Canton Coin:
A Canton-Network-native payment application

Digital Asset
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Abstract

Accessibility and connectivity across subnets of the Canton Network will be supported by an infrastructure called the “Global Synchronizer”, decentrally run by a group of “Super Validators”. As part of the launch of the Global Synchronizer, the Super Validators will also launch a payment application called Canton Coin to facilitate the transfer of value, provide incentives, and serve as payment for infrastructure costs. Just as the Canton Network overcomes several of the key limitations holding back other networks from widespread enterprise adoption, Canton Coin is specifically designed to be compatible with an ecosystem used by regulated financial enterprises. This paper presents Canton Coin, its mechanics, and its role in incentivizing all stakeholders of the Canton Network to build a thriving ecosystem.

Introduction

Background

The whitepaper, "Canton Network: A Network of Networks for Smart Contract Applications," introduces the Canton Network as "a network of networks for smart contract applications with heterogeneity and scalability properties similar to the Internet, giving application providers control over their applications." It introduces the notion of "synchronization domains" as an underlying infrastructure that can be run as centralized or decentralized services. It also discusses plans to launch at least one decentralized version of a synchronization domain, called a "virtual Canton Service Provider":

> *At launch, the Canton Network will have at least one open virtual Canton Service Provider that is run by a consortium and accepts connection requests from any participant node.*

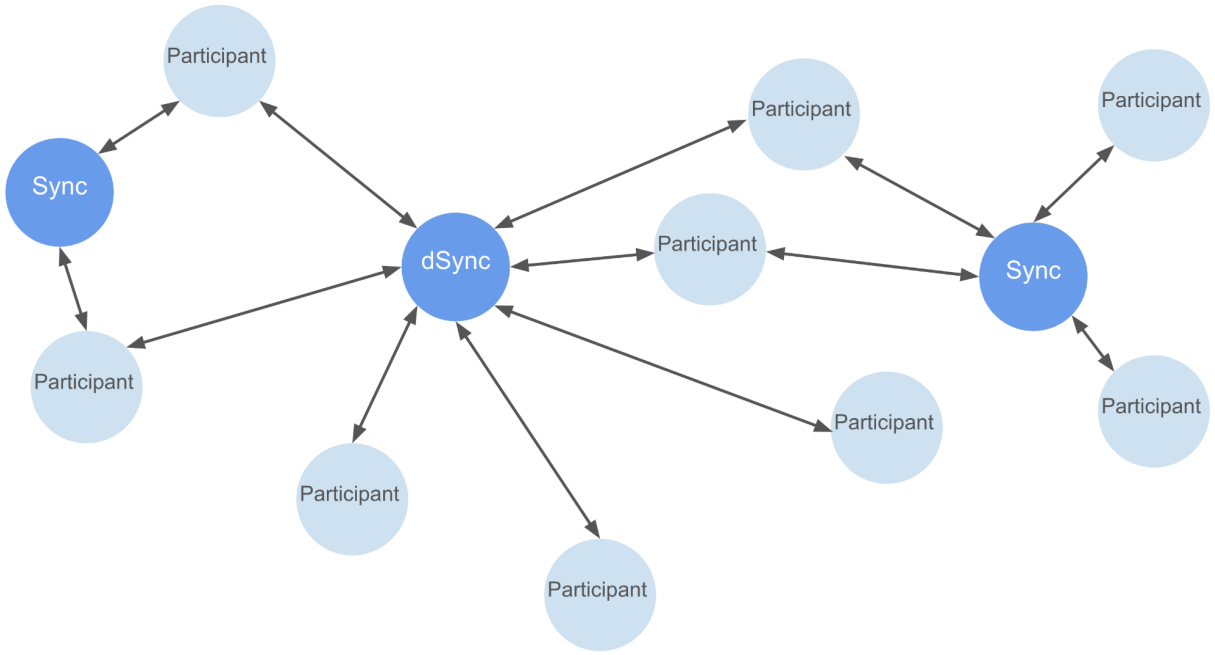

Figure 1: Canton Network topology. Participants connect to each other via centralized (Sync) or decentralized (dSync) Canton synchronizers. Parties can transact if their participant nodes are connected to a common synchronizer. No single node processes all network transactions.

