CONSTELLATION NETWORK, INC. TOKENOMICS

v2.0

A Scalable Economic Framework for Digital Entrepreneurs

Constellation Founding Team and Community

NOTICE AND DISCLAIMER

PLEASE READ THE ENTIRETY OF THIS "NOTICE AND DISCLAIMER" SECTION CAREFULLY. NOTHING HEREIN CONSTITUTES LEGAL, FINANCIAL, BUSINESS OR TAX ADVICE AND YOU SHOULD CONSULT YOUR OWN LEGAL, FINANCIAL, TAX OR OTHER PROFESSIONAL ADVISOR(S) BEFORE ENGAGING IN ANY ACTIVITY IN CONNECTION HEREWITH. NEITHER CONSTELLATION FOUNDATION COMPANY LIMITED (THE **FOUNDATION**), ANY OF THE PROJECT TEAM MEMBERS (THE **CONSTELLATION FOUNDING TEAM**) WHO HAVE WORKED ON THE CONSTELLATION NETWORK OR HGTP NETWORK (AS DEFINED HEREIN) OR PROJECT TO DEVELOP THE CONSTELLATION NETWORK OR HGTP NETWORK IN ANY WAY WHATSOEVER, ANY DISTRIBUTOR/VENDOR OF $DAG TOKENS (THE **DISTRIBUTOR**), NOR ANY SERVICE PROVIDER SHALL BE LIABLE FOR ANY KIND OF DIRECT OR INDIRECT DAMAGE OR LOSS WHATSOEVER WHICH YOU MAY SUFFER IN CONNECTION WITH ACCESSING THE TOKEN DOCUMENTATION, THE WEBSITE AT HTTPS://CONSTELLATIONNETWORK.IO/ (THE **WEBSITE**) OR ANY OTHER WEBSITES OR MATERIALS PUBLISHED BY THE FOUNDATION.

Project purpose: You agree that you are acquiring $DAG to participate in the Constellation Network or HGTP network and to obtain services on the ecosystem thereon. The Foundation, the Distributor and their respective affiliates would develop and contribute to the underlying source code for the Constellation Network or HGTP network. The Foundation is acting solely as an arms' length third party in relation to the $DAG distribution, and not in the capacity as a financial advisor or fiduciary of any person with regard to the distribution of $DAG.

Nature of the Token Documentation: The Whitepaper and Network Economics paper and any documentation on the Website relating to token or network functionality (collectively, the **Token Documentation**) and the Website are intended for general informational purposes only and do not constitute a prospectus, an offer document, an offer of securities, a solicitation for investment, or any offer to sell any product, item or asset (whether digital or otherwise). The information herein may not be exhaustive and does not imply any element of a contractual relationship. There is no assurance as to the accuracy or completeness of such information and no representation, warranty or undertaking is or purported to be provided as to the accuracy or completeness of such information. Where the Token Documentation or the Website includes information that has been obtained from third party sources, the Foundation, the Distributor, their respective affiliates and/or the Constellation Founding Team have not independently verified the accuracy or completeness of such information. Further, you acknowledge that circumstances may change and that

the Token Documentation or the Website may become outdated as a result; and neither the Foundation nor the Distributor is under any obligation to update or correct this document in connection therewith.

Token Documentation: Nothing in the Token Documentation or the Website constitutes any offer by the Foundation, the Distributor or the Constellation Founding Team to sell any $DAG (as defined herein) nor shall it or any part of it nor the fact of its presentation form the basis of, or be relied upon in connection with, any contract or investment decision. Nothing contained in the Token Documentation or the Website is or may be relied upon as a promise, representation or undertaking as to the future performance of the Constellation Network or HGTP network. The agreement between the Distributor (or any third party) and you, in relation to any distribution or transfer of $DAG, is to be governed only by the separate terms and conditions of such agreement.

The information set out in the Token Documentation and the Website is for community discussion only and is not legally binding. No person is bound to enter into any contract or binding legal commitment in relation to the acquisition of $DAG, and no digital asset or other form of payment is to be accepted on the basis of the Token Documentation or the Website. The agreement for distribution of $DAG and/or continued holding of $DAG shall be governed by a separate set of Terms and Conditions or Token Distribution Agreement (as the case may be) setting out the terms of such distribution and/or continued holding of $DAG (the Terms and Conditions), which shall be separately provided to you or made available on the Website. The Terms and Conditions must be read together with the Token Documentation. In the event of any inconsistencies between the Terms and Conditions and the Token Documentation or the Website, the Terms and Conditions shall prevail.

$DAG Token Functionality: $DAG is a non-refundable functional utility token which will be used as the medium of exchange between participants on the HGTP network. The goal of introducing $DAG is to provide a convenient and secure mode of payment and settlement between participants who interact within the ecosystem on the HGTP network, and it is not, and not intended to be, a medium of exchange accepted by the public (or a section of the public) as payment for goods or services or for the discharge of a debt; nor is it designed or intended to be used by any person as payment for any goods or services whatsoever that are not exclusively provided by the issuer. $DAG does not in any way represent any shareholding, participation, right, title, or interest in the Foundation, the Distributor, their respective affiliates, or any other company, enterprise or undertaking, nor will $DAG entitle token holders to any promise of fees, dividends, revenue, profits or investment returns, and are not intended to constitute securities in Singapore or any relevant jurisdiction. $DAG may only be utilised on the HGTP network, and ownership of

$DAG carries no rights, express or implied, other than the right to use $DAG as a means to enable usage of and interaction within the HGTP network.

