

PROJECT RESEARCH

Digital Asset Research

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Hedera TL;DR

- DLT for decentralized apps
- 10k TPS = scalable platform
- Staked nodes receive yield
- Visa style term-limited governance council
- Decentralized network
- HBARs publicly available in secondary in early Sep '19
- Est. \$1.9B of value flowing through network by '24
- Initial members of Hedera's governing council include IBM, Deutsche Telekom, and Tata Communications

Hedera Hashgraph: Low Cost, High Speed Public DLT for Enterprises Open Access key September milestone for developers, partners and coin holders

Hedera Hashgraph (HH) is a Distributed Ledger Technology (DLT) platform for decentralized applications (dApps), primarily for enterprise usage ([slide 18](#)). Assuming blockchain/DLT captures 4% of the gross enterprise services market, and Hedera achieves a high single/low double-digit share of that market, this would result in \$7-8B of value capture for Hedera's enterprise customers ([slide 38](#)). We like the technology and the team for the long-term while noting that risks to adoption of Hedera, and DLT in general, remain high. The launch of open access this month will allow new coin buyers to purchase Hedera's HBAR tokens in the secondary market.

- **Hedera has differentiated technology with scaling potential.** Hedera believes it addresses five challenges to successfully scaling a DLT: performance, security, governance, stability, and regulatory compliance. Notably, its use of "directed acyclic graph" technology (DAG) for recording data improves scalability ([slide 43](#)). The protocol achieves superior speed and lower latency compared to traditional blockchains because there are no wasted messages or blocks. Additionally, efficient hash computations and the stake-weighted virtual voting system helps achieve rapid consensus on transaction packages, called "events" ([slide 48](#)).
- **The platform architecture enables proper regulatory compliance and governance.** Hedera has built features into the code that give dApps the tools to comply with applicable regulations and has implemented "controlled mutability" ([slide 23](#)), which is a key governance feature to remove illegal content and to prove mandated regulatory deletions from the ledger. And, the Visa style 39-member, term limited governance council includes IBM, Deutsche Telekom, and Tata Communications, among others.
- **We estimate the total value of all transactions where DLT can reduce back office costs to be \$17T.** From this, we believe there are about \$250B of associated costs, 30% of which are directly portable onto DLT. Hedera could achieve a 10% share, addressing about \$7-8B. If Hedera could disintermediate ~74% of those costs, then \$1.9B of revenue could eventually flow through the network.
- **We believe Hedera can take \$7-8B of traditional back office costs (payment fees, administrative, financing) and reduce them by about 75%.** This translates to about 200k transactions per second per our estimates, which is within the Hedera network roadmap. We ran a simulation based on our assumptions to assess Hedera's platform. We estimate \$1.9B of fees could flow through the Hedera network by 2024.
- **HBARs first become publicly available in early September, with 3.6% or 1.8 billion of total 50 billion HBAR supply unlocked within the first week following "Open Access".** On Open Access the Hedera mainnet beta becomes available to join without direct interaction with Hedera ([slide 19](#)). An additional ~4% will become publicly available by year end. By 2025, the total available circulating supply could be 59%, or 30 billion tokens ([slide 29](#)).
- **What could go wrong? ([slide 39](#))** Adoption of Crypto in general, including Hedera technology, could lag, resulting in the category or the project to underperform. Price competition could lead to more savings being passed on to customers and lower fee capture for Hedera. A regulatory determination that HBARs are security tokens could adversely impact the network's utility. Finally, it is early to estimate the size of the addressable market, and our approach may prove to be inaccurate as new markets emerge and some predicted markets fail to materialize.

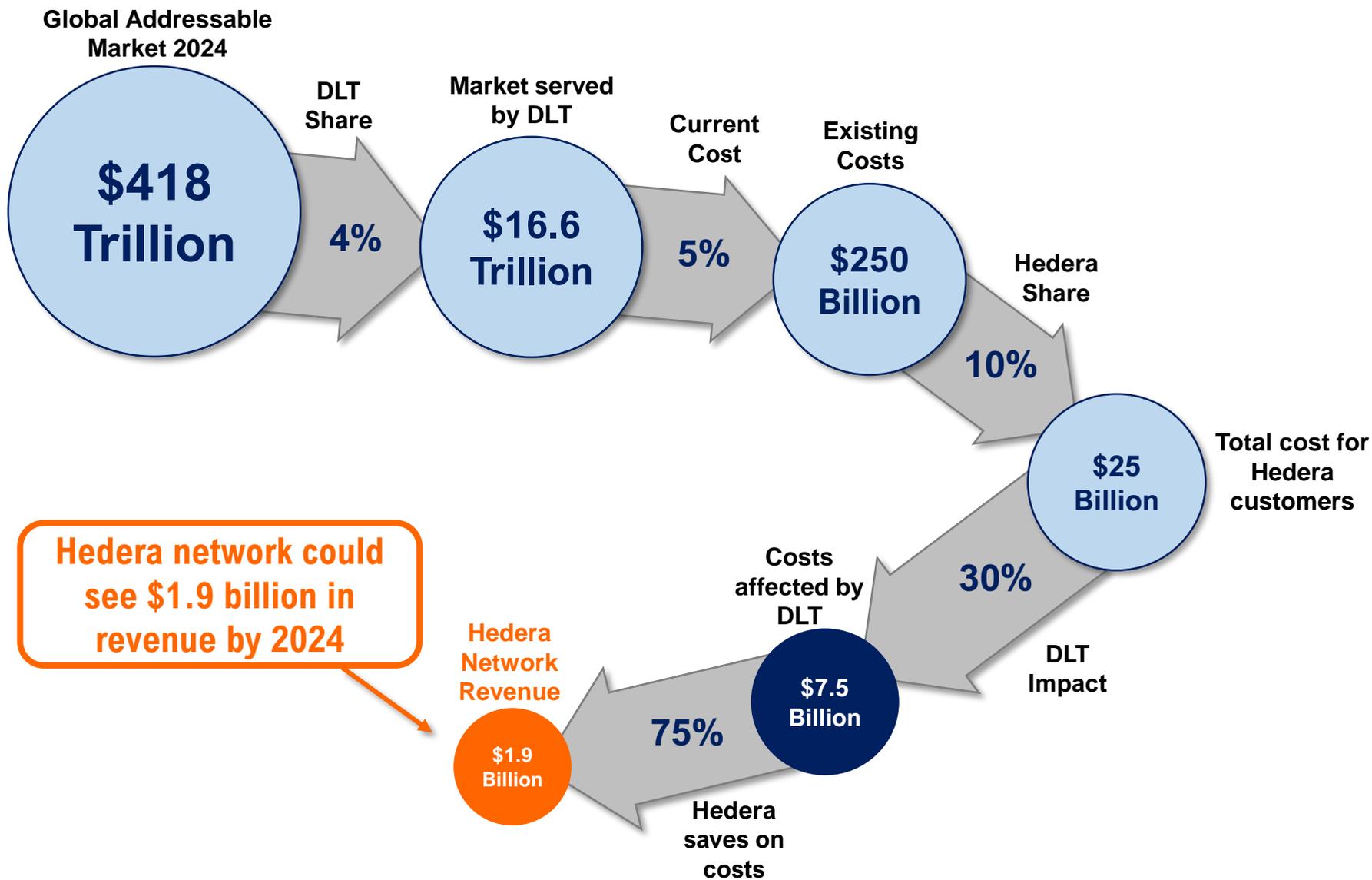
Bottom line: We believe Hedera Hashgraph is a DLT project with differentiated technology, governance structure, and large addressable markets. The project is positioned to benefit from the adoption of Distributed Ledger Technology, and, if successful, could disintermediate \$7-8 billion of costs, generating almost \$2 billion in fee revenue for the network.

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EXECUTIVE SUMMARY: Hedera could capture \$1.9 billion in 2024 revenue from a \$16.6 trillion market

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Source: Fundstrat

EXECUTIVE SUMMARY: Watching 2019/20 milestones to track multiyear adoption process

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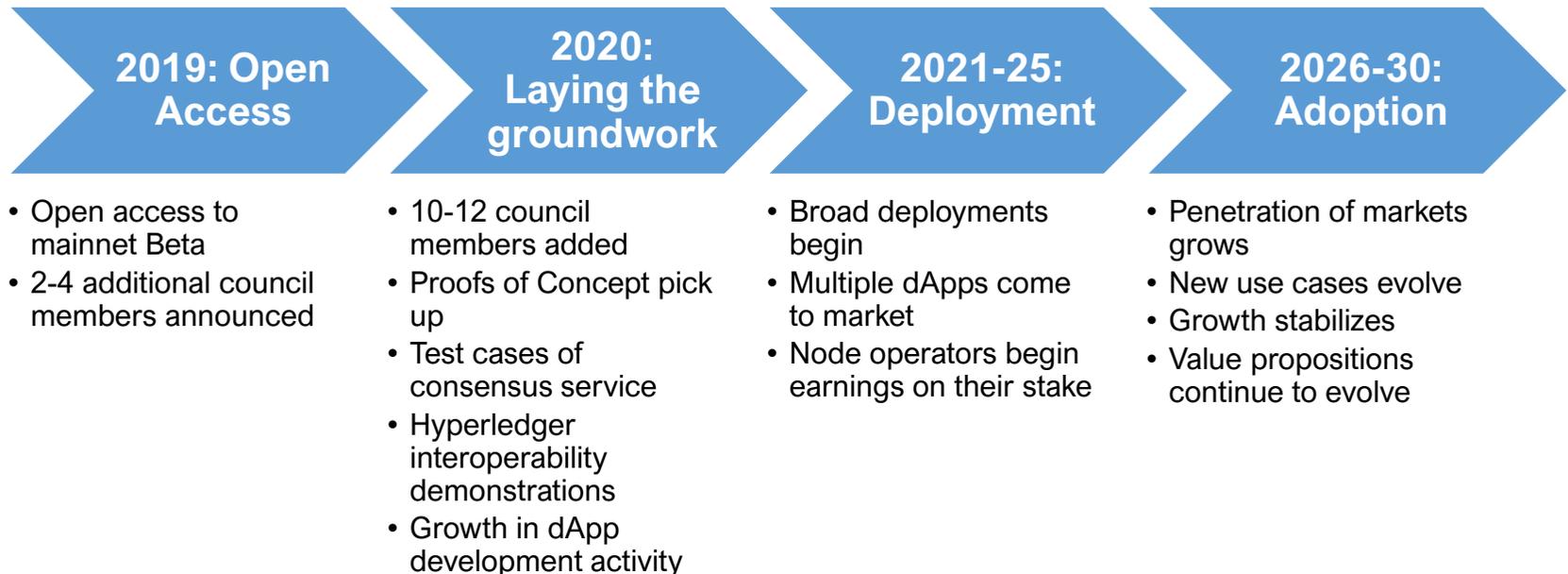
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- We believe 2019 - 2020 will deliver crucial evidence of adoption – specific milestones to watch for include:
 - Council member announcements: 2-4 more by end of 2019, 10-12 during 2020
 - Demonstrations of consensus service and Hyperledger interoperability
 - Growth in proofs of concept and dApp development activity
- Over the next 4-5 years, full deployments and dApps hitting the market are key evidence of successful traction
- We view delays or failure to meet these metrics as evidence of rising risk



Source: Fundstrat



EXECUTIVE SUMMARY: Hedera Hashgraph DLT features – scalable, secure, compliant governance

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Performance

- Hashgraph can process large numbers of transactions per second
- Expect 10,000 tps at mainnet launch, expected to scale to 100,000 tps to enable micropayments
- Permissionless consensus
- Consensus latency is measured in seconds

Stability

- Technical / legal safeguards prevent forks
- Code open review but patented
- Council controls whether / when to change code and ensure adoption

Security

- Proof of Stake consensus process + Asynchronous Byzantine Fault Tolerance
- Governing council will run nodes, staking both their own tokens (HBARs) as well as a proportionate amount of Hedera Hashgraph treasury HBARs.
- Nodes cast one vote per HBAR staked, giving the initially permissioned (governing council) nodes dominant share as the network ramps.