That decentralized synchronization domain is now called the Global Synchronizer. Following its "TestNet" launch in June 2023, and extensive testing with market participants, the Global Synchronizer's "MainNet" subsequently went live in June 2024. The Global Synchronizer is decentrally operated by independent entities called Super Validators. The Global Synchronizer will be the first instance of a decentralized synchronization domain for the Canton Network but is not intended to be the only one. Third parties may set up their own decentralized Canton synchronization domains using the code available through Splice, a Hyperledger Lab.

Governance of the Global Synchronizer will be facilitated by the Global Synchronizer Foundation (GSF), an independent entity managed by the Linux Foundation. The GSF will facilitate transparent governance and organizational neutrality in the operation of the Global Synchronizer.

Motivation for Canton Coin

The goal of the Super Validators is to build an ecosystem to foster and accelerate the creation of a “network of networks” of applications in regulated finance and other areas. A “backbone” infrastructure like the Global Synchronizer is an important part of doing so, but it is far from sufficient for starting an ecosystem. Networks acquire and deliver value through “network effects”, where existing users and applications provide value to new users and applications, and vice versa. To incentivize the first users and applications to do something in the absence of that preexisting value, special mechanisms are needed to provide first-mover advantages. This includes the Super Validators themselves, which are providing the first services within this ecosystem, including the Global Synchronizer.

Furthermore, ecosystems like the Canton Network benefit significantly from having both a means of transferring value, and publicly visible metrics for activity and use.

To meet these needs, the Super Validators have included a payment and incentivization application in the launch of the Global Synchronizer's MainNet. The application is based on a token called Canton Coin, and each Super Validator will independently run an instance of the Canton Coin application.

Canton Coin serves multiple purposes:

1. The Canton Coin application incentivizes all stakeholder groups to provide value, or more precisely utility, to the network. For example, third-party application providers can mint Canton Coin in return for offering their products and services via the Global Synchronizer[1], and Super Validators can mint Canton Coin in return for running the network backbone.
2. The Canton Coin token provides an optional network-native mechanism to pay for network use. For example, the Super Validators operating the Global Synchronizer will allow the creation of transaction traffic balances across the Global Synchronizer using Canton Coin.
3. The Canton Coin token provides an optional network-native payment mechanism for application use. Any application provider can choose to charge application fees in Canton Coin. For example, the Canton Name Service, an application offering Validator name lookup and operated by the Super Validators operating the Global Synchronizer, will charge application fees in Canton Coin.

[1] Applications are incentivized to use the Global Synchronizer and charge their application fees in Canton Coin.

4. The Canton Coin token provides a public gauge of some aspects of network and application use. It gives visibility into the fees paid to different application providers as a proxy of the value that their applications provide to users.
5. The Canton Coin application provides an example of how to build public applications on the Canton Network.

Principles

Canton Coin is carefully designed to match the needs of a network and ecosystem for regulated finance, while at the same time allowing its users to achieve the goals stated under Motivation above. This is accomplished by following the set of key principles set forth below.

1. Reward Value to the Ecosystem

Canton Coin rewards utility provided by users of the Global Synchronizer. Canton Coin is not issued in exchange for investment. In contrast, most blockchain networks issue tokens in exchange for an investment in the developer of the network and in anticipation of future network value.

Most of a network's value comes from its users, assets, and applications. The bulk of Canton Coin can be minted by these stakeholder groups rather than just the Super Validators, again in contrast to most blockchain networks, where only "miners" can mine tokens.