$DAG are designed to be utilised, and that is the goal of the $DAG distribution. In fact, the project to develop the HGTP network would fail if all $DAG holders simply held onto their $DAG and did nothing with it. In particular, it is highlighted that $DAG:

(a) does not have any tangible or physical manifestation, and does not have any intrinsic value (nor does any person make any representation or give any commitment as to its value);

(b) is non-refundable and cannot be exchanged for cash (or its equivalent value in any other digital asset) or any payment obligation by the Foundation, the Distributor or any of their respective affiliates;

(c) does not represent or confer on the token holder any right of any form with respect to the Foundation, the Distributor (or any of their respective affiliates), or its revenues or assets, including without limitation any right to receive future dividends, revenue, shares, ownership right or stake, share or security, any voting, distribution, redemption, liquidation, proprietary (including all forms of intellectual property or licence rights), right to receive accounts, financial statements or other financial data, the right to requisition or participate in shareholder meetings, the right to nominate a director, or other financial or legal rights or equivalent rights, or intellectual property rights or any other form of participation in or relating to the HGTP network, the Foundation, the Distributor and/or their service providers;

(d) is not intended to represent any rights under a contract for differences or under any other contract the purpose or pretended purpose of which is to secure a profit or avoid a loss;

(e) is not intended to be a representation of money (including electronic money), security, commodity, bond, debt instrument, unit in a collective investment scheme or any other kind of financial instrument or investment;

(f) is not a loan to the Foundation, the Distributor or any of their respective affiliates, is not intended to represent a debt owed by the Foundation, the Distributor or any of their respective affiliates, and there is no expectation of profit; and

(g) does not provide the token holder with any ownership or other interest in the Foundation, the Distributor or any of their respective affiliates.

Notwithstanding the $DAG distribution, users have no economic or legal right over or beneficial interest in the assets of the Foundation, the Distributor, or any of their affiliates after the token distribution. To the extent a secondary market or exchange for trading $DAG does develop, it would be run and operated wholly independently of the Foundation, the Distributor, the distribution of $DAG and the HGTP network. Neither the Foundation nor the Distributor will create such secondary markets nor will either entity act as an exchange for $DAG.

Deemed Representations and Warranties: By accessing the Token Documentation or the Website (or any part thereof), you shall be deemed to represent and warrant to the Foundation, the Distributor, their respective affiliates, and the Constellation Founding Team as follows:

(a) in any decision to acquire any $DAG, you have shall not rely on any statement set out in the Token Documentation or the Website;

(b) you will and shall at your own expense ensure compliance with all laws, regulatory requirements and restrictions applicable to you (as the case may be);

(c) you acknowledge, understand and agree that $DAG may have no value, there is no guarantee or representation of value or liquidity for $DAG, and $DAG is not an investment product nor is it intended for any speculative investment whatsoever;

(d) none of the Foundation, the Distributor, their respective affiliates, and/or the Constellation Founding Team members shall be responsible for or liable for the value of $DAG, the transferability and/or liquidity of $DAG and/or the availability of any market for $DAG through third parties or otherwise; and

(e) you acknowledge, understand and agree that you are not eligible to participate in the distribution of $DAG if you are a citizen, national, resident (tax or otherwise), domiciliary and/or green card holder of a geographic area or country (i) where it is likely that the distribution of $DAG would be construed as the sale of a security (howsoever named), financial service or investment product and/or (ii) where participation in token distributions is prohibited by applicable law, decree, regulation, treaty, or administrative act (including without limitation the United States of America and the People's Republic of China); and to this effect you agree to provide all such identity verification document when requested in order for the relevant checks to be carried out.

The Foundation, the Distributor and the Constellation Founding Team do not and do not purport to make, and hereby disclaims, all representations, warranties or undertaking to any entity or person (including without limitation warranties as to the accuracy, completeness, timeliness or reliability of the contents of the Token Documentation or the Website, or any other materials published by the Foundation or the Distributor). To the maximum extent permitted by law, the Foundation, the Distributor, their respective affiliates and service providers shall not be liable for any indirect, special, incidental, consequential or other losses of any kind, in tort, contract or otherwise (including, without limitation, any liability arising from default or negligence on the part of any of them, or any loss of revenue, income or profits, and loss of use or data) arising from the use of the Token Documentation or the Website, or any other materials published, or its contents (including without limitation any errors or omissions) or otherwise arising in connection with the same. Prospective acquirors of $DAG should carefully consider and evaluate all risks and uncertainties (including financial and legal risks and uncertainties) associated

with the distribution of $DAG, the Foundation, the Distributor and the Constellation Founding Team.