Regulatory Compliance

- The Hedera platform includes tools that enable dApps to be able to comply with applicable regulations

Governance

- Initial term-limited governing council of 39 global leaders in various fields
- **8 council members have already been publicly announced, with more to come in the coming weeks**
- Council will elect Board of Managers to oversee operations
- Permissioned governance

Hedera has sacrificed permissionless nodes in the short term to achieve scalability with security

Source: Fundstrat, Hedera Hashgraph



EXECUTIVE SUMMARY: Hedera’s platform is high speed, interoperable, and enterprise ready... but demand is unproven

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Pros

Cons

Technical	Market
<ul style="list-style-type: none"> • Directed Acyclic Graph topology allows high transaction speeds at scale in testing • Efficient computational load enables low fees • Solidity smart contracts can be ported from other platforms (ex. ETH) to run natively on HH • Java based Hedera SDK is developer friendly • Decentralization milestone: Open Access in early September allows any eligible entity to independently connect with the Hedera mainnet beta 	<ul style="list-style-type: none"> • Hedera infrastructure layer targets many large applications and markets • Enterprise ready interoperability with private / permissioned blockchains such as Hyperledger • Enterprises can connect Hedera to existing blockchain implementations • Governing members from high-visibility businesses like IBM and Deutsche Telekom endorse the platform and reduce risk perception, encourage further corporate involvement • “Visa of DLT” positioning can encourage adoption by driving competitive cooperation across industries
<ul style="list-style-type: none"> • Unproven technology: Mainnet Beta launching in Sep ‘19 • Transaction speeds untested in real-world production environment • Patented open-review code base prevents forks, which could impact growth of developer community 	<ul style="list-style-type: none"> • Visa style governance council is important selling point – but only 7 of 38 outside spots have been filled so far • Enterprise demand for distributed ledger technology unknown: no deployments at scale yet • Unclear that a general purpose DLT could gain critical mass in competition with products tailored for specific applications or markets

Source: Fundstrat

EXECUTIVE SUMMARY: Hedera's scalable potential with transaction fee architecture creates opportunity for high utility network economy

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Hedera one of few projects with theoretical scalability and built in transaction fees

	Hedera	Bitcoin	Ethereum	Ripple	Bitcoin Cash	Litecoin
Use case	dApp platform (all purpose)	Payments / SOV	dApp platform	Payments	Payments	Payments
Consensus algorithm base	Proof of stake	Proof of work	Proof of work	Proof of authority	Proof of work	Proof of work
Transaction fees	●	●	●		●	●
Fixed supply	●	●		🕒	●	●
Permissionless nodes	🕒	●	●		●	●
Block rewards		●	●		●	●
Scalability	●	🕒	🕒	●	🕒	🕒

Source: Fundstrat

EXECUTIVE SUMMARY: Hedera's governance council modeled after Visa could aid adoption

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- Visa unified competing entities onto a single platform; Hedera wants to do the same for distributed ledger technology
- The first eight members of the proposed 39-member governing council are IBM, Swisscom Blockchain, Magazine Luiza, DLA Piper, Tata Communications, Deutsche Telekom, Nomura and Swirls
- Membership is by invitation, and members vote on governance structures, proposed changes to code and node policies and processes
- Members operate nodes to validate transactions and stake an equal share of the treasury tokens on behalf of Hedera as part of the governance and security framework.
- Council members typically would join the council to either help contribute their technology (e.g. IBM) and participate in and help grow the ecosystem, where they see use cases that can either enable new business models or save cost. For example, legal firm DLA Piper could use contract law and real estate transactions stored and executed on the distributed ledger
- Council members can serve a maximum of two consecutive 3-year terms, provided two thirds of the council agrees to let them continue

Diverse geography and industry representation is key to general purpose adoption



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Source: Fundstrat

EXECUTIVE SUMMARY: Hedera's file service enables file verification across entities

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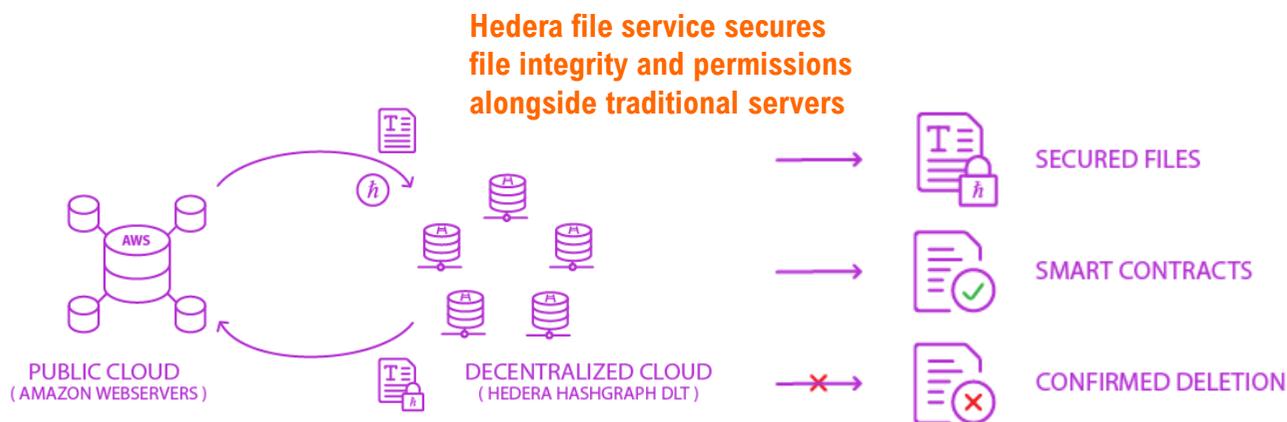
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- Hedera's file service can cryptographically verify a document or a database and manage credentials
- The timestamp verifies the data as it existed at a certain time
- The service can prove that credentials / documents have not been revoked by the issuing party by verifying signatures
- A file containing the hash of an external document or database can be stored on the ledger, and replicated on each node on the network to ensure security and availability
- The actual larger file can be stored off-ledger: on a side-ledger, centralized or cloud storage service
- Controlled mutability would allow the owner to delete a file (to comply with regulatory requirements including GDPR, for example), and a state proof can verify to third parties that it was deleted

Figure: The Hedera file service works with centralized storage to manage secured files, smart contracts, deletions and revocations



Source: Fundstrat. <https://hbarprice.com/hashgraph-file-storage/>



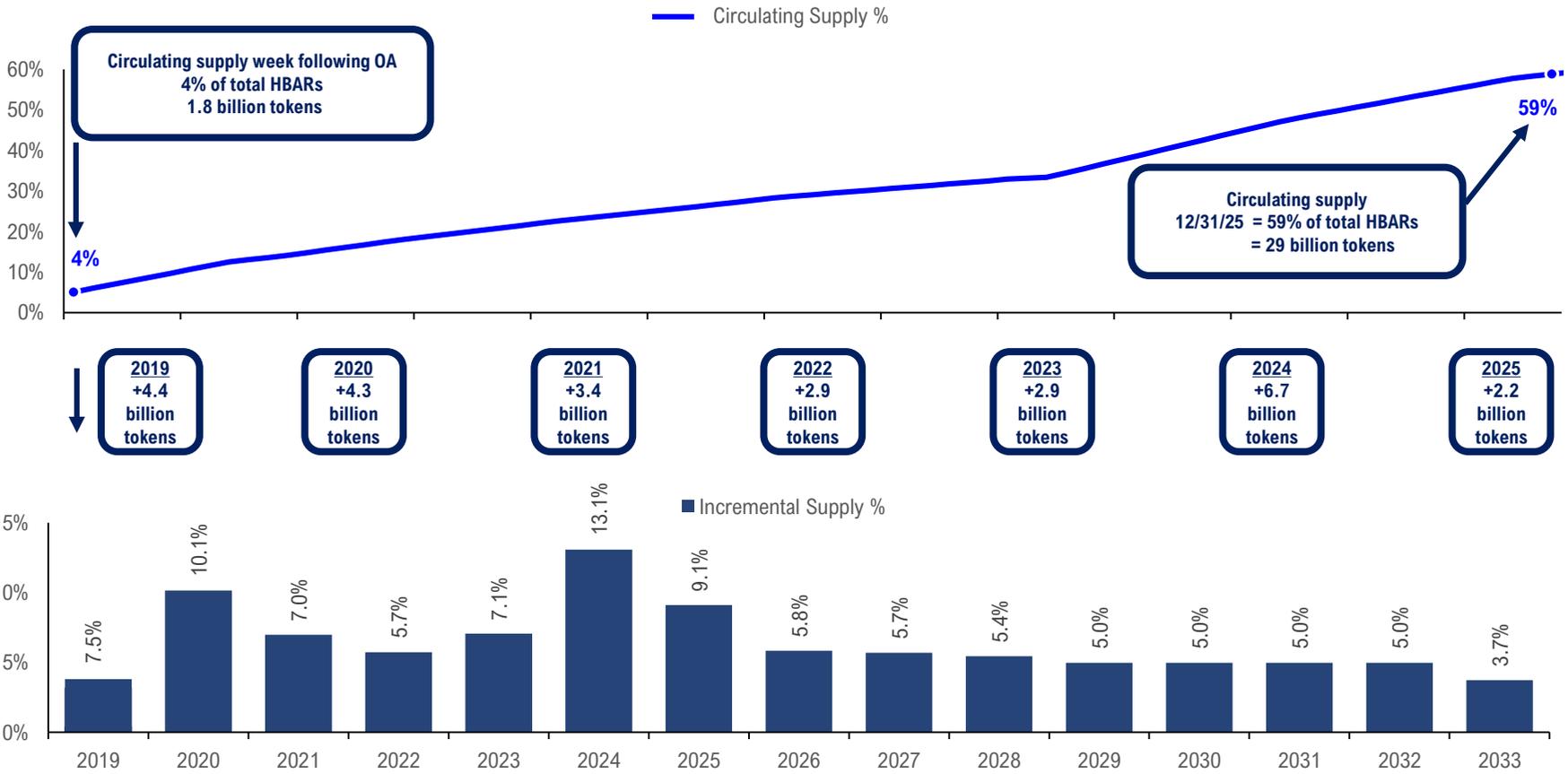
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Circulating supply to increase steadily to 30 billion over the next five years

In early Sept 2019, when Hedera launches Open Access, it is expected tokens will be publicly available for the first time.

- The initial float will be just 4% of the total supply in first week, increasing over 6 years to 59%.

Figure: Expected token release schedule through 2025*



*Actual token release schedule may change.
Source: Fundstrat, Hedera

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- Adoption of Crypto and Distributed Ledger technologies could lag expectations
- Hedera technology deployment may prove slower or less robust than plan
- Hedera may fail to sign on the full plan of 39 highly referenceable global leaders in their diverse fields, affecting the adoption curve and market share for Hedera
- Price competition among competing DLT solutions could lead to greater savings for customers at the expense of the Hedera network value. Cost compression > our 80% assumption could cause the network revenue to undershoot our estimates or need a larger share of a larger pie to align with our estimate
- Hedera may misprice its services, particularly in order to fund adoption, and find that volumes fail to materialize, and could be slow to respond with dynamic price adjustments
- Decentralized apps on the network fail to deliver compelling end-use applications that drive adoption
- Regulators may choose to view HBARs as securities, possibly leading network participants to exit the marketplace for compliance concerns
- Crypto is a volatile asset class with the potential for the category or any token or project to eventually prove worthless and is not suitable for every coin holder
- The opinions expressed in this report are the beliefs of the author at the time of publication. Fundstrat does not commit to update this report and is not responsible for any independent investment decisions made by a reader, based on this and / or any other sources of information

Source: Fundstrat

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- DLT adoption accelerates as projects and solutions achieve critical mass in multiple use cases
- Hedera believes the hashgraph technology is more scalable than Blockchain technology. Should this be proven correct Hedera may lead DLT adoption and gain larger share than our Base Case of about 10%. Management is likely of the view that the 10% assumption is too conservative
- Micropayments are a key use case that leverage native capabilities of the Hashgraph platform. Accelerating adoption of DLT for micropayments could benefit Hedera and expand market share and addressable market sooner than we model
- If Hedera emerges as the leader, it may retain more of the cost savings, delivering materially less than the ~75% savings we estimated customers could see
- A higher retention would result in higher transaction flows to the network, resulting in greater network utility
- As Hedera achieves critical milestones on the technology, governance council and end market adoption, risks to the project would diminish

Source: Fundstrat



Introduction to Hedera Hashgraph

Introduction to Hedera

Hedera Hashgraph (HH) is a public Distributed Ledger Technology (DLT) project which supports decentralized applications (dApps), primarily for enterprise usage. Hedera intends to be regulatory-compliant across jurisdictions and includes tools that allow dApps to do KYC / AML checks and identity verification

Key features:

- High transaction speeds and low fees at scale
- Interoperability layer between existing and emerging enterprise deployments
- Visa-style governance council with 39 term-limited members (8 announced so far include IBM, Deutsche Telekom and Nomura)

Services:

- **Consensus service** - transparent, reliable timestamps and transaction ordering to facilitate transactions between parties
- **File service** - verifiable storage, rights management with controlled mutability
- **Cryptocurrency service** - reliable, quick and cost efficient
- **Smart Contract service** - asset tracking, chain of custody, trade finance, legal and illiquid asset investing applications

Value Proposition:

- Up to 75% cost savings on existing payments and other business processes
- New business model creation such as micropayments
- Enhance supply chain efficiencies and access to trade finance

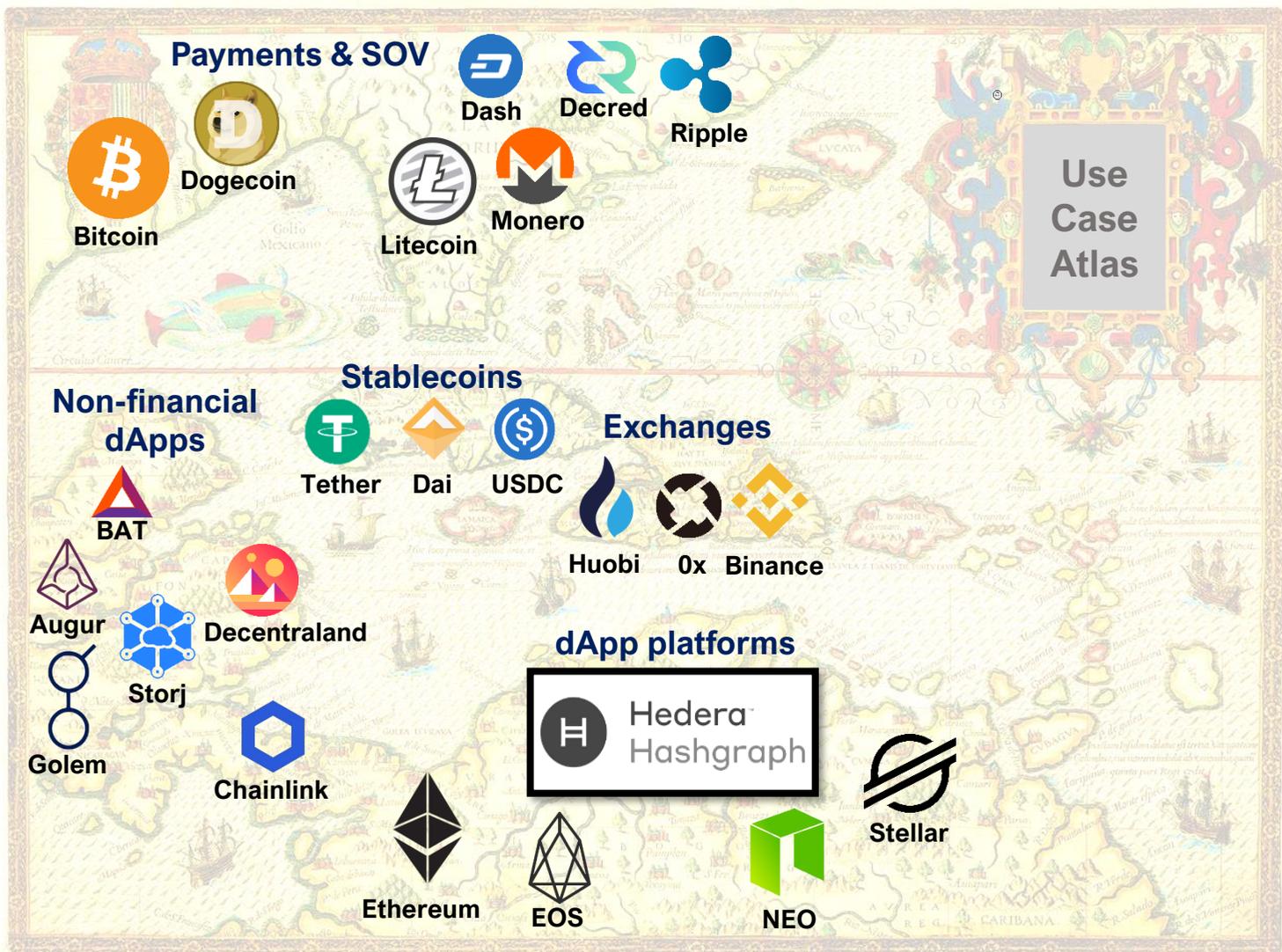
If Hedera succeeds, network fees could grow to as much as \$1.9 billion by 2024

Upcoming catalyst: Hedera launches its mainnet beta by early September, which will unlock 3.6% of token supply to be publicly available.