2. Encourage Utility, Discourage Speculation

Infrastructure providers and application providers can mint Canton Coin only by providing utility to the network. There are no presales or special pools for "founders". Canton Coin could only be minted once the fully decentralized Global Synchronizer was running.

Furthermore, we avoid design choices that could lead to artificial scarcity or speculation bubbles. A stated goal, pursued through the "Burn Mint Equilibrium" mechanism explained below, is that an open market conversion rate for Canton Coin always tends to a point that matches the utility provided by the Global Synchronizer's ecosystem of users, infrastructure, and applications.

3. Optionality

Canton Coin is an optional token for users of the Global Synchronizer. This is in stark contrast to almost all other blockchain networks, where tokens are built into the protocol and cannot be avoided. For example, in Ethereum, Gas is paid in ETH as part of every transaction.

Participant node operators that want to connect to the Global Synchronizer *can* use Canton Coin to prepay their traffic directly, or they can arrange with a third party to set up a traffic balance (like a cell phone data plan paid in fiat currency) on their behalf. Canton participant nodes can then use the Global Synchronizer, with or without Canton Coin, by drawing down this traffic balance. Super Validators provide a small amount of transaction traffic for free, and any additional traffic is prepaid.

Besides serving as an optional method for purchasing transaction traffic, Canton Coin also provides an optional payment mechanism for application providers. Application providers can denominate their service fees in Canton Coin or in USD, and process these as Canton Coin payments via the Global Synchronizer.

4. Provide Signaling while Preserving Privacy

While most assets currently available on the Canton Network are private by default and visible to only the issuer, owner, and other permissioned parties, one of the design goals of Canton Coin is to provide public visibility of application use for those application providers who choose to share information about the volume of traffic their application processes. To this end, Canton Coin positions and transfers are publicly visible. These public transactions may be composed together with private transactions into a single atomic transaction. This composition does not alter the core privacy properties of the Canton protocol, and composed transactions preserve the privacy of all private sub-transactions (that is, the private, non-Canton Coin part of the transaction remains private).

Governance

All actions taken by Super Validators operating the Global Synchronizer, and Canton Coin application configurations and transactions, are subject to a ⅔ majority action of all Super Validators. This includes all parameters described in this paper, including the set of active Super Validators, the minting curve and rights split, fees, and protocol improvements.

The remainder of this white paper details how Canton Coin achieves its goals while adhering to these core principles. This paper will first discuss Canton Coin's high-level tokenomics, followed by an Appendix that describes the detailed fees and minting procedures.

High-Level Canton Coin Tokenomics

As discussed above, Canton Coins can only be minted in exchange for providing value to the network. This section covers how the ability to mint Canton Coin is made available to different users and roles over time, and what activities allow a user to mint Canton Coin and on what basis. The "Burn Mint Equilibrium" section covers the detailed mechanics of the tokenomics.

Roles

There are four main roles in the Canton Coin application:

1. User - anyone holding and transacting with Canton Coin via the Global Synchronizer. Users can choose to self-host participant nodes or use a participant node hosted by others.
2. Validator - a Canton participant node with the Canton Coin application installed. Validator nodes provide network access to users; validate both Canton Coin transactions and

other installed applications' transactions, exclusively for the parties hosted on that participant node[2]; and, in return, are able to mint Canton Coins.

3. Super Validator (SV) - a multi-component node, consisting of a Validator and also a Canton synchronizer node, that participates in the Global Synchronizer. Super Validator nodes validate every Canton Coin transfer via a ⅔ majority Byzantine Fault Tolerant (BFT) consensus; and offer the Name Service and a small number of other applications that support the Global Synchronizer and Canton Coin ecosystems.
4. Application Provider - A Validator operator that gives users, and their validator nodes, access to a Canton application that submits at least some portion of its transactions through the Global Synchronizer.