Informational purposes only: The information set out herein is only conceptual, and describes the future development goals for the Constellation Network and HGTP network to be developed. In particular, the project roadmap in the Token Documentation is being shared in order to outline some of the plans of the Constellation Founding Team, and is provided solely for **INFORMATIONAL PURPOSES** and does not constitute any binding commitment. Please do not rely on this information in deciding whether to participate in the token distribution because ultimately, the development, release, and timing of any products, features or functionality remains at the sole discretion of the Foundation, the Distributor or their respective affiliates, and is subject to change. Further, the Token Documentation or the Website may be amended or replaced from time to time. There are no obligations to update the Token Documentation or the Website, or to provide recipients with access to any information beyond what is provided herein.

Regulatory approval: No regulatory authority has examined or approved, whether formally or informally, of any of the information set out in the Token Documentation or the Website. No such action or assurance has been or will be taken under the laws, regulatory requirements or rules of any jurisdiction. The publication, distribution or dissemination of the Token Documentation or the Website does not imply that the applicable laws, regulatory requirements or rules have been complied with.

Cautionary Note on forward-looking statements: All statements contained herein, statements made in press releases or in any place accessible by the public and oral statements that may be made by the Foundation, the Distributor and/or the Constellation Founding Team, may constitute forward-looking statements (including statements regarding intent, belief or current expectations with respect to market conditions, business strategy and plans, financial condition, specific provisions and risk management practices). You are cautioned not to place undue reliance on these forward-looking statements given that these statements involve known and unknown risks, uncertainties and other factors that may cause the actual future results to be materially different from that described by such forward-looking statements, and no independent third party has reviewed the reasonableness of any such statements or assumptions. These forward-looking statements are applicable only as of the date indicated in the Token Documentation, and the Foundation, the Distributor as well as the Constellation Founding Team expressly disclaim any responsibility (whether express or implied) to release any revisions to these forward-looking statements to reflect events after such date.

References to companies and platforms: The use of any company and/or platform names or trademarks herein (save for those which relate to the Foundation, the Distributor or their respective affiliates) does not imply any affiliation with, or endorsement by, any third party. References in the Token Documentation or the Website to specific companies and platforms are for illustrative purposes only.

English language: The Token Documentation and the Website may be translated into a language other than English for reference purpose only and in the event of conflict or ambiguity between the English language version and translated versions of the Token Documentation or the Website, the English language versions shall prevail. You acknowledge that you have read and understood the English language version of the Token Documentation and the Website.

No Distribution: No part of the Token Documentation or the Website is to be copied, reproduced, distributed or disseminated in any way without the prior written consent of the Foundation or the Distributor. By attending any presentation on the Token Documentation or by accepting any hard or soft copy of the Token Documentation, you agree to be bound by the foregoing limitations.

Table of Contents

** Throughout this paper, we interchangeably use the phrase State Channel, L_0 Applications, and microservice. Constellation's approach to State Channels are validated by the base layer (Layer 0) consensus mechanism.*

Abstract

The HGTP ecosystem and the $DAG token economics outlined in the following document have been inspired by and designed according to the principles of a new economic model, Generative Economics. The term “Generative Economy” was coined by Marjorie Kelly, who defined it as "a living economy that is designed to generate the conditions for life to thrive, an economy with a built-in tendency to be socially fair and ecologically sustainable" (2012[1]). Generative economic systems sustain life and benefit the many versus the few. In a generative economic blockchain system, all participants in the network benefit from the success of each individual node and State Channel. This is analogous to a single neuron’s function within a collection of neurons that in conjunction form a brain. In Generative Economics, the sum is greater than the parts in terms of security, throughput and the economic growth of the network.

Hypergraph[2] - Constellation’s decentralized network - enables and defines a new economic model that is dependent on all stakeholders and actors in the network, including the cryptocurrency $DAG. Holding $DAG tokens within the Hypergraph network permits access to Constellation’s ecosystem and data rich solutions, businesses, and products. This paper will articulate how a scalable digital economy will function that is verified by mathematical proofs and maintained by a decentralized architecture, converging econometrics, cryptography, and advanced data infrastructure tools.

*Note: Throughout this paper, we interchangeably use the phrases “State Channel”, L_0 Applications, and microservice. Constellation’s approach to State Channels are validated by the base layer (Layer 0) consensus mechanism.

[1] Marjorie Kelly, 2012, “Emerging Ownership Revolution” 2012, https://wiki.p2pfoundation.net/Emerging_Ownership_Revolution

[2] We define the Hypergraph Transfer Protocol (HGTP) as a base layer protocol (L_0). Within this document, the terms base layer, HGTP and L_0 are used interchangeably. An L_0 protocol may be defined as the layer beneath all other protocols where BTC and ETH and other blockchains are layer 1 (L_1) protocols. The power of an L_0 protocol is that it provides a convergence layer for all connected L_1 protocols. At the time of writing, HGTP is the first L_0 protocol to be developed in the blockchain industry. HGTP enables digital data entrepreneurs to develop applications unlike any other platform due to its unique features.

Opportunity

Over the past 30 years, the internet has become a digital walled garden economy only accessible to a few major tech companies that have figured out how to monetize data and actions. Constellation's Hypergraph democratizes existing digital infrastructures and acts as a global accounting, notarization, and audit layer of all digital information and activity. With $DAG and our L_0 standard, cryptographic security, notarization, and immutability will connect real world data, assets, and business performance/activity to a currency.