Source: Fundstrat



Hedera's use case is in the realm of decentralized application platforms



Source: Fundstrat



Hedera's platform is high speed, interoperable, and enterprise ready... but demand is unproven

Technical

Market

Pros

- Directed Acyclic Graph topology allows high transaction speeds at scale in testing
- Efficient computational load enables low fees
- Solidity smart contracts can be ported from other platforms (ex. ETH) to run natively on HH
- Java based Hedera SDK is developer friendly
- Decentralization milestone: Open Access in early September allows any eligible entity to independently connect with the Hedera mainnet beta

- Hedera infrastructure layer targets many large applications and markets
- Enterprise ready interoperability with private / permissioned blockchains such as Hyperledger
- Enterprises can connect Hedera to existing blockchain implementations
- Partnerships with high-visibility businesses like IBM and Deutsche Telekom endorse the platform and reduce risk perception, encourage further corporate involvement
- "Visa of DLT" positioning can encourage adoption by driving competitive cooperation across industries

Cons

- Unproven technology: Mainnet Beta launching in Sep '19
- Transaction speeds untested in real-world production environment
- Patented open-review code base prevents forks, which could impact growth of developer community

- Visa style governance council is important selling point – but only 7 of 38 outside spots have been filled so far
- Enterprise demand for distributed ledger technology unknown: no deployments at scale yet
- Unclear that a general purpose DLT could gain critical mass in competition with products tailored for specific applications or markets

Source: Fundstrat



Hedera's scalable potential with transaction fee architecture creates opportunity for high utility network economy

Hedera one of few projects with theoretical scalability and built in transaction fees

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Transaction fees	●	●	●		●	●
Fixed supply	●	●		◐	●	●
Permissionless nodes	◐	●	●		●	●
Block rewards		●	●		●	●
Scalability	●	◐	◐	●	◐	◐

Source: Fundstrat



Project Overview



Hedera Hashgraph DLT features – scalable, secure, compliant governance

Performance

- Hashgraph can process large numbers of transactions per second
- Expect 10,000 tps at mainnet launch, expected to scale to 100,000 tps to enable micropayments
- Permissionless consensus
- Consensus latency is measured in seconds

Stability

- Technical / legal safeguards prevent forks
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Security

- Proof of Stake consensus process + Asynchronous Byzantine Fault Tolerance
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- Nodes cast one vote per HBAR staked, giving the initially permissioned (governing council) nodes dominant share as the network ramps.

Regulatory Compliance

- The Hedera platform includes tools that enable dApps to be able to comply with applicable regulations

Governance

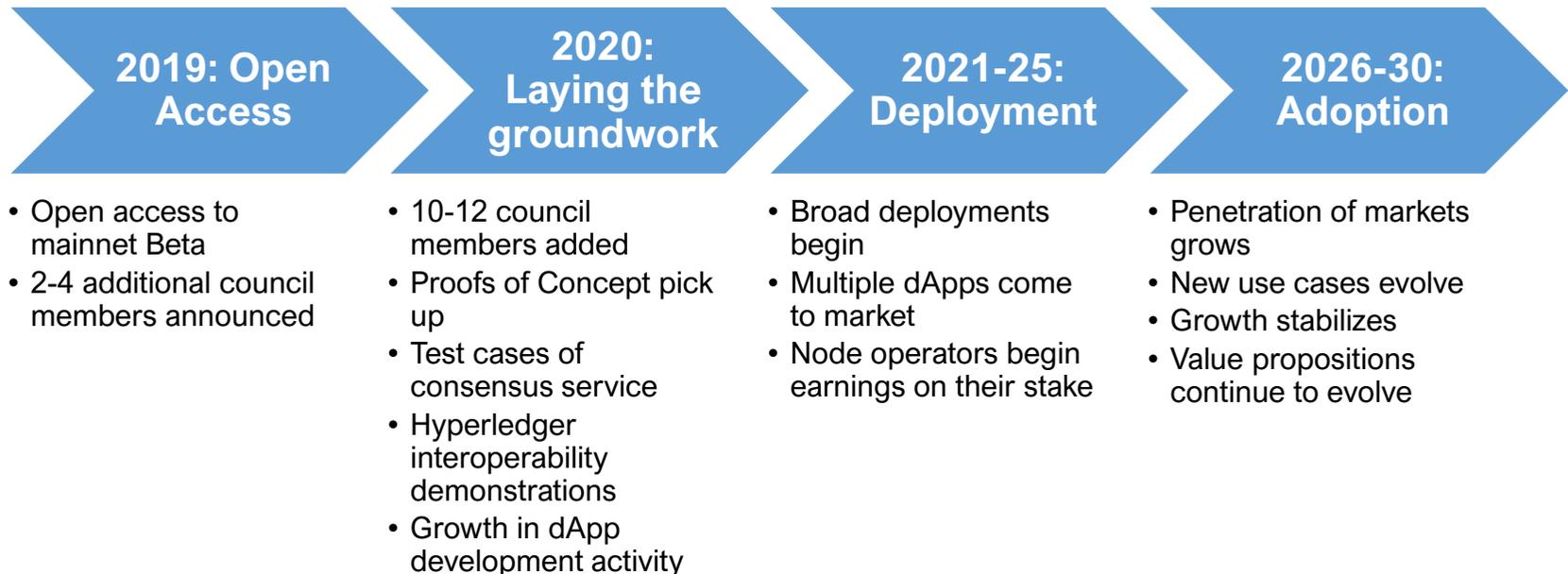
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Hedera has sacrificed permissionless nodes in the short term to achieve scalability with security

Source: Fundstrat, Hedera Hashgraph

Watching 2019/20 milestones to track multiyear adoption process

- **We believe 2019 - 2020 will deliver crucial evidence of adoption – specific milestones to watch for include:**
 - **Council member announcements: 2-4 more by end of 2019, 10-12 during 2020**
 - **Demonstrations of consensus service and Hyperledger interoperability**
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- **We view delays or failure to meet these metrics as evidence of rising risk**



Source: Fundstrat

Hedera's Proof of Stake DAG is more resource efficient compared to proof of work systems

Proof of Work

- Traditional Proof of Work systems such as Bitcoin and (currently) Ethereum require “miners” to solve complex cryptographic puzzles with a brute force approach
- The first miner to solve the puzzle receives the entire reward, and all miners then start over on the next, sequential block and the next puzzle, discarding any efforts spent on the current block
- Miners have an incentive to increase their share of computing power to increase their likelihood of winning the next reward, resulting in an escalating scale of the network – for example, the Bitcoin network represents \$5-6 billion of capital investment and consumes about 6GW of electricity
- **Thus proof of work tends to be relatively slow and resource-intensive, and has difficulty scaling**

Proof of Stake

- Hashgraph uses proof of stake on a DAG or Directed Acyclic Graph topology
- A completed validation does not cause other in-progress transactions to be discarded, allowing for higher throughput and increased network speed – validations can proceed in parallel
- Nodes share in the fees paid by customers for network usage, proportional to the number of HBAR tokens “staked” or “proxy staked”, backing that node. Every active node receives a share of network cash flow, and the incentive is to hold tokens and receive a regular payout based on network activity
- POS is much more resource efficient because capital is held as a liquid asset rather than being deployed as depreciating mining equipment, with incentives to conserve capital rather than add node equipment
- **Hedera's proof of stake implementation leads to faster transaction speeds and better resource utilization than proof of work**

Source: Fundstrat

Hedera's governance council modeled after Visa could aid adoption

- Visa unified competing entities onto a single platform; Hedera wants to do the same for distributed ledger technology
- The first eight members of the proposed 39-member governing council are IBM, Swisscom Blockchain, Magazine Luiza, DLA Piper, Tata Communications, Deutsche Telekom, Nomura and Swirlds
- Membership is by invitation, and members vote on governance structures, proposed changes to code and node policies and processes
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Diverse geography and industry representation is key to general purpose adoption



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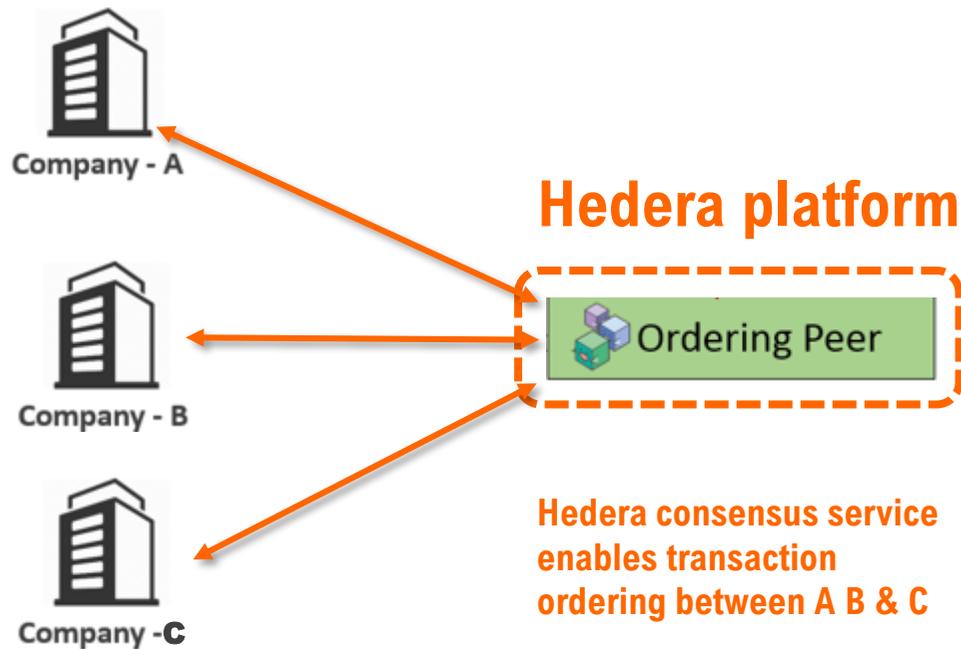
Source: Fundstrat

Hedera's Consensus service = interoperability between IBM's private DLTs

- The core motivation for IBM to join the council is the interaction between public and private networks: Hedera and Hyperledger Fabric.
- IBM is excited about the Hedera Consensus service, according to Bryan Gross, principal offering manager, IBM Blockchain.
- The Consensus service would allow multiple private Hyperledger networks to use Hedera to put transactions in order, eliminating the need for individual projects to create and agree to timestamps.
- The service would provide transparent timestamps that would allow different entities to agree about the order in which events occurred. This would allow private networks to interact with each other with the trust of public networks
- Example: Trading desks need to know, share and agree upon the order and time of trade and settlement transactions

Figure: The Hedera platform enables IBM Hyperledger implementations to interact

Hyperledger Implementations

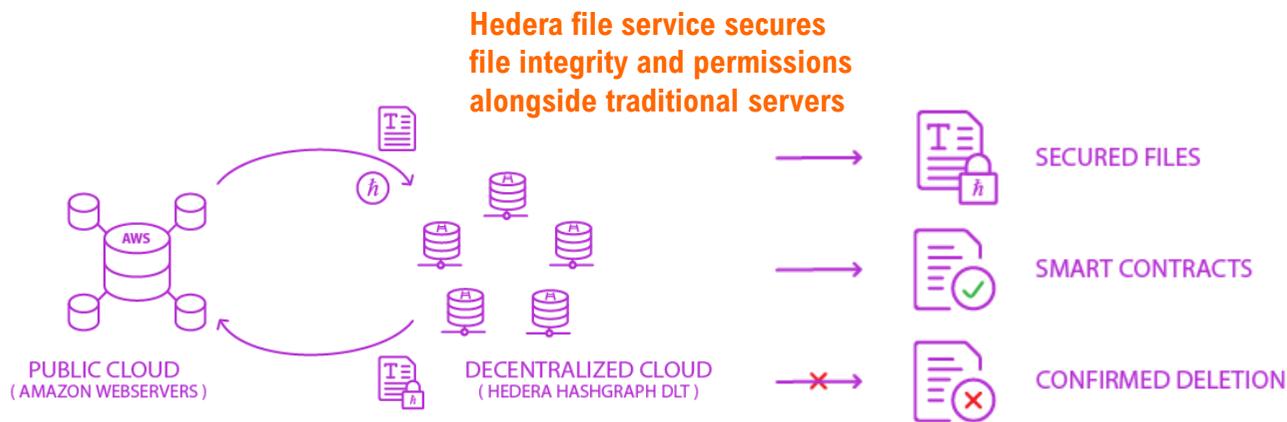


Source: Fundstrat

Hedera's file service enables file verification across entities

- Hedera's file service can cryptographically verify a document or a database and manage credentials
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- Controlled mutability would allow the owner to delete a file (to comply with regulatory requirements including GDPR, for example), and a state proof can verify to third parties that it was deleted

