2023, on the fifth anniversary of the mainnet launch. Leemon and Mance are delaying the release of 76% of the HBAR which they own until after 2023.

It is worth noting that 1,208,333,333 HBARs were released on the first day of the project's mainnet launch for the project's community rewards program. Of this, a total of, 208,333,333 will be used for the Hedera community testing plan, and the remaining 1 billion is set aside for a committed rewards program.

According to the release plan created by the Hedera Governance Council, the total proportion of HBAR that the project releases before mid-2023 will be less than 33%. This is designed to ensure the operation of the network. Until HBAR is fully dispersed or the price gets high enough to make it difficult for malicious users to own one third of HBAR, the Hedera Governance Council will maintain control of more than 66% of HBAR.

Figure 4-5 Release Schedule of HBAR

Source: HBAR Economics Paper



The above figure outlines the current HBAR release plan decided by the Hedera Governance Council for the next 15 years. Using the above table, it is easy to independently verify the release schedule. Within the first week of open access to the mainnet 3.6%, HBAR should be released; by the end of 2019, a total of 7% HBAR should be released; and by the end of 2024, the proportion of HBAR released should reach 50%.

Following 2025, the rate of release will be maintained at 4 to 5% per year until all HBAR is released (August 23, 2033). As of September 25, 2019, the HBAR in circulation according to the project browser was 1,829,017,699 (approximately 3.65% of the total). This is in line with the planned estimate for this period.

05.
CORE TEAM & PARTNER

5.1 Core Team

Hedera Hashgraph's team is has a high proportion of staff focused on technology and development. The team has a total of 79 people, including 32 developers (40.5% of staff). The other personnel include 13 management members and 15 employees on the marketing teams. For the Hedera Hashgraph project, there is a corresponding senior person in charge of development, operations and marketing.

The key personnel of the Hedera Hashgraph project, the CEO, CTO, CMO and other personnel have extensive entrepreneurial experience. CEO Mance Harmon has worked together with and co-founded several projects with CTO Dr Leemon Baird for more than 10 years.

Dr.Leemon Baird
Co-founder, CTO, and Chief Scientist

Dr. Leemon is the inventor of the hashgraph distributed consensus algorithm, as well as a Co-Founder and the Chief Scientist of the Hedera Hashgraph project. Dr. Leemon received his Ph.D. in Computer Science from Carnegie Mellon University in 1999. After graduation, he served as Chief Technology Officer and other important technical positions, at Trio Security, Motorola, and Blue Wave Security. In addition to his current role at Hedara Hashgraph, he serves as the current CTO for Swirlds Inc. He also served as Professor of Computer Science at the US Air Force Academy from 2003 to 2009. Years of experience in technology and innovation ensure that he has the ability to solve the problems and challenges encountered in developing and implementing the Hedera Hashgraph project.

Mance Harmon
Co-founder, CEO

Mance Harmon is currently serving as CEO and Co-founder at Swirlds Inc and Hedera Hashgraph. Mance Harmon earned his master's degree in computer science from the University of Massachusetts, Amherst in 1998. After graduation, he first served as the project development leader for the missile defense simulation game at theMissile Defense Agency. After that, he co-founded several projects with Dr. Leemon Baird over the course of more than 10 years. He founded Trio Security together with Dr. Leemon in 2002, and also co-founded Blue Wave and Swirlds Inc. later on. Mance has extensive experience in both computer technology and the blockchain industry.

Christian Hasker
CMO

Christian Hasker graduated from the University of Manchester with a Bachelor of Arts Degree (Honours) in 1996. He is currently the CMO of Hedera Hashgraph and a partner of the online platform Lingo Jingo. Christian has nearly 20 years of work experience. He has extensive experience in product marketing. He has worked as the Director of Product Management and Marketing at Quest Software and the Vice President of Marketing at DataStax. His main responsibilities at Hedera Hashgraph include managing and adjusting marketing strategies for various database products.

Lionel Chocron
CPO

Lionel Chocron received a Master's Degree in Engineering from McGill University in Canada in 1995 and an MBA from the University of California, Berkeley in 2000. Currently, Lionel serves as the Chief Product Officer of Hedera Hashgraph. In the past he has worked as a Quantitative Investment Manager for equity derivatives at BNP Paribas, and was responsible for the development of new pricing, hedging and trading strategies. Since then, he has served as a Senior Management Consulting Officer at Kearney Consulting and as a Senior Manager and a Vice President for Cisco for 10 years. His most recent experience was as Vice President of Industry and Emerging Technology at Oracle in 2015 where he designed and launched Oracle's emerging technology cloud solutions for various industries to the market. In general, Lionel Chocron has been involved in the computer technology industry and blockchain related industries for many years; he is experienced in creating enterprise products and bringing them to market.

Mehernosh(Nosh)Mody
Senior Vice-President,
Engineering

Mehernosh Mody earned his Master's Degree in Computer Science from the University of Massachusetts, Lowell in 1992 and gained his MBA from the University of Texas, Austin in 1998. He is currently Senior Vice President of Engineering at Hedera Hashgraph. He started his career in 1996 and has worked in R&D for Britestream Networks and Core Trace. Prior to joining Hedera Hashgraph, he worked as an Engineering Director at HP's network security division, Tipping Point. Nosh has more than 20 years of experience in software development and innovation.