Since the early 2000s, tech companies have been collecting data and insights on users' tastes and preferences. This data is processed and exchanged between micro-services (or micro-processors) and then developed into products and solutions that we interact with. By creating walled gardens around data, tech companies use these new products and solutions to further mine, productize, and monetize user data. The perceived value exchange amounts to new products to purchase, applications to use, and services that meet users' data profiles and interests. The general public does not think of data as a currency and is more than willing to supply their information (data) in the belief that the value exchange of the service provided is justified. From an economic perspective, people do not view a scarcity of their data in the same way they would a shortage of physical currency. In contrast, when people think about physical currency, they understand the value exchange because they pay for things that are of value to them, which directly impacts their bank account (economic scarcity). The abundance of data has created a distorted reality on the economics of transactions.

The existence of new decentralized digital infrastructures and currencies presents an opportunity to democratize data for the general public and bridge the gap between physical money and perceived value. The physical transfer of money for products does not come with a payload of information and data to tell you about those products. However, if you purchase something like artwork or a house, you might receive a physical certificate or title to prove that the artwork or house is real and verified by the central governing bodies that ascertain its authenticity. $DAG and our L_0 Standard merge the concept of data collection with the exchange of value and the means to transact. This means you can attach more logic, information and to better understand your perceived value with the transfer of money by inserting information into the payload of the transfer.

$DAG is an expression of a new digital economy that trades in data, be it tokenizing data as it is transacted from machine-to-machine or from crypto user-to-crypto user. $DAG also rewards people

for sound business models, activity, and performance. Constellation has developed the necessary infrastructure and rails (Hypergraph) to transact currency and index to the network ($DAG), and the programmable interface to build solutions (our L_0 standard) to merge the concept of data collection, the exchange and transfer of value, and the ability to transact in an open framework. Using the L_0 token standard, any user will be able to develop L_0 applications built on Hypergraph while defining data types that attach more logic, information, and perceived value to the payload of the transfer. This will open up a multi-trillion data economy to new opportunities, entrepreneurs, and businesses while giving individuals the freedom to control their information and reality.

Overview of Constellation Network and the Cryptocurrency $DAG

Network Features

- Instant, fee-less transactions
- Direct streaming data validation through the Hypergraph Transfer Protocol (HGTP)
- Integration of any external data source or blockchain (oracalization of data pipelines)
- Concurrent consensus mechanisms (local sensitivity and network state)
- A domain specific programming language, called Babel, for interacting with Hypergraph
- A JVM sandbox, where developers can define rich types and concurrent processes for more robust and complex applications
- Use of L_0 applications (State Channels/microservices) - a more robust and evolved alternative to smart contracts

Currency Features

- HGTP L_0 token standard (the first L_0 in the blockchain space)
- Cross-chain liquidity and atomic swaps without additional routing
- Frontrunning protection
- Arbitrage and manipulation protection (optimizing trade results)

- Generative economic model[3]
- Underwriting of economic activity with compute resources
- Merged mining

Relationship between Hypergraph and $DAG

- All secondary tokens connected via L_0 is defined in terms of $DAG as the base medium
- $DAG is defined as information gained or lost (bits/second) (generative economics defines utility in terms of bits/second)
- Hypergraph encourages all entrepreneurial activity to occur on blockchain whilst aligning all stakeholder incentives

Utility features of $DAG

- Native digital cryptographically-secured utility token of the HGTP network
- $DAG is a transferable representation of attributed functions specified on HGTP, designed to be used solely as an interoperable utility token on the network
- $DAG provides the economic incentives which will be distributed to encourage users to contribute and maintain the ecosystem on the HGTP network, thereby creating a win-win system where every participant is fairly compensated for its efforts
- Given that additional $DAG will be awarded to a user based only on its actual usage, activity and contribution on the HGTP network, users of the HGTP network and/or holders of $DAG which did not actively participate will not receive any $DAG incentives
- As the native medium of exchange, $DAG forms the basis for the economic activity and compute resources on the HGTP network
- Compute resources are required for running applications, executing transactions or storing information on the HGTP network, so providers of these services / resources would require payment for the consumption of these resources (i.e. "mining" on the HGTP network) to maintain network integrity, and $DAG will be used as the native network currency to quantify and pay the costs of the consumed compute resources
- As the base layer (L_0) token standard, $DAG is necessary for cross-chain liquidity and atomic swaps

3 https://github.com/Constellation-Labs/economic-model/blob/master/constellation_token_model.pdf

- Conversely, $DAG is also used as a deterrent for penalising nodes/service providers for various offences which would result in the network charging a $DAG penalty (e.g. State Channel still goes above the one transaction per finality window snapshot)
- In order to promote community governance for the network, $DAG would allow holders to propose and vote on governance proposals to determine features and/or parameters of the HGTP network as well as protocol improvements or even changes to the governance process itself, with voting weight calculated in proportion to their token holdings. For the avoidance of doubt, the right to vote is restricted solely to voting on features of the HGTP network and/or changes to the governance process; the right to vote does not entitle $DAG holders to vote on the operation and management of the Foundation, its affiliates, or their assets, and does not constitute any equity interest in any of these entities