Figure: The Hedera file service works with centralized storage to manage secured files, smart contracts, deletions and revocations



Source: Fundstrat. <https://hbarprice.com/hashgraph-file-storage/>



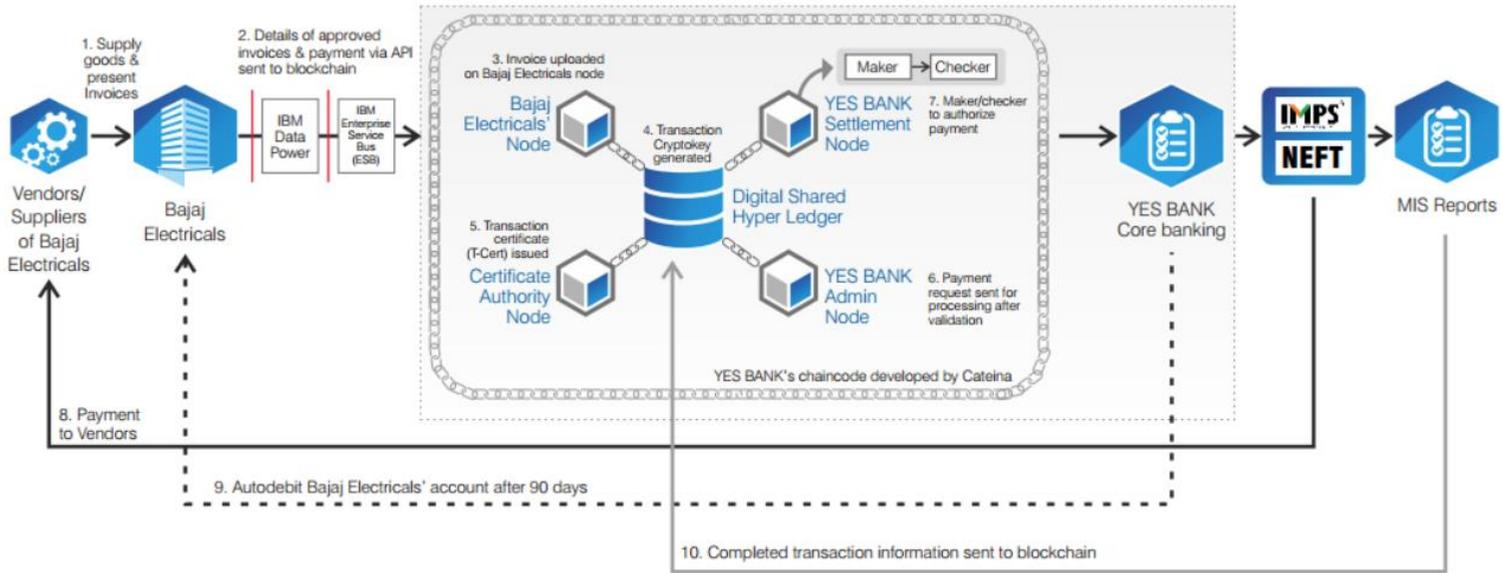
Hedera can reduce inventory and financing costs and accelerate supply chain

Below we depict a small section of Apple's supply chain

- Ordering and shipping information on the Hedera network could speed up the supply chain and ease financing
- Inventory costs can be reduced through higher traceability
- This reduces credit risk and costs in financing the supply chain

DLT platforms like Hedera automate and accelerate document and information verification, which reduces credit risk

Vendor Financing on Blockchain for Electrical Company



Source: Fundstrat, Bajaj

Hedera is led by a strong and experienced team with a history of success

Co- Founders

Dr. Leemon Baird

Co-Founder and Chief Scientist

Leemon is the inventor of the hashgraph distributed consensus algorithm, and is the Co-Founder and Chief Scientist of Hedera. With over 20 years of technology and startup experience, he has held positions as a Professor of Computer Science at the US Air Force Academy and as a senior scientist in several labs. He has been the Co-Founder of several startups, including two identity-related startups, both of which were acquired. Leemon received his PhD in Computer Science from Carnegie Mellon University and has multiple patents and publications in peer-reviewed journals and conferences in computer security, machine learning, and mathematics.

Mance Harmon

Co-Founder and CEO

Mance is an experienced technology executive and entrepreneur with more than 20 years of strategic leadership experience in multi-national corporations, government agencies, and high-tech startups, and is Co-Founder and CEO of Hedera. His prior experience includes serving as the Head of Architecture and Labs at Ping Identity, Founder and CEO of two tech startups, the senior executive for product security at a \$1.7B revenue organization, Program Manager for a very-large scale software program for the Missile Defense Agency, the Course Director for Cybersecurity at the US Air Force Academy, and research scientist in Machine Learning at Wright Laboratory. Mance received a MS in Computer Science from the University of Massachusetts and a BS in Computer Science from Mississippi State University.

Leadership

Lionel Chocron

Chief Product Officer

Lionel was vice-president for Blockchain, IoT and AI at Oracle, and previously co-launched Cisco's IoT business

Natalie Grunfeld Furman

General Counsel

Christian Hasker

Chief Marketing Officer

Edgar Seah

Head of Asia-Pacific

Zenobia Godschalk

Senior Vice-President, Corporate Communications

Atul Mahamuni

Senior Vice-President, Product

Mehernosh Mody

Senior Vice-President, Engineering

Jordan Fried

Senior Vice-President, Business Development

Source: Fundstrat, <https://www.hedera.com/about#team>



Token Supply Schedule

Disclaimer: The following slides detail Hedera's expected HBAR release schedule. However, the actual token release schedule may change.

HBARs are expected to become available for purchase on the secondary market in Sep 2019

As of August 2019, about 54% of HBARs are owned by Treasury

- **17% are held by outside holders in prior private SAFT sales**
- **~20% are held by “insiders” : Founders, the Hedera team, and Swirls**
- **Swirls (5% holder) is a software platform designed to support distributed app development in the Hashgraph environment. It was co-founded by the Hedera founders, and counts New Enterprise Associates and Happy Life Capital as Venture investors**

Figure: HBAR ownership and expected public availability in 2019

In millions, as of August 2019

	HBAR ownership	Share	HBARs available in 2019	Share
Seed SAFTs	7,798.3	15.6%	1,046.3	27.8%
SAFT 3	926.3	1.9%	458.8	12.2%
Hedera Team *	7,761.7	15.5%	381.8	10.1%
Community **	1,208.3	2.4%	1,208.3	32.1%
Advisors, Vendors & Others	1,450.2	2.9%	150.2	4.0%
Market Development Funds	1,298.0	2.6%	7.3	0.2%
Swirls	2,500.0	5.0%	60.0	1.6%
Hedera Treasury	27,057.1	54.1%	450.0	12.0%
Total	50,000.0	100.0%	3,762.8	100.0%

*Includes current team tokens + budget for hiring through 2022

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

Source: Fundstrat, Hedera

Supply growth moderated by founders' lockup up of 76% of holdings

In early September 2019, at Open Access, it is expected that the tokens will be publicly available for the first time, with a 15-year release schedule.

- Initial tokens available for sale will be 3.6% of total supply, growing to 7.5% by year end 2019
- 17% of all private sale tokens will see lockups expire, representing 40% of tokens available for sale in 2019
- An additional 8% of 2019 token availability is from the Hedera team, representing 4% of total team holdings
- Founders have agreed to lock the distribution of 76% of their HBAR holdings past Aug 2023

Figure: Lockup expiration schedule and planned release of HBARS***

In millions

	Seed SAFTs	SAFT 3	Hedera Team *	Community **	Advisors, Vendors & Others	Market Development Funds	Swirls	Hedera Treasury	Total
Total	7,798.3	926.3	7,761.7	1,208.3	1,450.2	1,298.0	2,500.0	27,057.1	50,000.0
2019	1,046.3	458.8	381.8	1,208.3	150.2	7.3	60.0	450.0	3,762.8
2020	2,076.8	322.0	1,681.0	0.0	280.2	88.9	122.7	431.3	5,002.8
2021	1,956.9	48.5	439.5	0.0	114.6	145.2	299.4	479.9	3,484.1
2022	1,450.3	48.5	490.6	0.0	75.8	145.2	168.1	479.9	2,858.5
2023	694.0	48.5	1,156.2	0.0	168.0	251.6	227.0	981.6	3,526.8
2024	342.7	0.0	2,283.6	0.0	414.9	659.9	347.7	2,485.6	6,534.5
Thereafter	231.3	0.0	1,329.0	0.0	246.5	0.0	1,275.1	21,748.8	24,830.6

**3.7B tokens
released by
end of 2019**

*Includes current team tokens + budget for hiring through 2022

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

***Disclaimer: The chart shows the expected HBAR release schedule. Actual token release schedule may change.

Source: Fundstrat, Hedera

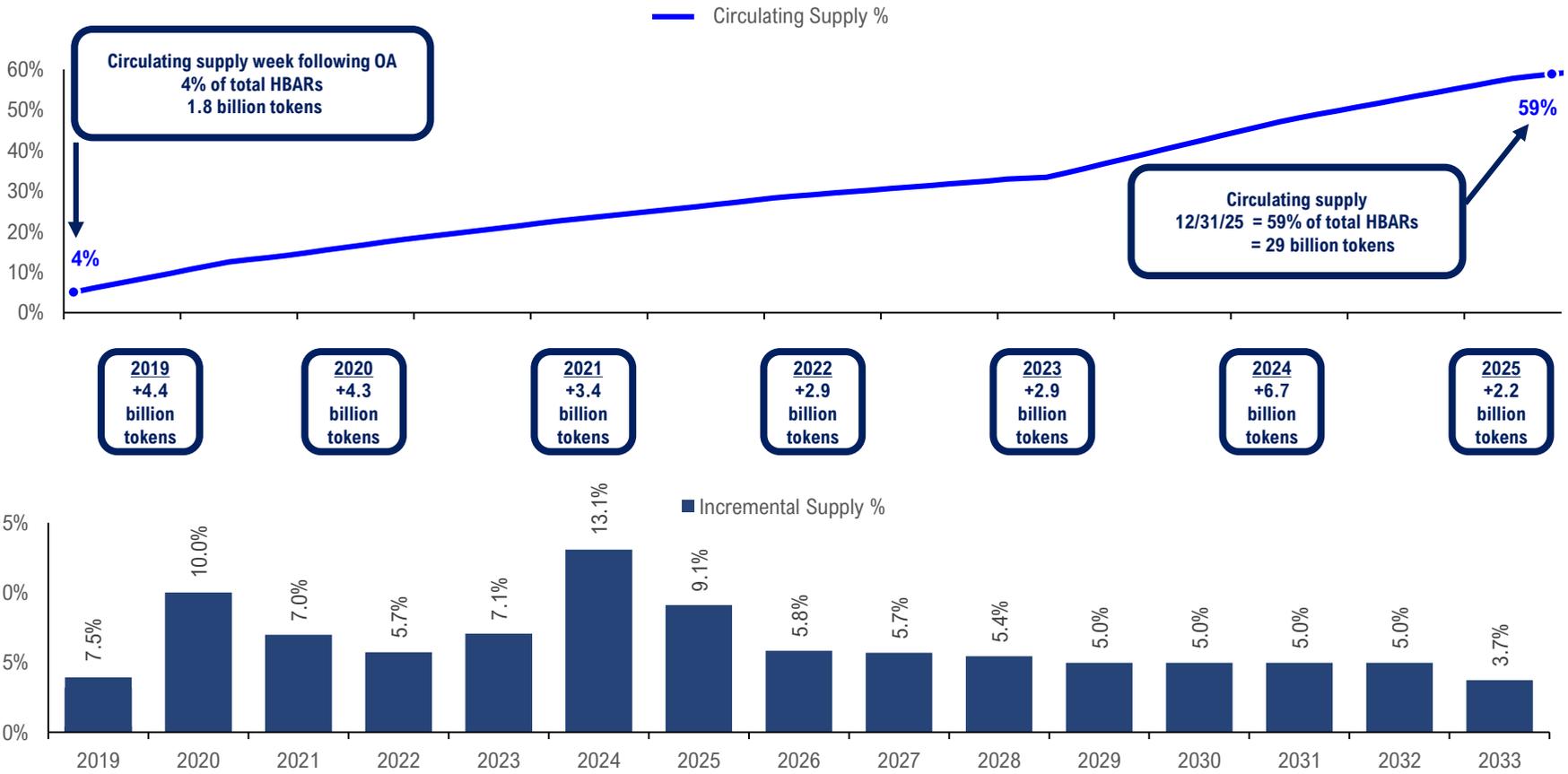


Circulating supply to increase steadily to 30 billion over the next five years

In early Sept 2019, when Hedera launches Open Access, it is expected the tokens will be publicly available for the first time.

- The initial float will be just ~4% of the total supply in first week, increasing over 6 years to 59%.