Minting Curve

Over the first ten years of operation of the Global Synchronizer, 100 billion Canton Coins can be minted, with availability split 50/50 between infrastructure providers and application providers. Following the first ten years, 2.5 billion Canton Coins can be minted yearly, with approximately 75% going to application providers and 25% going to infrastructure providers.

The allocation of Canton Coins that can be minted by infrastructure providers is shared between Validators and Super Validators. Initially, this distribution will be biased towards bootstrapping the Super Validator network, as the Super Validators bear the costs of deploying and maintaining early infrastructure.

Over time, the allocation of Canton Coins that can be minted by Super Validators will decrease significantly after the first few years of the Global Synchronizer's operation. Five years after launch, the pool of Canton Coin that can be minted by Validators will be larger than the pool available to Super Validators.

The Canton Coin minting curve and split are shown on the next page.

[2] To reduce the complexity of hosting Validator nodes, Validators do not by default load, validate and serve all public Canton Coin data; they participate only in transactions to which their hosted users are parties. In parallel, each Super Validator makes all Canton Coin data publicly available by sharing the Super Validator BFT consensus view of the entire ledger for independent validation.

Figure 2: Cumulative Minting Over Time

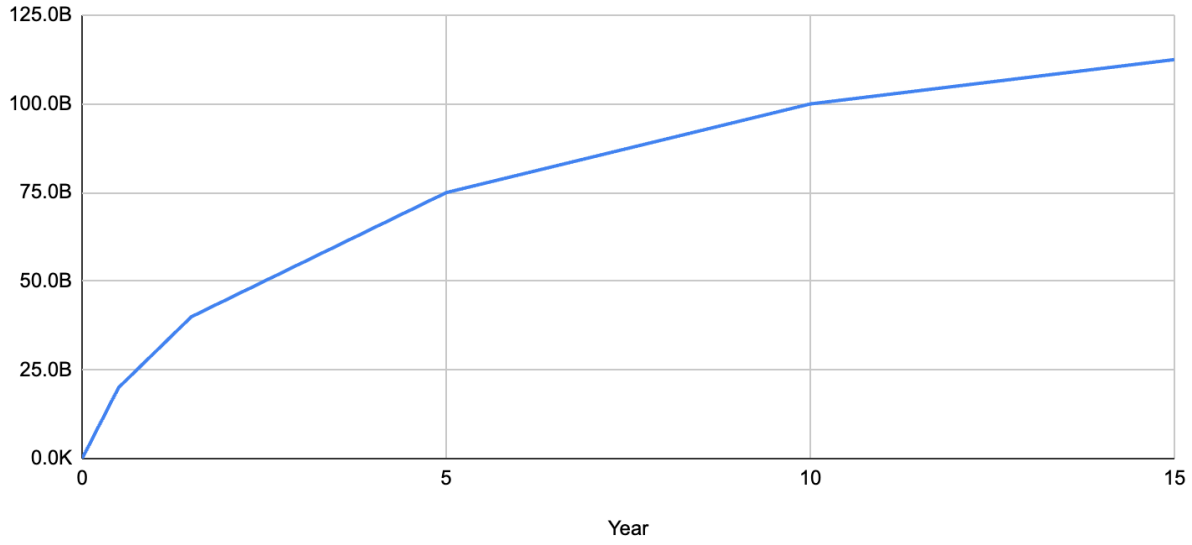

Figure 3: Minting Split

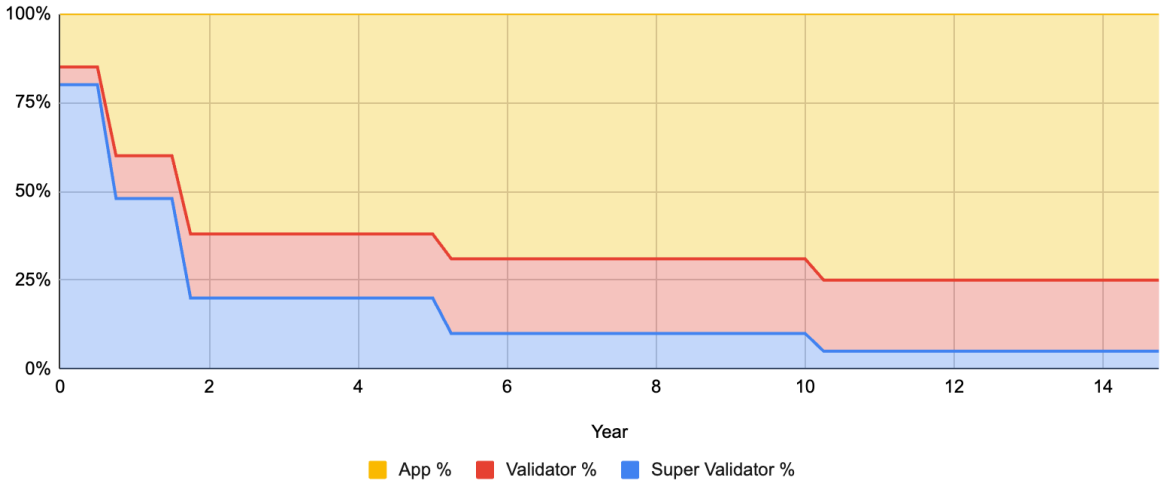

Figure 4: Canton Coin Minting Curve

Years	Rate / Year	Total Minting	Application %	Validators %	SV %
0-0.5	40b	20b	15%	5%	80%
0.5-1.5	20b	20b	40%	12%	48%
1.5-5	10b	35b	62%	18%	20%
5-10	5b	25b	69%	21%	10%
10 yr Cumulative	10b	100b	50b	15b	35b
10+	2.5b	2.5b/yr	75%	20%	5%

Burn-Mint Equilibrium