Dependencies on the Growth of Hypergraph

- The total amount of tokens held across all addresses registered on L_0 (including $DAG)
- The maximum throughput at any given snapshot round
    - The number of nodes increases or decreases dynamically (this is commonly referred to as elastic infrastructure) based on backpressure (transactions left in mempool)
- Summary: The value of the network and network bandwidth are correlated

The Distribution of $DAG Within the Ecosystem

Circulation and supply data for Constellation's HGTP network:

Swapped to Hypergraph mainnet in May 2020: 2,093,588,685 (genesis block)
Max supply: 3,693,588,685
Current circulating supply: 2,320,488,685[4]

Node validators: 226,900,000 (minted, liquid; 1,373,100,000 remaining over 10 years)

Wallets held by Constellation:
Community: 31,453,506 (community incentives)
Foundation: 332,035,723 (operations)

[4] http://lb.constellationnetwork.io:9000/total-supply

Nodes, State Channels and Reward Mechanisms

A distributed network of decentralized nodes is essential for the operation and security of the network. Payments of $DAG incentives to these nodes are proportional based on each node's Proof of Reputable Observation score (PRO score). The maximum PRO score is 1.0. This is a function of time on the network, validation consistency and behavior. Nodes with a higher PRO score (measure of effective contributions) get relatively more of the fees distributed to the network per finality window.

Node Rewards

Phase 1: March 2020 – March 2021

Nodes v1.0. Onboarding of one hundred foundation nodes. Whitelisted. 25,000,000 $DAG distributed between them each month. Validators required to lock up 85% of their rewards until market liquidity is sufficient, as voted by decentralized governance.

Phase 2: Q2 2021

Node rewards paid proportionately to network transactions per second (TPS) and throughput demand to incentivize resource optimization on the network. In order to determine rewards emission TPR (transactions per rewards or rewards in relation to TPS) for node validators in Phase 2 the emissions need to be parameterized in relation to TPS "consumed" on the network. Therefore the protocol uses two formulas to determine TPS and TPR.

For TPS we have[5]:

$$T(n) = \Sigma_n p_n log_2 p_n$$

This constitutes normalized entropy.

For TPR we have:

$$R(k+1) = C^T T^k$$

where C^T is the result of retraining EigenTrust[6] and such that

$$|R(k+1)| < 1.0 * RewardsAmount$$

Summary: Rewards per account = C(a) * t(a)

[5] Hypergraph can be described in terms of the cohomology theory of statistical mechanics. See Baudot, P. (2019): https://www.mdpi.com/1099-4300/21/9/881

[6] Kamvar, S.D.; Schlosser, M.T.; Garcia-Molina, H. (2003): https://dl.acm.org/doi/10.1145/775152.775242

The two equations are related by their domains or the input to the functions themselves. The input is a representation of disorder or decoherence within the network determined by a self-avoiding random walk[7], which forms a vector space that can be decomposed into probability density (series of distributions) from which decision problems can be formed. TPS and TPR are both decision problems solved online (real time) to optimize network utility from two sides of the economy: producers/sellers and consumers/investors. Solving these two achieves pareto-optima and computable network stability. This system entangles the incentives of buyers and sellers to maintain the infrastructure of the ecosystem itself.[8]

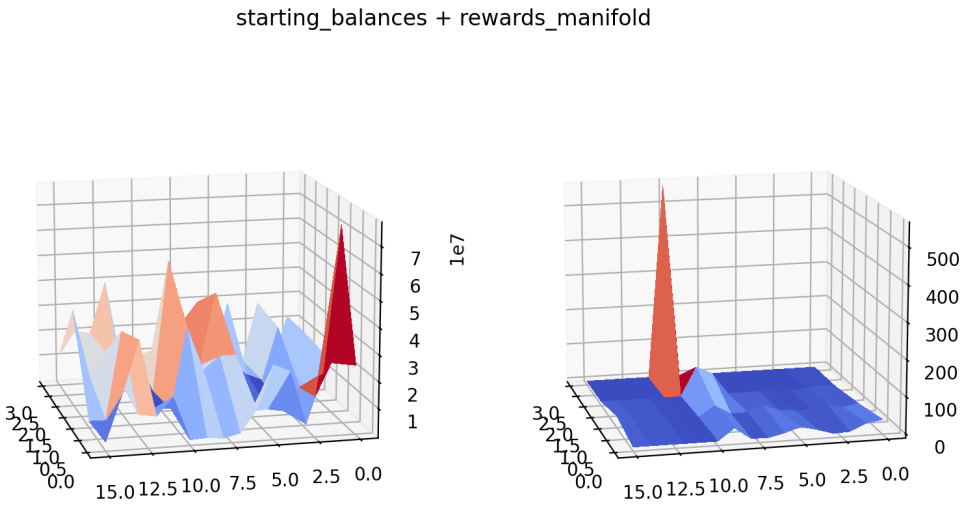

Fig 1.0 A potential surface of L_0 addresses balances with its potential state before reward attribution.

Fig 1.1 Potential rewards due to be distributed. The red spike represents the rewards amplitude surface that fluctuates over time as account balances increase.