Figure: Expected token release schedule through 2025*



*Actual token release schedule may change. Source: Fundstrat, Hedera



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Market & Value Potential



Value creation in crypto is centered around frictionless value transfer

Many of the opportunities for value creation in the economy by crypto projects stem from cryptocurrencies' ability to offer users frictionless (or near-frictionless) transfer of value (the transfer of 1s and 0s which represent value in digital economy).

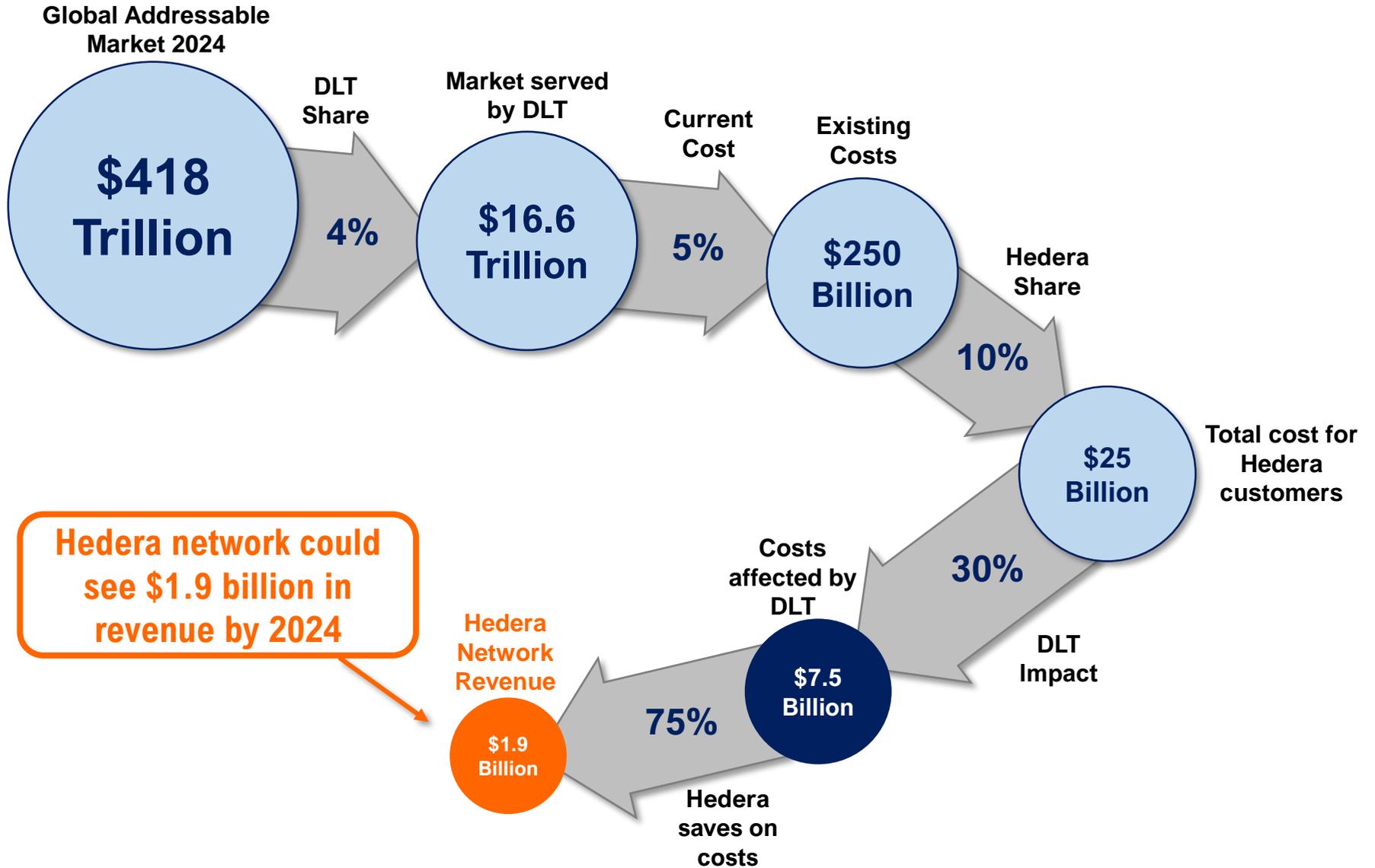
HH has multiple vectors for value creation

Category	Description	Hedera	Bitcoin	Ethereum	Ripple	Bitcoin Cash	Litecoin
Enterprise cost savings	Financing and tracking	●			●		
Payments	Reduced payment fees	●	◐	◐	◐	●	●
Store of value	Trusted asset storage and retrieval		●	◐		◐	◐
Enable open sourced funding	Funding platform or token open to public		●	●		●	●
New business models	New payment streams	●	◐	●		◐	◐

Source: Fundstrat



Hedera could capture \$1.9 billion in 2024 revenue from a \$16.6 trillion market



Source: Fundstrat



Aim to grow network fees through direct partnerships and independent solutions

Direct corporate partnerships



Independent Solutions & Products (Sample)

MEDIA	ENVIRONMENTAL	ENTERTAINMENT
<p>AdsDeX</p> <p>TRANSPARENT AD PLATFORM</p> <p>AdsDax looks to right the ad marketplace by using Hedera Hashgraph to provide transparency through the entire ad lifecycle.</p> <p>VISIT</p>	<p>ALMOND</p> <p>ETHICAL BRANDS ECOSYSTEM WITH TOKENISED REWARDS</p> <p>Almond is a Hedera powered platform that aims to create an alternative goods market to better benefit consumers, the planet, and purpose driven brands.</p> <p>VISIT</p>	<p>ALTO</p> <p>GAME DEVELOPMENT PLATFORM</p> <p>Alto provides a developer platform to incorporate distributed ledger technology beginning with tokenized gaming assets and marketplaces.</p> <p>VISIT</p>
TECHNOLOGY	LOGISTICS	MEDIA
<p>AoChain</p> <p>CUSTODY, TRADING, AND SETTLEMENT PLATFORM</p> <p>AoChain integrates all end-to-end requirements for the lifecycle of a non-traditional asset, from origination to maturity.</p> <p>VISIT</p>	<p>ARMADA</p> <p>COLLABORATIVE SUPPLY CHAIN</p> <p>Armada is a collaboration hub that authenticates transactions, streamlines communication, and connects supply chains without compromising existing workflows.</p> <p>VISIT</p>	<p>ATTESTIV</p> <p>TRUSTED PHOTO AND MEDIA TECHNOLOGY</p> <p>Attestiv puts authenticity back into photo and media files, utilizing advanced technologies in mobile, AI, and DLT.</p> <p>VISIT</p>

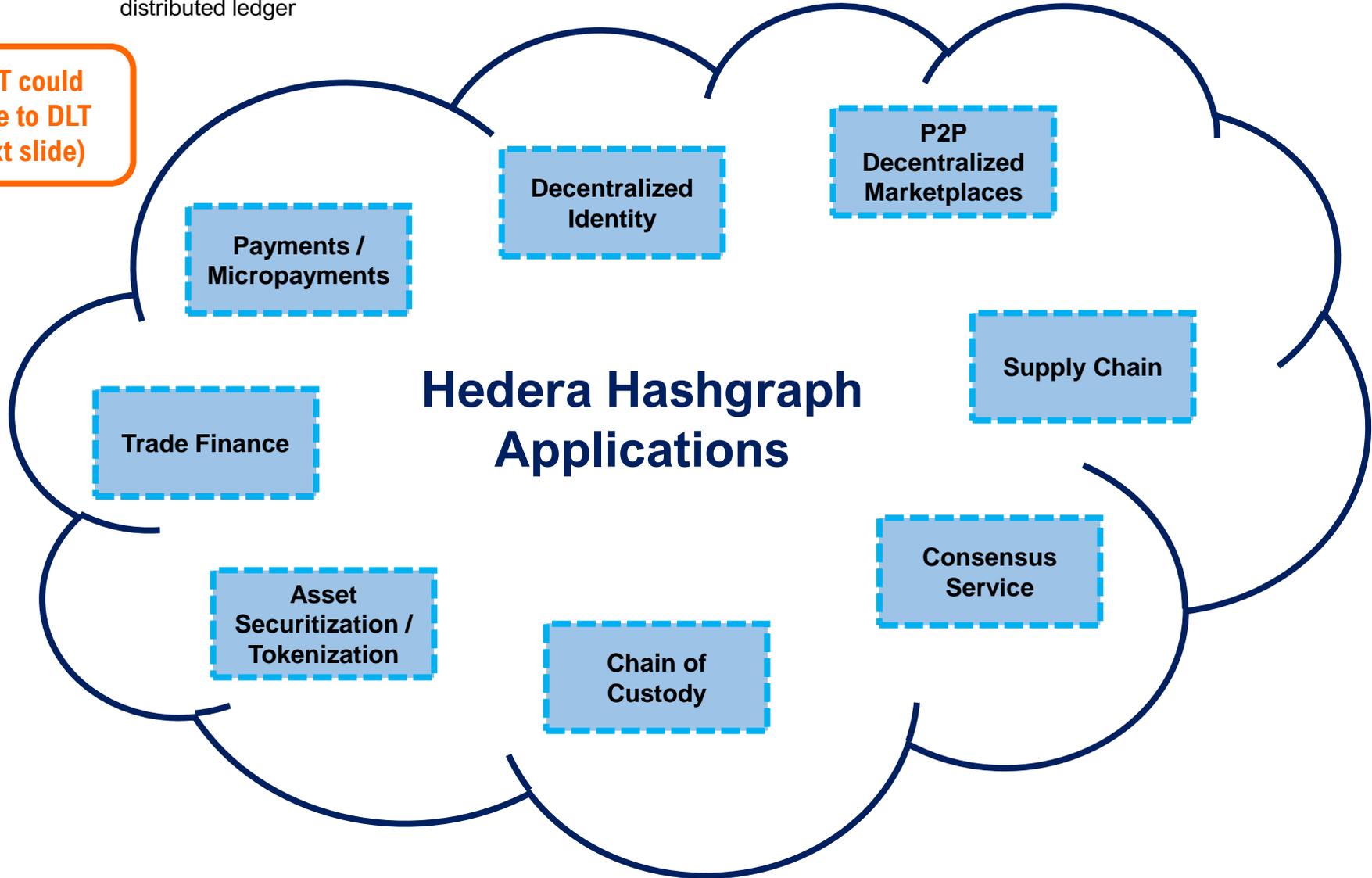
Source: Fundstrat, <https://www.hedera.com/users/>



Hedera's core offering spans 8 services or markets

The potential for a multi-trillion-dollar opportunity in DLT, Hedera's highly regarded team, compliance ready platform, scalable technology (in theory), and existing institutional support all point to the possibility Hedera Hashgraph becomes a top public distributed ledger

\$17T could move to DLT (next slide)



Source: Fundstrat



Network Value: Total Addressable Market of \$16.6 trillion by 2024

Below we've estimated the total market size across various use cases where DLT/blockchain technology has the potential to reduce costs and increase liquidity. For the present valuation exercise we have excluded the opportunity in Healthcare owing to uncertainty around data sharing and HIPAA rules in the US

- **We estimate Distributed Ledgers could serve \$16.6T of Global activity by 2024, disintermediating \$250B fees**

Figure: Use cases and total addressable market sizes for DLT/blockchain technology

\$ billions

	Annual Transaction Value, \$B	2024 Potential Annual Transaction Value, \$B	Typical Fee / Spread / Cost Structure	Current Costs	Share substituted by DLT in 5 yrs	DLT Served Market	Existing Costs being disintermediated
Flow Based Applications							
Payments B2C	\$22,154.3	\$26,954.1	2.0%	\$539.1	5.0%	\$1,347.7	\$27.0
B2B	20,000.0	23,185.5	1.0%	231.9	10.0%	2,318.5	23.2
C2C Decentralized Marketplaces	500.0	701.3	3.0%	21.0	7.0%	49.1	1.5
Micro-transactions*	1.0	97.7	1.0%	1.0	80.0%	78.1	0.8
Remittances	613.0	693.6	4.0%	27.7	25.0%	173.4	6.9
Financing Asset Backed Issuance	516.0	598.2	5.0%	29.9	10.0%	59.8	3.0
Factoring / Forfeiting	30.0	34.8	7.0%	2.4	10.0%	3.5	0.2
Trade Finance*	5.8	21.5	5.0%	1.1	80.0%	17.2	0.9
Banking the unbanked*	2.0	344.2	7.0%	24.1	50.0%	172.1	12.0
Investing Real Estate	1,480.0	1,715.7	2.0%	34.3	10.0%	171.6	3.4
Art, Collectibles & Non Fungible Assets	63.7	73.8	10.0%	7.4	15.0%	11.1	1.1
Legal Title Insurance	15.0	17.4	100.0%	17.4	10.0%	1.7	1.7
Liens	15.0	17.4	100.0%	17.4	5.0%	0.9	0.9
Contract Law	21.0	26.8	100.0%	26.8	5.0%	1.3	1.3
e-Discovery	19.8	26.5	100.0%	26.5	5.0%	1.3	1.3
Data Sensor / IoT	4.0	35.8	12.0%	4.3	25.0%	8.9	1.1
Computation	280.0	411.4	100.0%	411.4	5.0%	20.6	20.6
Logistics Asset Tracking	11.8	23.7	100.0%	23.7	15.0%	3.6	3.6
Inventory Storage	616.7	680.8	100.0%	680.8	2.0%	13.6	13.6
Inventory Financial Cost	631.7	697.4	100.0%	697.4	2.0%	13.9	13.9
Inventory Obsolescence, Shrinkage, Insurance, Handling	535.0	459.4	100.0%	459.4	15.0%	68.9	68.9
Logistics Support Costs	421.7	362.1	100.0%	362.1	5.0%	18.1	18.1
Gaming Betting / Book Making	300.0	440.8	10.0%	44.1	5.0%	22.0	2.2
Video Game micro-transactions	5.0	15.3	3.0%	0.5	75.0%	11.4	0.3
Digital Sen Consensus Service	0.0	1.0	100.0%	1.0	100.0%	1.0	1.0
Decentralized Identity	0.0	0.5	100.0%	0.5	100.0%	0.5	0.5
Stock Applications (Issuance and trading costs)							
Global Corporate Debt Outstanding	66,000.0	80,299.1	1.0%	803.0	1.0%	803.0	8.0
Global Sovereign Debt Outstanding	47,300.0	57,547.7	1.0%	575.5	0.5%	287.7	2.9
Global Agency / Local Govt Debt O/S	25,000.0	30,416.3	1.0%	304.2	0.5%	152.1	1.5
Global Equities (Mkt Value)	77,566.0	94,370.9	0.8%	707.8	1.0%	943.7	7.1
Custody Management	81,000.0	98,548.9	0.0%	19.7	10.0%	9,854.9	2.0