The Canton Coin application employs a burn-mint equilibrium mechanism, aiming to stabilize the conversion rate of Canton Coin[3] around the intrinsic value it provides to network users. Token price is a function of supply and demand. As such, if supply is fixed and demand is volatile, the conversion rate becomes volatile. The burn-mint equilibrium mechanism is expected to allow total supply to adjust according to demand, thus reducing conversion rate volatility. Furthermore, under this mechanism, the conversion rate is expected to align, over the long run, with the utility value of the network. The burn-mint mechanism works as follows:

1. Canton Network users use Canton Coin to pay fees denominated in United States Dollars (USD) as they use applications and infrastructure services.
2. Instead of paying fees directly to network infrastructure providers, all fees for using Canton Coin, and for creating a traffic balance on the Global Synchronizer, are burned by the user who submits the Canton Coin transaction. Thus, Canton Coins are retired from circulation, decreasing the token supply by the amount of real utility provided to network users (in USD). The users specify the application or infrastructure service for which they're burning fees.
3. In return for operating applications and network infrastructure, providers can mint new Canton Coins. Thus, the usage fee from user to provider is indirect via the burn-and-mint mechanism. Below, both fees and minting are described in more detail, as is the motivation for using this burn-and-mint mechanism.
4. As defined by the minting curve, the Canton Coin application creates a predetermined amount of Canton Coins that can be minted over time. At steady-state, the Canton Coin application allows the minting of 2.5 billion Canton Coin per year. Thus, the cumulative number of Canton Coins minted is always increasing. This is offset by the number of Canton Coins burned. Accordingly, network usage must burn 2.5 billion Canton Coins per year to keep the number of Canton Coins in circulation stable.