Summary: Consider Fig 1.0 as the 'ledger space' containing all addresses in the L_0 layer at time t=1, and Fig 1.1 as the amplitude of rewards to be distributed. The ledger space at t=1 is the sum of both spaces. Mind the scale on the right hand side.

Phase 3: Node v2.0 Release Q3 2021

The HGTP protocol allows for merged mining within the Hypergraph ecosystem. Therefore, hybrid nodes run by L_0 and State Channel node operators can select State Channels and switch between

[7] https://en.wikipedia.org/wiki/Node_influence_metric

[8] Input Matrix: https://github.com/Constellation-Labs/economic-model/blob/generative_economics/reference-impl/balance_transition.py

them to supply their TPS and hashpower. This is based on shifting incentives and business models for each State Channel, thus optimizing network resources and business metrics.

The node operator whitelist has been abandoned and the network opened for anyone to join. Node operators are incentivized to run nodes through rewards and an increasing bandwidth allowance they gain over time, since PRO score and time on the network increase their prospective future sale value.

Node Reward Pool

The node reward pool is designed to be self-sustaining. Hypergraph optimizes the activity of the network by penalizing those that misuse the network and rewarding those that use it correctly.

Tokens entering the pool:

The HGTP network is fee-less when there are enough performing nodes or enough staked liquidity has been attracted to the associated State Channel. Each State Channel that runs an L_0 token therefore constitutes a wallet of said L_0 token as well as reserves of other L_1 tokens within its liquidity pool. Transactions in or out of a liquidity pool are orchestrated via consensus logic and online facilitator nodes. L_0 applications (State Channels) may be run poorly in the sense that:

- They do not have enough L_0 tokens in reserve in their State Channel liquidity pools (wallets) to pay for bandwidth
- They send more transactions than allotted by the rate limit (poor config or bad actor)
- Their nodes do not gather rewards due to poor configuration.

In such an event, 0.00000001 $DAG is charged per transaction above the 1 tx allowed per finality window (rate limit). The $DAG held in the State Channel wallet will be slowly migrated back into the reward pool. Network governance may adjust future rates in relation to network growth and resource optimization.

Tokens leaving the pool:

1. From Q2 2021, total node rewards will be paid in a proportional manner to the TPS of the network. As network usage and demand increase, more nodes will be incentivized to join the network due to the larger facilitator pool. As more nodes join, the speed of the network will increase, but each nodes' relative rewards will diminish until equilibrium is found.

The number of nodes that can run consensus at any given time:

dc/dn = e^(c-n)

Where C is number of nodes, and N is snapshot/block height. Rewards are divided between these active nodes.

Fee-Less Transactions

At its core, HGTP is designed to be a fee-less network. Fee-less transactions are enabled by holding $DAG or by running a node. The $DAG held within an address relative to the circulating $DAG supply will determine its throughput allowance. This percentage will determine its proportional share of the maximum total bandwidth of the network (TPS) at any given time (see Fig. 2.0 below). Increases in the amount of $DAG held or the number of nodes operated in turn increase the bandwidth available to a network participant (node or State Channel). Given that State Channels run their own protocols in parallel, they only need to send one snapshot per finality window to converge. If an individual State Channel still goes above the one transaction per finality window snapshot (approximately every 20 seconds) they are charged $100{,}000^{th}$ of a $DAG, that is 0.00000001 $DAG per transaction. Technically, a State Channel only needs to commit its internal state by sending a one-off snapshot to the L_0 nodes each finality window. This mechanism enforces individual ownership and responsibility over the specific use cases a State Channel tries to resolve. It adds a small penalty for mismanaged State Channel configurations and incentivizes State Channel businesses to operate efficiently in order to remain fee-less.