Aggregate	\$345,108.4	\$418,819.6	1.5%	\$6,103.4	4.0%	\$16,631.5	\$250.6
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Source: Fundstrat

\$17T of economic value could migrate to DLT by 2024

We estimate \$250B in existing fees could be disintermediated by distributed ledger technology

Network Value: Key Base Case Assumptions for Monte Carlo

Variable	Mean assumption	Basis	Comments
Node Fee	\$0.0001	Per transaction	
Service and Network Fees	\$0.0001	Base case, plus per byte & per second costs	Substantially higher for large transactions with file storage or contractual execution clauses
Hedera Market Share	~10%	For flow-based applications; 0 for financial markets stock applications	Range from 50% of DLT market for Consensus service and as low as 2% in Asset Backed Issuance
Potential costs impacted	50%	Share of use case costs moving to DLT	Share of addressed transaction costs impacted by DLT; other costs such as personnel may not change much
Hedera Savings	75%	Cost reduction on cost moved to DLT	Estimated savings vs. affected traditional costs using Hedera Hashgraph

Source: Fundstrat

Note that price structure is approximate and is currently being worked on by Hedera



Hedera Hashgraph vs other DLT platforms

	Yield	Supply scarcity	Equation of exchange	Fat protocols
Summary	<ul style="list-style-type: none"> With fee-based networks, staked nodes can expect a yield for their contribution to the network This yield can be valued relative to the value flowing through the network 	<ul style="list-style-type: none"> Enough demand for a token with limited supply will naturally drive up price This applies to commodity type digital assets and collectible tokens (ERC-721, for example) 	<ul style="list-style-type: none"> $MV = PQ$ Size of asset base x money velocity = price of digital resource x quantity of goods A certain "asset base" or market value is necessary to support an economy with velocity, v 	<ul style="list-style-type: none"> "Fat protocols, think applications" Protocols, not applications atop the protocols, will create value for holders Protocol tokens incentivize protocol adoption, which should drive value
Examples	 Hedera Hashgraph	 bitcoin	 ethereum	 IOTA

Source: Fundstrat, Joel Monegro, Chris Burniske



Hedera could reduce \$7-8 B in traditional costs by ~ 74%

The table below shows that of a potential \$4.6 trillion of economic activity using DLT by 2024, Hedera could gain about a 10% share.

- In addition, we believe about ¼ of costs move onto distributed ledgers; costs such as personnel, physical devices and storage (asset / inventory tracking applications) might change but not necessarily reduce significantly
- This leads to \$7.5B of costs directly replaced by Hedera at a ~74% savings
- The Hedera Hashgraph network would thus see ~\$1.9B in revenue

Figure: Hedera Revenue and cost savings delivered across use cases

\$ billions

		Market using DLT	Average Transaction size, \$	# of Transactions, in millions	Hedera Share	Hedera Transaction Flow	Costs Disintermediated by Hedera	Share of cost recaptured due to Hedera	Cost subject to savings	Node Fee	Service & Network Fee	Hedera Network Revenue	Cost Savings on Hedera Network	% Cost reduction
Flow Based Applications														
Payments	B2C	\$1,347.7	\$25.0	53908	10.0%	\$134.8	\$2.70	50.0%	\$1.35	\$0.001	\$0.270	\$0.270	\$1.08	(80.0%)
	B2B	2,318.5	1,500.0	1546	10.0%	231.9	\$2.32	50.0%	\$1.16	0.000	0.155	0.155	1.00	(86.7%)
	C2C Decentralized Marketplaces	49.1	10.0	4909	10.0%	4.9	\$0.15	50.0%	\$0.07	0.000	0.025	0.025	0.05	(66.6%)
	Micro-transactions*	78.1	0.5	156250	20.0%	15.6	\$0.16	60.0%	\$0.09	0.003	0.063	0.063	0.03	(30.0%)
	Remittances	173.4	200.0	867	5.0%	8.7	\$0.35	50.0%	\$0.17	0.000	0.043	0.043	0.13	(75.0%)
Financing	Asset Backed Issuance	59.8	10,000,000.0	0.006	2.0%	1.2	\$0.06	20.0%	\$0.01	0.000	0.000	0.000	0.01	(99.0%)
	Factoring / Forfeiting	3.5	1,000,000.0	0.003	10.0%	0.3	\$0.02	20.0%	\$0.00	0.000	0.000	0.000	0.00	(92.9%)
	Trade Finance*	17.2	10,000.0	1.72	10.0%	1.7	\$0.09	20.0%	\$0.02	0.000	0.002	0.002	0.02	(90.0%)
	Banking the unbanked*	172.1	20.0	8605	5.0%	8.6	\$0.60	60.0%	\$0.36	0.000	0.004	0.004	0.36	(98.8%)
Investing	Real Estate	171.6	25,000.0	6.9	5.0%	8.6	\$0.17	25.0%	\$0.04	0.000	0.003	0.003	0.04	(92.0%)
	Art, Collectibles & Non Fungible Assets	11.1	500,000.0	0.022	10.0%	1.1	\$0.11	25.0%	\$0.03	0.000	0.000	0.000	0.03	(99.2%)
Legal	Title Insurance	1.7	2,000.0	0.869	10.0%	0.2	\$0.17	25.0%	\$0.04	0.000	0.009	0.009	0.03	(80.0%)
	Liens	0.9	6,000.0	0.145	10.0%	0.1	\$0.09	25.0%	\$0.02	0.000	0.001	0.001	0.02	(93.3%)
	Contract Law	1.3	2,500.0	0.536	10.0%	0.1	\$0.13	25.0%	\$0.03	0.000	0.003	0.003	0.03	(92.0%)
Data	e-Discovery	1.3	10,000.0	0.132	10.0%	0.1	\$0.13	25.0%	\$0.03	0.000	0.013	0.013	0.02	(60.0%)
	Sensor / IoT	8.9	0.1	178932	20.0%	1.8	\$0.21	75.0%	\$0.16	0.004	0.036	0.039	0.12	(75.6%)
Logistics	Computation	20.6	75.0	274	5.0%	1.0	\$1.03	20.0%	\$0.21	0.000	0.001	0.001	0.20	(99.3%)
	Asset Tracking	3.6	200.0	18	10.0%	0.4	\$0.36	20.0%	\$0.07	0.000	0.002	0.002	0.07	(97.5%)
	Inventory Storage	13.6	5,000.0	3	10.0%	1.4	\$1.36	10.0%	\$0.14	0.000	0.027	0.027	0.11	(80.0%)
	Inventory Financial Cost	13.9	25,000.0	1	10.0%	1.4	\$1.39	10.0%	\$0.14	0.000	0.028	0.028	0.11	(80.0%)
	Inventory Obsolescence, Shrinkage, Insurance, Handling	68.9	150.0	459	15.0%	10.3	\$10.34	20.0%	\$2.07	0.000	0.345	0.345	1.72	(83.3%)
Gaming	Logistics Support Costs	18.1	18.1	1000	15.0%	2.7	\$2.72	15.0%	\$0.41	0.000	0.150	0.150	0.26	(63.2%)
	Betting / Book Making	22.0	1,000.0	22	5.0%	1.1	\$0.11	40.0%	\$0.04	0.000	0.001	0.001	0.04	(97.5%)
Digital Services	Video Game micro-transactions	11.4	0.3	45776	15.0%	1.7	\$0.05	60.0%	\$0.03	0.001	0.007	0.008	0.02	(75.6%)
	Consensus Service	1.0	0.0001	9765625	50.0%	0.5	\$0.49	100.0%	\$0.49	0.483	0.005	0.488	0.00	(0.0%)
	Decentralized Identity	0.5	0.0001	5252188	50.0%	0.3	\$0.26	100.0%	\$0.26	0.260	0.003	0.263	0.00	(0.0%)
Aggregate Hedera Market		\$4,590.1	\$0.3	15,470,393.2	9.6%	\$440.5	\$25.6	29.2%	\$7.5	\$0.8	\$1.2	\$1.9	\$5.5	(73.9%)

Hedera could save ~74% costs and generate \$1.9B network revenue

Source: Fundstrat

Downside risks to our thesis

- Adoption of Crypto and Distributed Ledger technologies could lag expectations
- Hedera technology deployment may prove slower or less robust than plan
- Hedera may fail to sign on the full plan of 39 highly referenceable global leaders in their diverse fields, affecting the adoption curve and market share for Hedera
- Price competition among competing DLT solutions could lead to greater savings for customers at the expense of the Hedera network value. Cost compression > our 80% assumption could cause the network revenue to undershoot our estimates or need a larger share of a larger pie to align with our estimate
- Hedera may misprice its services, particularly in order to fund adoption, and find that volumes fail to materialize, and could be slow to respond with dynamic price adjustments
- Decentralized apps on the network fail to deliver compelling end-use applications that drive adoption
- Regulators may choose to view HBARs as securities, possibly leading to network participants exiting the marketplace for compliance concerns
- Crypto is a volatile asset class with the potential for the category or any token or project to eventually prove worthless and is not suitable for every token holder
- The opinions expressed in this report are the beliefs of the author at the time of publication. Fundstrat does not commit to update this report and is not responsible for any independent investment decisions made by a reader, based on this and / or any other sources of information

Source: Fundstrat

Upside potential to our thesis

- DLT adoption accelerates as projects and solutions achieve critical mass in multiple use cases
- Hedera believes the hashgraph technology is more scalable than Blockchain technology. Should this be proven correct Hedera may lead DLT adoption and gain larger share than our Base Case of about 10%. Management is likely of the view that the 10% assumption is too conservative
- Micropayments are a key use case that leverage native capabilities of the Hashgraph platform. Accelerating adoption of DLT for micropayments could benefit Hedera and expand market share and addressable market sooner than we model
- If Hedera emerges as the leader, it may retain more of the cost savings, delivering materially less than the ~75% savings we estimated customers could see
- A higher retention would result in higher transaction flows to the network, resulting in a higher network utility
- As Hedera achieves critical milestones on the technology, governance council and end market adoption, the risks to the project would diminish

Source: Fundstrat



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Technical Overview

What is the Hashgraph Distributed Ledger?

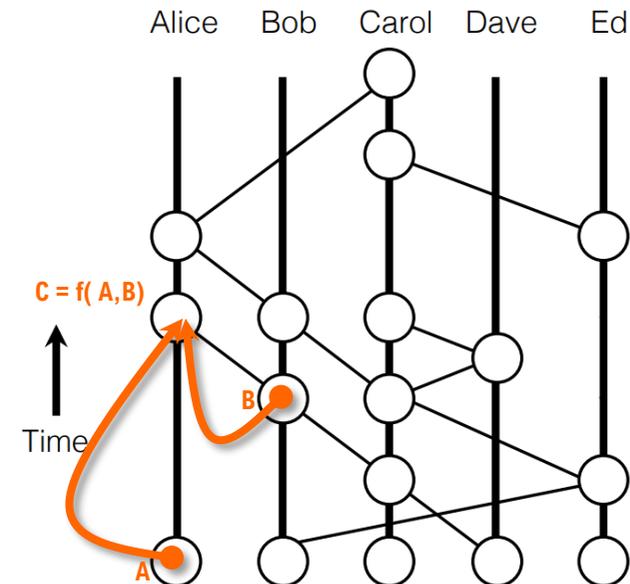
A Directed Acyclic Graph

Hashgraph is a consensus alternative to the blockchain. It uses a gossip protocol that works in the following manner: Every node in Hashgraph can spread signed information (called events) on newly-created transactions and transactions received from others, to its randomly chosen neighbors.

These neighbors will aggregate received events with information received from other nodes into a new event, and then send it on to other randomly chosen neighbors. This process continues until all the nodes are aware of the information created or received at the beginning. Due to the rapid convergence property of the gossip protocol, every piece of new information can reach each node in the network in a fast manner.

Full technical details can be found in the Hedera Hashgraph [white paper here](#).

Figure: Hashgraph's Gossip Protocol



Gossip history is a directed graph. When one member creates a new event, it adds the hashes of the previous event it itself created (hash **A**) and the hash **B** received from the last event of another node. The new event generates its own hash **C**.



Comparing Hashgraph vs Blockchain: Low processing overhead improves efficiency

- Distributed consensus mechanisms allow for a group of users to agree on the order, details and value of a series of transactions in the absence of a single / centralized trusted entity.
- Blockchain is one way of achieving distributed consensus, using one of several algorithms such as Proof of Work (Bitcoin), Casper FFG (Ethereum), dBFT (Neo) and others. Iota's Tangle is an example of a non-blockchain distributed consensus mechanism; Hashgraph is another.