Atul Mahamuni
VP, Product

Atul Mahamuni received a Master's Degree in Engineering and Computer Science from the Indian Institute of Technology in 1991. In 1999, he started to work as a Senior Software Manager at Amber Networks. The company was later acquired by Nokia in 2001 to promote Nokia's future intelligent network development. From 2006 to 2008, he served as Engineering Director of the Ethernet Products Business Group at Juniper Networks. Since then, he has served in Cisco and Oracle for nearly 10 years as a Technical Department Leader. At Oracle, he served as Emerging Technology Vice President and Senior Product Manager. He was responsible for developing and promoting Oracle's cloud services, blockchain Apps, and other related products. Atul has at least 6 years of experience in the development and promotion of emerging technology products. His position and responsibilities at Hedara Hashgraph are identical to Oracle, and his experience and abilities are well suited to the position of Vice President of Products.

Ken Anderson
Chief Development Advocate

Ken Anderson graduated from California State University, Sacramento with a BBA in Management Information Systems in 2011. He is currently the Chief Development Advocate of Hedera Hashgraph. In the past, he founded Concordus Application by himself and served as the COO and President for three years. He was also the lead contributor to the TM Forum's REST API design guidelines, which are now used throughout the global telecom industry. Between 2015 and 2019, he also served as a technical consultant in Mingo, which is the first company to undergo its ICO on the Hedara platform itself, and is also one of the apps that run the hashgraph consensus mechanism for accounting. In addition to serving as the Chief Development Advocate for Hedera Hashgraph, he is also the CEO of Launch Badge. Ken has more than 5 years of experience in technology and blockchain related industries, and can provide the necessary technology and industry support in the development of Hedera Hashgraph products.

Natalie Grunfeld Furman
General Counsel

Natalie Grunfeld Furman received her JD from Columbia University School of Law in 2006. She is currently serving as General Counsel at Hedera Hashgraph. Prior to this position, she worked as a senior associate at Paul Hastings LLP, one of the largest law firms in the United States, for 10 years. Her practice focused on intellectual property, unfair competition, and privacy and publicity rights. Prior to her JD, she also served as the Director of Strategy and Business Development at Yahoo's eGroups and ONEList. Natalie's expertise provides excellent professional legal support and advice on any compliance requirements that must be met during the development of the Hedera Hashgraph project.

5.2 Partners

At present, Hedera Hashgraph has established partnerships with 10 companies from different countries and industries including Boeing, Deutsche Telekom, DLA Piper, FIS, IBM, Magalu, Nomura, Swirlds, Swisscom Blockchain, and Tata Communications.

5.4 Investors

Hedera Hashgraph has secured a total of three rounds of financing, with a total investment of $124 million. $3 million of this is from family and friends, $15 million from strategic financing, and $16 million from public offering and corporate financing.

Figure 5-1 Hedera Hashgraph finance information

Round	Source	Amount (Million)
1	Crowdsale / Institutional	106
2	Strategic	15
3	Friends / Family	3

Source: TokenInsight

06.
COMMUNITY ANALYSIS

The Hedera Hashgraph project has a relatively large number of followers on Twitter and Telegram, 35,000 and 19,913 respectively. While, the followers on Facebook are relatively low (only 9,811); the social platform with the least followers is LinkedIn, with only 4,580. The table below lists the number of followers of Hedera Hashgraph on each social platform.

Figure6-1 Social Medias Followers of Hedera Hashgraph

	Platform	Followers
1	Twitter	35,000
2	Telegram（Hashgraph)	19,913
3	Facebook	9,811
4	Telegram（HederaHashgraph)	8,850
5	Discordapp	8,087
6	Reddit	6,200
7	LinkedIn	4,580

Source: TokenInsight (27-09-2019)

TokenInsight

Symbols and Definition of Risk Ratings

AAA The technical foundation is extremely solid, the status of operations is extremely stable, the extent of influence on the project by unfavorable changes in the environment or un- certain factors is extremely small, and risk is extremely low.

AA The technical foundation is very solid, the status of operations is very stable, the extent of influence on the project by unfavourable changes in the environment or uncertain factors is very small, and risk is very low.

A The technical foundation is solid, the status of operations is stable, the extent of influence on the project by unfavourable changes in the environment or uncertain factors is relatively small, and risk is relatively low.

BBB Technical feasibility is very good, the status of operations is stable, influence on the project by unfavourable changes in the environment or uncertain factors exists to a certain extent, and risk is controllable.

BB Technical feasibility is good, the status of operations is relatively stable, the possibility of influence on the project by unfavourable changes in the environment or uncertain factors exists to a relatively large extent, and risk is basically controllable.

B Technical feasibility is moderate, the status of operations is relatively stable, the possibil- ity of influence on the project by unfavourable changes in the environment or uncertain factors exists to a very large extent, and risk is to a definitely limited extent controllable.

CCC The technical foundation or idea has certain problems, the application scenarios are lim- ited, the project is susceptible to influence by uncertain factors, both internal and external, and has relatively large risk.

CC The technical foundation or idea has considerable problems, and application scenarios are highly limited, which makes for a project that has few internal or external factors to consider in the context of sound development, and carries a very large risk.

C The technical foundation or idea has substantial problems, and lacks deliberation upon possible application scenarios. The token has almost no usage value, and the project suffers from extremely large risk.

D The project is riddled with problems and carries an extremely high risk of failure.

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