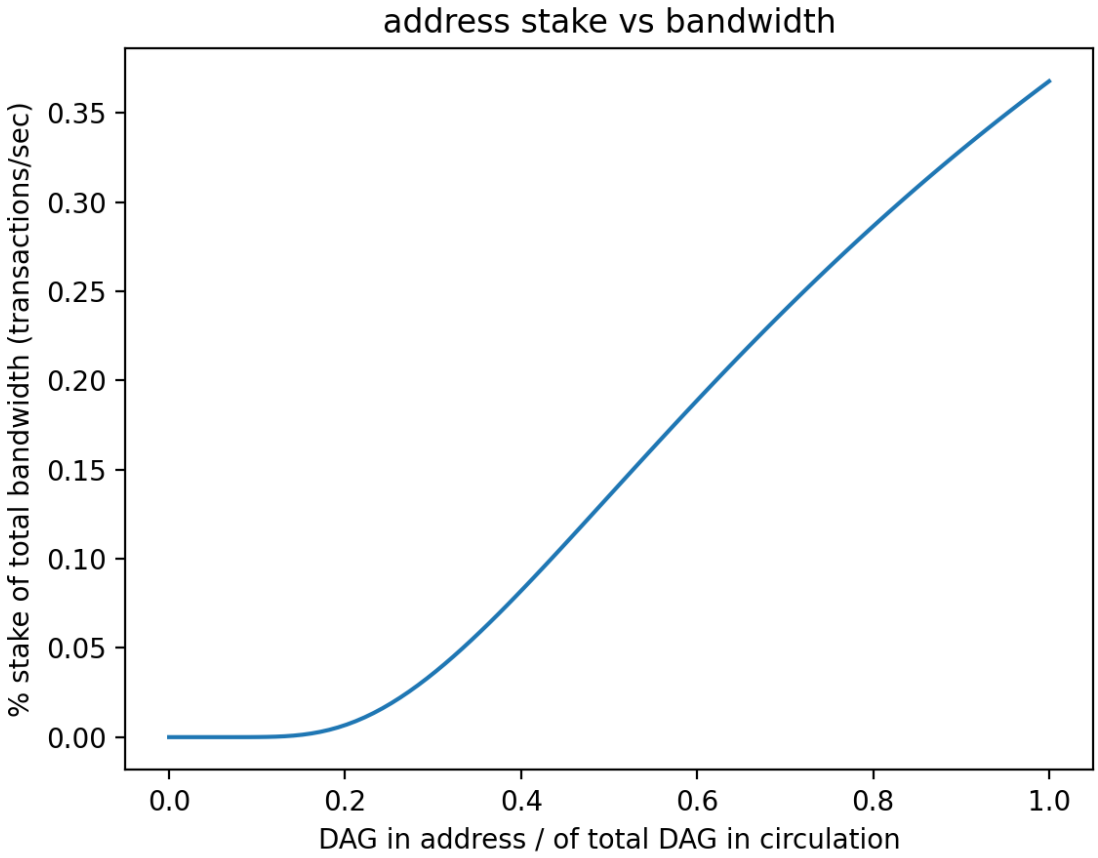

Fig 2.0 $DAG held versus bandwidth/TPS

L_0 Applications | State Channels | Microservices On-chain

Hypergraph constitutes a fully digitized economy. Its principles of generative economics create a self-reinforcing loop of growth and network success for all stakeholders. As the first truly free economy it removes middlemen and lets all stakeholders participate in the success of each L_0 business through $DAG.

L_0 Applications and Nodes

State Channels are their own networks (subnets with their own consensus metrics that converge with the L_0 main layer). As such, some will have their own node operators and will pay them in their native tokens or $DAG.

I. Any node running L_0 and/or L_1 will be incentivized in $DAG.
   Where a State Channel chooses to incorporate hybrid nodes (i.e. nodes running consensus for more than one State Channel or the $DAG channels in its liquidity pools) then those nodes will receive the same rewards as ordinary $DAG node validators.
II. Where a State Channel has its own token, tokenomics and nodes, rewards are paid in that State Channel's native token.

State Channel Businesses

Hypergraph and State Channel consensus facilitate a tighter relationship between business model, resource consumption and token. Therefore, State Channels open up the blockchain space to a wide range of business applications and the connection of real world business objectives.. State Channels allow for the implementation of complex logic and consensus parameters and can be used by businesses wanting to develop a range of products, including launching their own token on the network or designing complex financial instruments equivalent to and beyond what exists today in legacy markets. The difference between existing token standards (e.g ERC20) and the L_0 token standard on Hypergraph is the latter's ability to define custom consensus parameters. Thus, each State Channel has the ability to define its own consensus and business parameters that converge with the main Hypergraph consensus.

Digital entrepreneurs - or *Datapreneurs* - can use L_0 Applications (State Channels) to validate, secure and exchange data as well as create their own data-based business models underwritten by their own tokens and tokenomics. Conversely, they can also utilize the $DAG token. Launching nodes, creating new tokens and new data schematics and logic will be facilitated via the DAG Terminal.

In order to secure, validate and stream large quantities of data for free, State Channels have three options:

1. Staking $DAG to grant increased access to network utility (TPS/bandwidth). Rewards are directly tied to work performed by hosting the network (i.e. no free lunch). In order to secure utility (TPS, bandwidth), it is necessary to purchase $DAG or backing in the form of $DAG or L_0 token liquidity. This liquidity is locked up within the State Channel. The more liquidity that is locked up, the higher the TPS and the higher the bandwidth the State Channel can facilitate for free. Higher TPS and bandwidth will allow for more avenues towards monetization and more network utility within the $DAG network.

Examples are given below of how State Channels may incentivize and encourage $DAG holders to add staked liquidity:

i. Performance-based. A successful State Channel business might offer to make periodic payments to network participants based on performance parameters (i.e. revenue generated). For example, the Department of Defense (DoD) or other enterprise State Channels (initiated by the Foundation or other network participants) may offer this reward mechanism.

ii. Fixed-pricing. A State Channel may offer a fixed APR (i.e. pre-determined fee to be paid periodically).

iii. Fees. In return for a fee, participants may add liquidity to any pairing of L_1 tokens on Hypergraph (e.g. DAG/BTC, BTC/DAI, DAG/ETH etc.), thereby enabling tokenized cross-chain liquidity. Cross-chain liquidity will be enabled for any pair of L_1 tokens and will be a simple two-step process. E.g. Lattice Exchange will provide the UI for this transaction. In addition, HGTP will protect against front running and arbitrage trade manipulation.

iv. Fees. In return for adding liquidity to a native DAG L_0 pairing.

v. “Proof of work” rewards. Rewards may be issued to users based on the compute resources they contribute to the network.