Figure: Traditional Blockchain

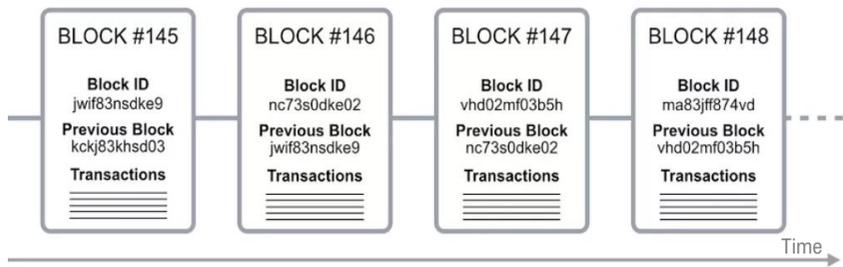
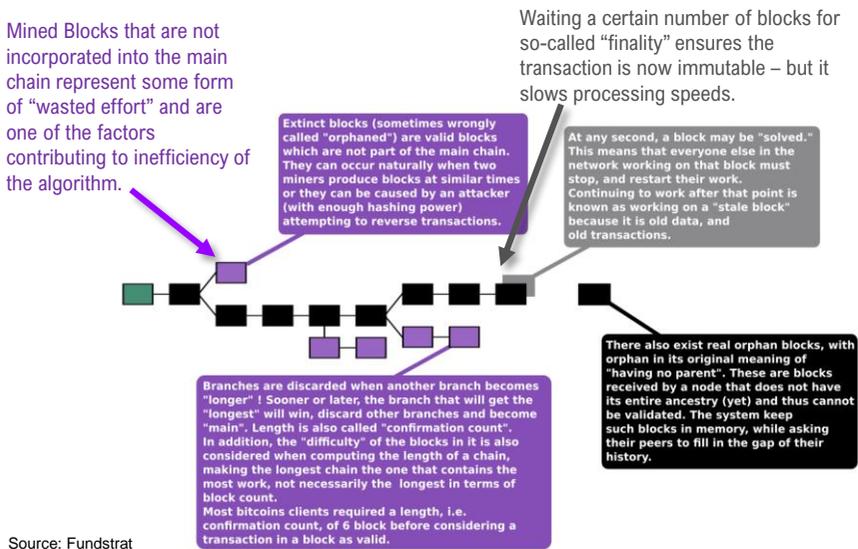
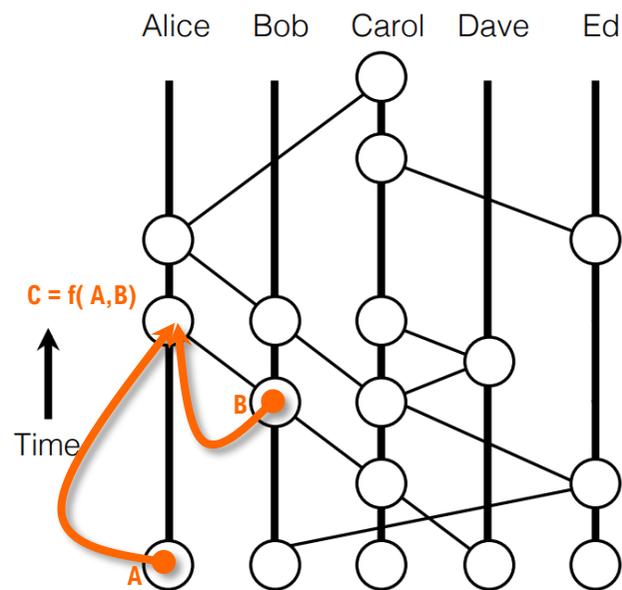


Figure: Processing overheads and confirm times add inefficiency



Source: Fundstrat

Figure: Hashgraph's Gossip Protocol



Hashgraph is efficient compared with Proof of Work algorithms because there are no wasted messages or blocks, and hashes only add a minimal overhead to the transaction payload

Source: Fundstrat, Swirls



High speed, low latency of network: 10,000 transactions per second expected at OA

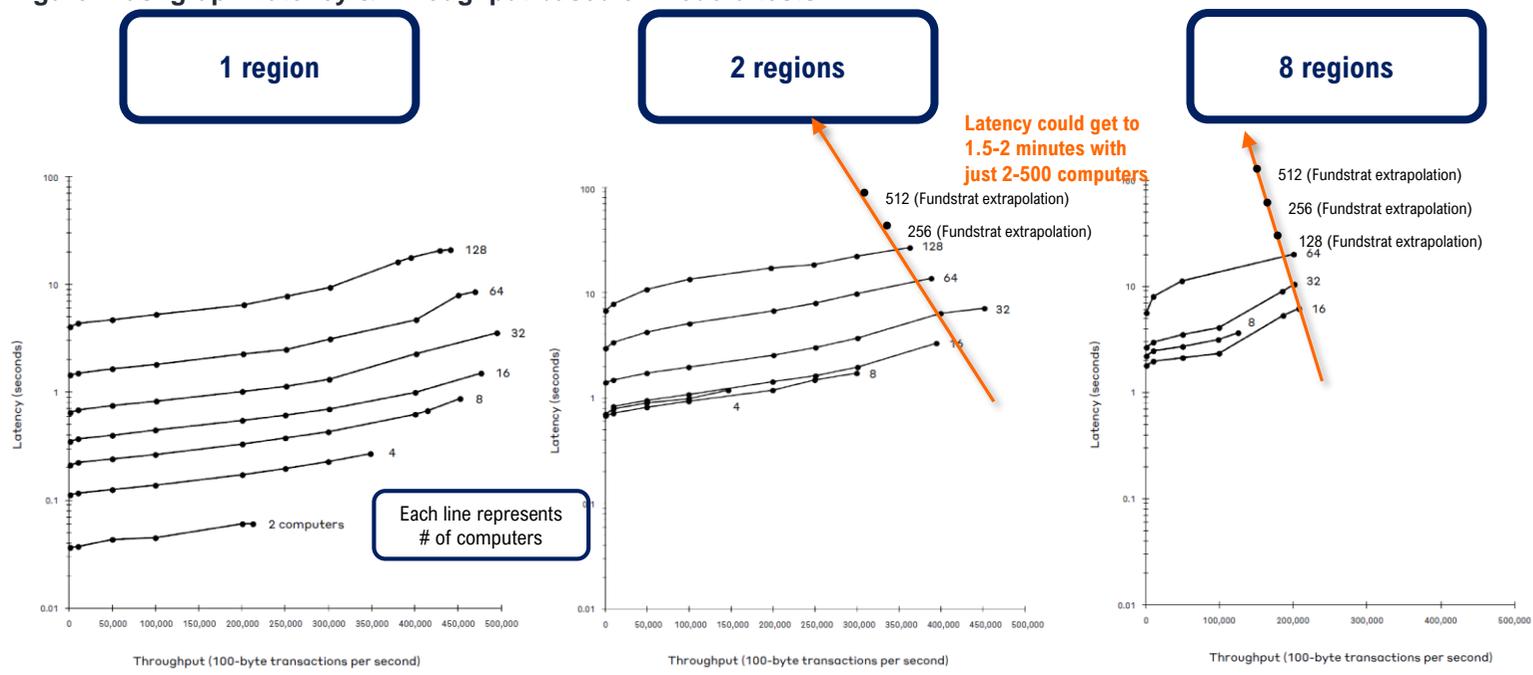
Network performance starts at 10k TPS, throttled at Open Access

Hedera sees a path to achieve the 100k TPS needed to enable micropayments at scale

The tests below were conducted to test the time to achieve consensus using 100-byte transactions, without accounting for any time to process transactions or to upload large files

- One key challenge in any distributed network is that latency increases non-linearly as more computers are connected to the network, although Hashgraph metrics are still far superior to something like Bitcoin
- Transaction speeds do not appear to respond much to the number of computers in use, but do degrade based on geographic distribution of the nodes – which makes sense based on the number of server / switch hops as the data traverses the internet
- We believe that sharding – which is built into the code - would be necessary to allow the network to scale
- **Each shard can be individually optimized for applications, preferring low latency in some, or high throughput in other shards**
- Although nodes are permissionless, payments to nodes are based on stake (except for node fees) and are likely small for new nodes until the amount staked on such nodes reaches critical mass. This may cause the node network growth to lag transaction volumes, retaining Hedera’s speed and latency advantage

Figure: Hashgraph Latency & Throughput based on Hedera tests



- Per Fundstrat’s extrapolations, node network growth would need to be moderate to retain speed and latency advantages
- Key incentive for a new, non-governing council node to come online would be node fees paid for transactions directly submitted to the node.
- Indirect payments from Hedera based on stake add to the node revenue
- This should keep node growth aligned with real-world transaction growth

Source: Fundstrat, Hedera
 1 region = Virginia; 2 regions = Virginia and Oregon; 8 regions = Virginia, Oregon, Canada, Sao Paulo, Australia, Seoul, Tokyo and Frankfurt . This is for consensus only and does not include the handling of transactions. If you include the handling of transactions, then the speeds will be slower. We expect Hedera to achieve 10k tps for cryptocurrency speeds at OA."

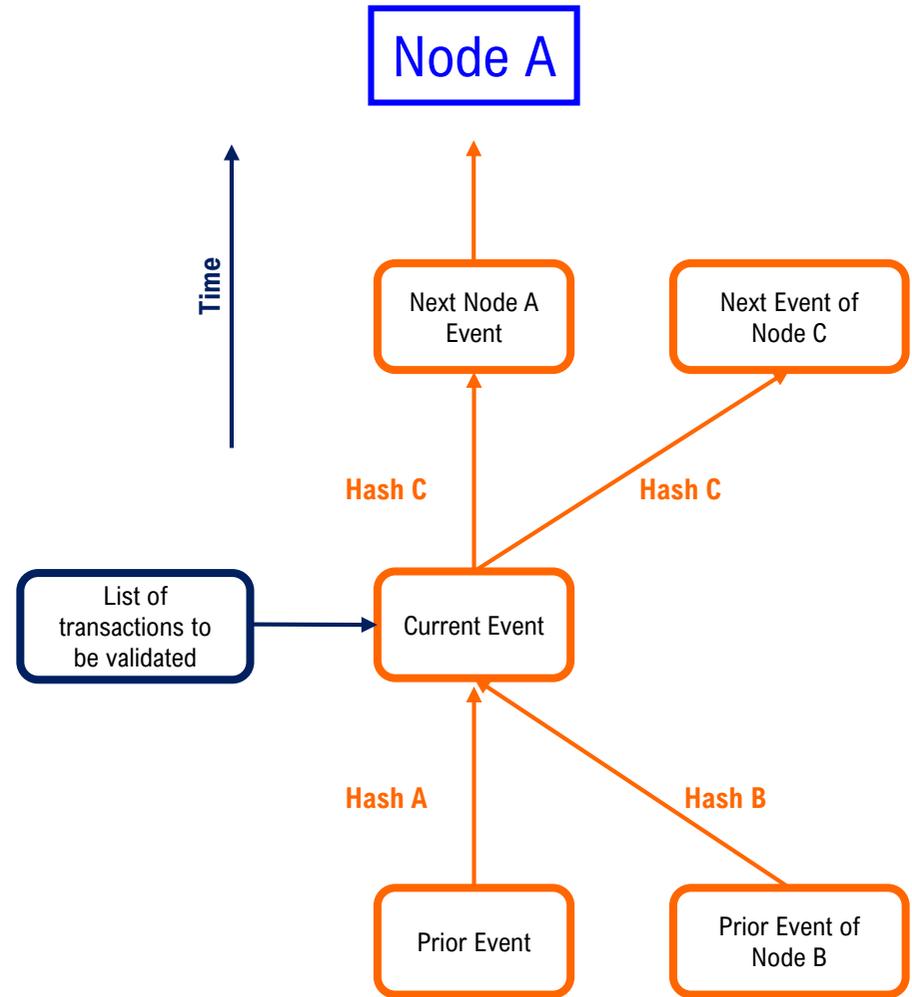


Controlled Mutability a key feature of “events” that batch transactions for validation