As an example of this burn-mint equilibrium mechanism, if the use of the Global Synchronizer grows in a given year and users burn 3.5 billion Canton Coins as fees, the supply of coins will decrease by one billion that year. In this scenario, since supply decreases as utility increases, it would be reasonable to expect the Canton Coin to USD conversion rate would increase. Since the Global Synchronizer charges USD-denominated fees, any conversion rate increase would cause a decrease in the number of Canton Coins users will burn as fees. This decrease in burn would continue until the network reaches an equilibrium of 2.5 billion Canton Coins burned per year. The opposite effect would be observed if the use of the Global Synchronizer shrinks in a given year and users burn fewer Canton Coins as fees than are minted; the conversion rate of Canton Coin to USD would be expected to decrease until the number of Canton Coins burned increases to reach 2.5 billion Canton Coins per year.

[3] Denominated in USD.

To summarize:

Increased utility → Burn > Mint → supply decrease → conversion rate increase → burn decrease → Burn = Mint = 2.5b coins/year

Decreased utility → Burn < Mint → supply increase → conversion rate decrease → burn increase → Burn = Mint = 2.5b coins/year

Stable utility → Burn = Mint → supply stable → conversion rate stable

Fee Structure

Canton Coin users pay two types of fees to use the Global Synchronizer and its Canton Coin application, detailed below. These fees are not paid to any other party directly; instead, users burn Canton Coin to cover these fees; this supports the Global Synchronizer's burn-mint equilibrium. While there are multiple fees described below, the design principle is simple: the fee structure looks to (1) increase the amount of coins burned as utility increases and vice-versa, (2) have similar total costs to the user as well-established payment systems, and (3) incentivize efficient usage of common resources such that each Canton Coin owner pays for their fair share of the common resources they utilize[4].

1. Percentage transfer fees - A small percentage fee based on the amount of value transferred, with a regressive cost structure.[5] Percentage transfer fees take inspiration from the fee structure and cost of existing cash payment networks.
2. Resource usage fees - Fees that cover the infrastructure costs of shared resources, regardless of the value transferred. These fees are calculated based on the amount of bandwidth and storage used, and the amount of time the storage is used[6].

All fees are denominated in USD and settled in Canton Coin, based on a Canton Coin to USD conversion rate published on-chain, as part of the minting cycle every ten minutes. Super Validators operate the oracle that provides the on-chain conversion rate, which is computed by allowing every Super Validator to submit a proposed conversion rate at any time. An automated calculation then publishes the median of the proposed conversion rates at the start of each minting cycle.

Minting Structure

The minting curve defines how to split the total amount of Canton Coin available for minting. There are four scenarios under which Canton Coin can be minted:

Application providers can mint Canton Coin for operating valuable services on the network. The total pool of Canton Coins that can be minted by application providers, as defined by the minting curve, is split among application providers relative to the value each application

[4] CPU, memory, disk space, etc.
[5] Higher value transactions pay a lower percentage as a fee. See Usage Fees and Traffic Price Parameters for more info.
[6] See Resource Usage Fees for a detailed explanation of these fees.

provider's application provides to the network. To calculate that value the Canton Coin application inputs the total amount of Canton Coin fees burned by users when using the application. Each application provider is subject to some minting caps, described below, to avoid gaming and arbitraging.

Validators can mint Canton Coin for "Coin usage" based on the value of Canton Coin transfers initiated by users of the Validator[7]. Each Validator is subject to caps on the number of Canton Coins it can mint this way to avoid gaming and arbitraging.

Validators can mint Canton Coin for node uptime, or "liveness". If Validators do not mint all available Canton Coin for Canton Coin usage (as described in the paragraph above) in a given minting cycle, the remaining Canton Coins can be minted for liveness by dividing the remaining Validator mints across all the active Validators. This creates an incentive for Validators to be ready to host potential users of new applications and use cases. As activity picks up, the allocation of Canton Coin minted by Validators that facilitate network activity overtakes the minting due to liveness, so passive Validator nodes will stop being eligible to mint Canton Coin. The number of Canton Coins that can be minted for liveness per Validator is capped to avoid first movers being incentivized to resist new joiners.