2. Spin up or purchase nodes. New State Channels may spin up their own nodes. Depending on the configuration and hardware resources used, new nodes will enable the State Channel to process a certain amount of bandwidth and transactions per second. Increasing the amount of $DAG staked in the node and holding the node for longer will increase this allowance since nodes with a higher PRO score and longer service will have increased capabilities. Therefore, some businesses may choose to purchase existing nodes and their rewards as a package (for other currencies USD, ETH., BTC etc) as their sum value is

greater than that of its parts - guaranteeing immediate bandwidth and a high TPS.[9]

3. A combination of 1 & 2 above.

Fee-Paying

Alternatively, a State Channel can opt not to spin up their own nodes. However, they may still require Hypergraph consensus and validation. In this case, payment beyond the rate limit of 1tx/snapshot will be deducted from a wallet on a pay-as-you-go basis with $DAG.

In the unusual case of limited network resources where bandwidth (number of nodes) is insufficient, network participants can bid increased amounts of $DAG to increase confirmation rates.

Examples of How Third Party L_0 Applications May Monetize Their Capabilities

1. Subscription models. These include all services that allow users to access certain data, insights and resources and offer data monetization (DataFi), analytics (cross-chain, unchain, off-chain), oracles, merged mining, memberships, atomization, etc.
2. Service models. These connect real world business efforts with HGTP and offer various rewards and incentives for economic activity.
3. Business development and integration services. These onboard enterprise clients onto Hypergraph and offer service level agreements, consulting, and developer operation integrations.
4. Trading and finance. DeFi for on-chain trading activity, ETF's, funds, money management, bots, loans and fundraising.
5. Validation and consensus as a microservice. For smart cities, compliance, and machine interoperability.
6. Liquidity pools. These attract liquidity with APY rates underwritten by L_0 State Channel nodes, making it possible to configure your own trading fees and thus income. Lattice is the hub and user interface for cross-chain pools and liquidity on the network.

[9] For a representation, use a contour plot of the "rewards_manifold" from our GitHub: https://github.com/Constellation-Labs/economic-model/blob/generative_economics/reference-impl/balance_transition.py

An Ecosystem of Economic Sinks

Constellation's architecture ensures that anyone can issue their own secondary token and design a token economy using the tools provided by HGTP and Hypergraph. Thus, the $DAG token economy does not have one overarching $DAG sink as this would limit economic activity and narrow the use cases that could proliferate on Hypergraph. By using the L_0 standard on Hypergraph, anyone can develop a business application that programs a sink. This encourages infinite network growth and economic scalability. The opportunity for $DAG token sinks exists for each new L_0 application that is onboarded to the network: the monetization of verified and validated data by tokenizing data streams, advanced tokenomics around minted tokens, and businesses that programmatically issue rewards and incentivizes to backers tied to real world business activity and metrics. In this vein, the Foundation may choose to operate/develop a number of L_0 applications on Hypergraph just like any other third party developer. This will set precedent for a new wave of Datapreneurs to connect value to data in this emerging digital economy.

L_0 Applications currently being onboarded:

1. Projects: Hand selected companies that articulate the utility of a cryptocurrency with real world business activity. These projects have developed tokenomics and clear business proposals that leverage HGTP.
2. Federal and public sector: Applications required to validate and notarize data created by the US Federal Government.
3. Enterprise innovation: Innovation labs that are creating new businesses for enterprise parent companies with robust data assurance and data monetization capabilities.
4. Cryptocurrency liquidity: Cross-chain bridges to other native L_1 and L_2 blockchain solutions.
5. Lattice Exchange (DeFi Platform): Multiple State Channels will be required for Lattice Exchange (LTX). Lattice is the hub and user interface for cross-chain pools and liquidity on the network.

Summary

The traditional economic model for data movement within distributed ledger networks is based on a pay-per-transaction economy. Whilst this is a clear advancement towards the decentralization, democratization, and monetization of data tied to a currency, it has limited the ability of many cryptocurrencies to scale beyond a store of value and peer-to-peer transactions. To enable a scalable and free digital economy to prevail, we must converge decentralized networking and tokenized economies with scalable data infrastructure tools and best practices used by centralized tech companies. In the fee-per-transaction model, costs quickly become prohibitive and non-viable for businesses and machines dependent on these means to accelerate growth and process thousands of transactions a second. Traditional decentralized networks break down when the velocity of the network is correlated with rising and variable transaction fees, ultimately de-incentivizing network utility. These variable costs make it unpredictable to conduct business and scale their operations. Therefore, infrastructure layers utilizing transaction fees as their overarching economic sink are only justifiable for use cases and businesses with limited economic scope and technical scalability.

Hypergraph defines a new economic model that provides a framework and rails to encourage and incentivize trade activity and network utility. Within the HGTP network, holding $DAG is an index to the economic activity on the network and permits access to applications and services built on the network with fee-less transferability of value.

Finally, Hypergraph is built on a new economic model called Generative Economics. Within Generative Economics the sum is greater than the parts; that is, as more State Channels attract $DAG, the overall value of the network increases. As the overall throughput increases and/or the total amount of tokens held across all L_0 addresses increases, the ecosystem *holds more value*.