Events

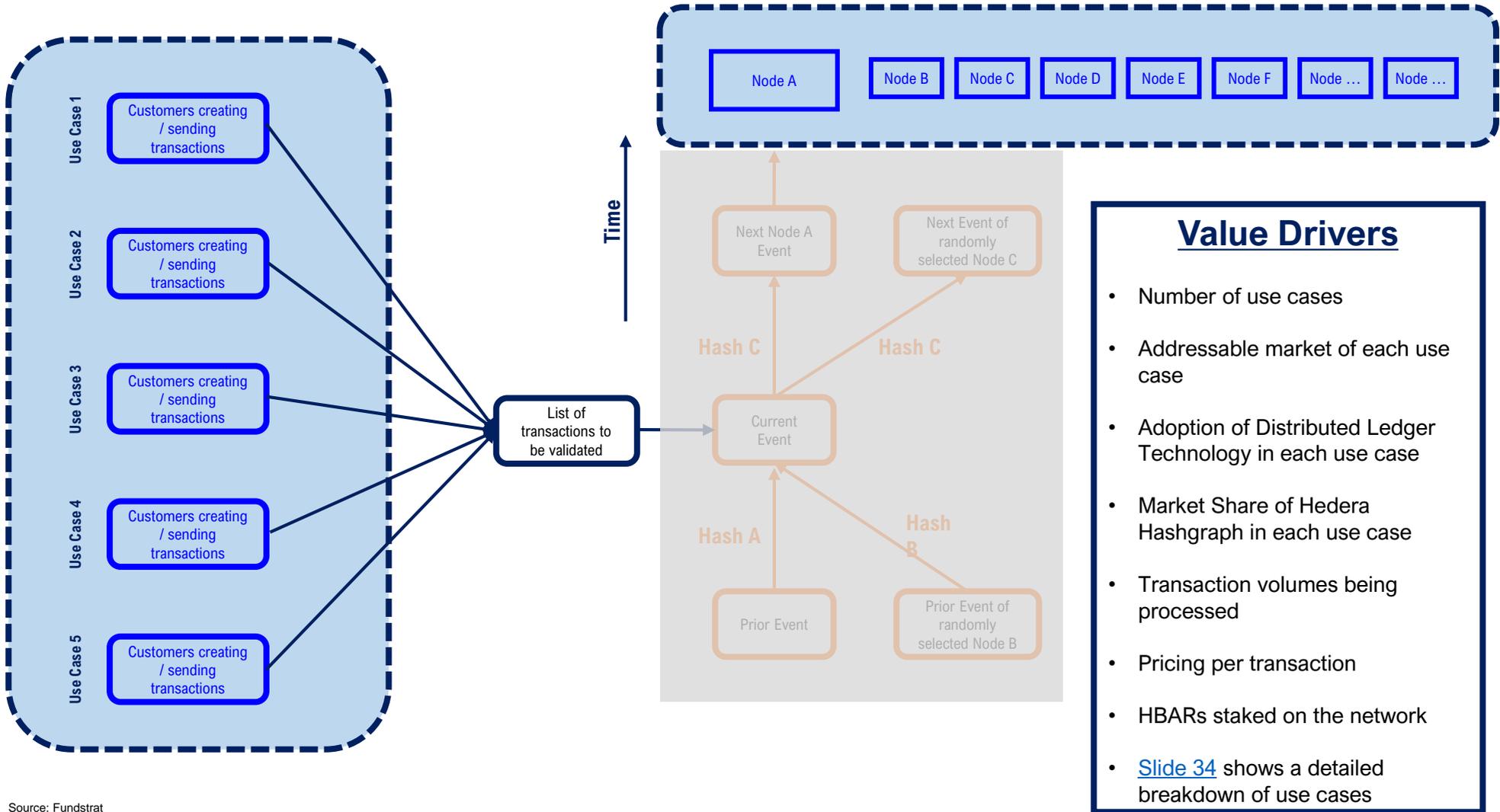
- Each “event” contains a set of transactions including smart contracts, as well as two embedded hashes – one from the predecessor event of the node, and one from another node, and a timestamp, and creates a digital signature to sign off on the event.
- There is no fixed block size, so no inherent limit to the number of transactions per block.
- **The memo field in a transaction can be at most 100 bytes, while the total size of the transaction is limited to 4kb.**
- Duplicate transactions are handled at the application layer based on transaction timestamps.
- The algorithm does not concern itself with duplicates or otherwise opine on validity of the transaction.
- The algorithm records a transaction as received from a third party / customer, not whether that recorded transaction is valid or correctly created outside of the distributed ledger.
- Nodes are not required to persist transactions - but rather the consequent state.
- Hashgraph contains a key feature of “controlled mutability” which allows for the network to remove incorrect content. A “correcting transaction” would roll back the incorrect transaction and brings the state back to correctness.
- **Controlled mutability is the ability of the Council to logically override the default permissions of who can delete illegal content from the ledger to keep it compliant.**

Source: Fundstrat





Drivers that affect the value flowing through the network and related fees

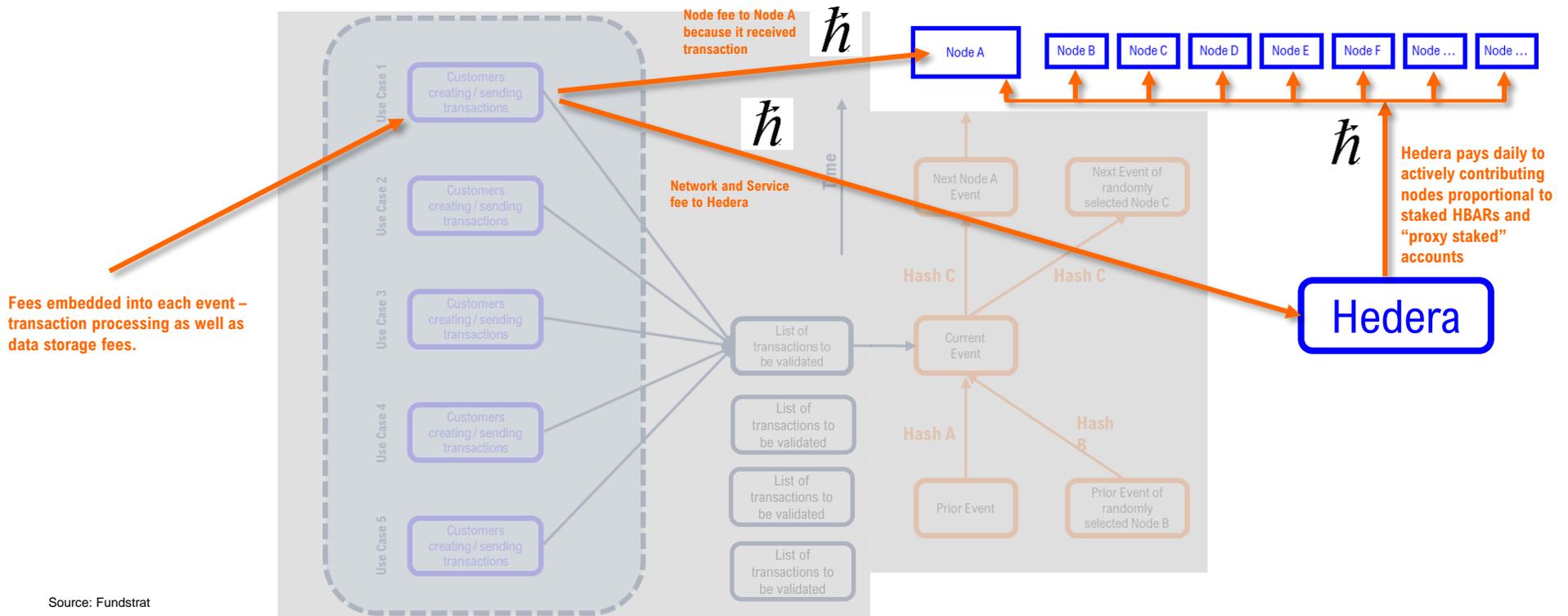


Source: Fundstrat



Transaction fees are paid out to the node infrastructure based on stake

- Node fee – market determined, paid by client to node receiving and processing transaction for submission to the network.
- Network and Service fee – Hedera determines schedule; client is charged a fee as a per transaction plus per byte amount, charged by the network to the originating node and recouped from the client. There may be an additional amount for extended file storage.
- The client pays the total transaction fee; the Node fee is retained by the node submitting the transaction to the network, while the rest is sent to Hedera.
- Hedera distributes a daily payout to all nodes that have actively participated in the network (90% uptime) that day, proportional to the amount of HBARs each node has staked.
- The payout may exceed fees initially, with additional tokens paid out of treasury to help grow the network.
- **Longer term, the payout is expected to be less than fees received, with the difference used to fund Hedera operations.**



Source: Fundstrat

Proof of Stake voting with Asynchronous BFT algorithm provides security

Hedera believes its consensus timestamping addresses previously unsolved security concerns

Timestamps & Voting

- The consensus timestamp for an event being accepted by the network is the weighted median of received timestamps from a subset of nodes.
- Weight for each node's vote and contribution to the consensus timestamp is based on the number of HBARs (Hedera Hashgraph's token) staked on the node, to provide security to the network.
- This proof of stake helps provide security through a process called virtual voting – the amount of staked HBARs and the resulting weight to the timestamp. This helps mitigate the risk of certain attacks by requiring attackers own HBARs – the value of which their attack would damage.
- Initial nodes will be operated by the governing council, staking both any HBARs they own as well as 1/39th of treasury tokens.
- However, Hedera will limit the amount of HBARs that can be staked on a single node, to encourage wider deployment of additional nodes by entities that control more HBARs than the maximum amount per node.
- Processing payments in HBARs would be distributed to participating nodes in proportion to amount staked or “proxy staked” by HBAR owners not operating their own node.
- For the purposes of our analysis, we assume 100% of HBARs are staked; any reduction in staked HBARs would increase the per –HBAR allocation of transaction processing fees.

aBFT ensures consensus in hostile environment

aBFT

- Hashgraph is asynchronous Byzantine Fault Tolerant.
- Hashgraph's aBFT property was validated by a professor at Carnegie Mellon using the Coq system.
- It takes over 33% of members (weighted by stake, which we think is an additional safety feature) to prevent consensus.
- Once achieved, consensus cannot be changed.
- Hedera uses BFT to mean that (1) every member eventually knows consensus has been reached, (2) attackers may collude, and (3) attackers even control the internet itself (with some limits).
- Asynchronous BFT means the algorithm can achieve consensus even if malicious actors are able to control the network and delete or slow down messages of their choosing.
- Assumptions are 1) more than $\frac{2}{3}$ are following the protocol correctly, and 2) that if messages are repeatedly sent from one node to another over the internet, eventually one will get through, and then eventually another will, and so on.

Source: Fundstrat, Hedera



Introduction

Project Overview

Token Supply

Market &
Value Potential

Technical
Overview

Appendix

Appendix

A general introduction to Blockchain

- **Blockchain** is a distributed database existing on multiple computers at the same time. It is constantly growing as new sets of recordings, or 'blocks', are added to it. Each block contains a series of transactions or other information, a timestamp and a link to the previous block, and a cryptographic hash or signature. Any change to a block changes the signature, which affects the header field for the next and subsequent blocks. Thus, any altered block is immediately identifiable, making the blockchain immutable.
- **Distributed Ledger** is a more general version of a blockchain, and encompasses other constructs, as long as the ledger is independently replicated across multiple computers with no single computer acting as the source of data in the ledger.
- **Consensus** is the process by which all of the computers reconcile their version of the database and come to an agreement as to which entries to add into their database in the latest block, and to discard their block and replace it with the one a minimum percentage of other computers (typically 51%-67%) all agree is the valid block.
- **Bitcoin**, the most popular blockchain cryptocurrency, has been evolving into a store of value, while another popular blockchain cryptocurrency, **Ethereum**, is developing use cases in areas such as decentralized applications, smart contracts and token issuance
- **Proof of Work** is the process by which Bitcoin or other token “Miners” process and validate transactions, with the first miner to solve a cryptographic puzzle validating the block and receiving a reward (currently 12.5 bitcoin each); other miners have to then replicate the result to confirm and move on to the next block.
- **Proof of Stake** is a validation process by which owners of the token “stake” their holdings on a node to vote on the validity of a given block, and have voting rights and potentially receive rewards proportional to their staked holdings. Examples include Binance Coin (BNB, 0% annual yield), Dash (DASH, 6.44% APY) and Decred (DCR, 10.53% APY), where yields are measured in token terms, not USD.
- **Directed Acyclic Graph** is a form of distributed ledger where each transaction or group of transactions validates multiple algorithmically selected preceding transactions, in parallel with each other. This creates a web of connections linking a given transaction back through history to the original genesis transaction that launched the ledger. Because these validations take place in parallel, transaction throughput can scale, reducing speed bottlenecks commonly experienced in proof of work protocols.

- **Hedera Hashgraph is an example of a Directed Acyclic Graph**

A Distributed Ledger disintermediates trust providers – for a reduced fee

Traditional Trust Providers

- Trust providers enable transactions as intermediaries vouching for each party and protecting each party from accidental or intentional breach of terms by the other
- They do this by knowing the transacting party or the trust provider representing a transacting party – Know Your Customer (KYC) and Anti Money Laundering (AML) regulations
- Their fees include the cost of creating the knowledge about the transacting parties, operating costs, as well as “insurance” against a particular transaction being invalidated, for example in credit card fraud or in the case of title insurance
- The “insurance” component also covers the expected loss from theft or fraud by insiders

Distributed Ledger

- A distributed ledger maintains immutable records of each party in the transaction
- Each set of transactions is “signed” through a cryptographic hash process.
- If a previously validated transaction is changed, the hash signature would be invalid not only on the transaction set that was modified, but also each subsequent transaction set, unless a new hash signature was created for all affected transaction sets
- Since the identical ledger exists in multiple, unrelated entities, any changes to the ledger and the resulting hashes needs to be reflected in a large number of copies (between 51% and 67% depending on the security protocol being used) before it is accepted as true and replicated in the remaining copies of the ledger
- This creates trust that the network agrees on all transactions being processed, and the ability of the party to conduct the transaction (e.g. that it actually has the funds it is attempting to spend, and hasn’t spent them elsewhere)
- The primary cost of the distributed ledger system is the basic KYC / AML provision and the operating cost of the network.
- A distributed ledger can be slower than centralized processing owing to the time for the transactions to propagate throughout the network

• Protection against fraudulent transactions is built into the system and does not require “insurance premiums” to be charged, reducing the cost of providing trust

Source: Fundstrat

Building blocks of a successful distributed ledger

Performance

- High throughput is necessary to enable transaction processing at scale
- Compelling use cases need the DLT to deliver tens of thousands to millions of transactions per second
- Deliver superior tradeoffs between speed, cost, transaction reliability and audit trails vs existing centralized solutions

Stability

- High reliability / availability
- Low downtime

Security

- Security is a key component of creating trust and thus adoption
- A successful network is going to be targeted by hackers and malicious actors
- **Consensus mechanism must provide security; this is difficult achieve without sacrificing scalability or decentralization**
- Vulnerabilities and points of failure must be anticipated and eliminated

Security, decentralization, and scalability make up blockchain trilemma...

...No project has yet to achieve all three

Regulatory Compliance

- Anti Money Laundering (AML) / Know Your Customer (KYC) checks on all initial nodes and initial coin holders
- Cross-checking transaction terms and conditions against applicable regulations
- Compliant token issuance and public ledger transactions

Governance

- Provide oversight, solve problems and fuel growth
- Governed by leading entities in a variety of sectors and geographies
- Technical, Business, Legal and Economic skillsets needed from different governing entities

Source: Fundstrat, Hedera Hashgraph

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