Super Validators can mint Canton Coin for running a node in the Global Synchronizer. The total pool of Canton Coins that can be minted by Super Validators is defined by the minting curve and is split among Super Validators relative to the efforts each Super Validator has made or committed to make to grow the network, as determined and agreed by ⅔ of the Super Validators. These weighted Super Validator allocations are part of the BFT network configuration.

Featured Applications and Minting Caps

Minting caps exist to prevent network users from arbitraging and gaming the Canton Coin application without adding value to the network. To avoid this gaming scenario, we distinguish between "featured" and "unfeatured" applications.

All applications are unfeatured initially, meaning the rewards they can mint are capped. This cap can be lifted by the Super Validators with a ⅔ majority vote by marking the application as a "featured application", indicating that they consider the application to be providing real utility to the network.

Featured application providers may mint up to 100x more Canton Coin than was burned as fees in Canton Coin transfers coordinated by their applications. This creates an incentive for application providers to build featured applications early on and provide high value to the network. As more featured applications gain usage, their providers will mint all Canton Coins

[7] To be precise, calculation of Canton Coins that can be minted by Validators also takes into account locking fees resulting from these transfers and burning of Canton Coin to create a traffic balance on behalf of a given network user.

available to application providers as defined by the minting curve, thus splitting available rewards between the different applications and reducing the effective multiplier they can reach.

Unfeatured application providers cannot arbitrage the incentive system by creating a high volume of transfers between parties they control. They may mint at most 80% of their fees back as Canton Coin. This ensures that application providers are disincentivized from wasting network resources without providing real utility to network users as a whole.

As an example, if an unfeatured application user pays $100 in fees to the application and in the process of this transfer burns $1 worth of Canton Coin, the application provider will receive $99 in fees and be eligible to mint up to $0.8, whereas a featured application provider would be able to mint up to $100 worth of Canton Coin, assuming there are enough coins in this round to reach the cap, as defined by the minting curve.

Minting Caps and Featured Applications are discussed in more detail in the Canton Coin Fees and Minting in Detail appendix.

Unclaimed Coins

It is possible that the Canton Coins available for minting in a given minting cycle are not all claimed and minted. Unminted Canton Coins, if any, will go to a pool of unminted Canton Coins. Super Validators will vote on methods for network participants to mint these unminted Canton Coins.

Conclusion

The Global Synchronizer for the Canton Network provides publicly accessible integration infrastructure that makes it possible to integrate across independent Canton blockchains with high guarantees of consistency and transaction atomicity. To make sure this service can't be disrupted by its operators, the Global Synchronizer provides its services via multiple independent Super Validator nodes all executing decentralized BFT algorithms. These algorithms require a ⅔ majority of all nodes to agree on any action.

To help bootstrap the ecosystem of operators and users of this service, the Global Synchronizer includes a payment mechanism, an incentive reward system, a public gauge of usage, and an example application, called Canton Coin. The Canton Coin application generates Canton Coins as long as the service is in operation, and network participants earn the ability to mint that coin based on their contributions to the Global Synchronizer ecosystem.

Appendix: Canton Coin Fees and Minting in Detail

The following section goes into detail about Canton Coin's implementation and configuration at launch. All implementation details, configurations, and network parameters are subject to change by vote of at least ⅔ of Super Validators and following a Canton Improvement Proposal (CIP) process. The code which implements the Global Synchronizer and Canton Coin is open source and available at Splice, a Hyperledger Lab.

Main Data Structures

Coin Data structure

Each Canton Coin is an active smart contract record with two signatories: the decentralized synchronizer operator (`dso`) party, representing the ⅔ majority vote of Super Validators, and an owner.

Each Canton Coin record has the following parameters:

1. owner
2. amount[8]
3. round[9] it was minted in
4. holding fee rate applicable to the coins[10]
5. optional time lock[11]

Activity Record Structure

Activity records are used to record which parties provided utility to the network, for the purpose of calculating Canton Coin minting rights. There are three types of activity records, one each for application providers, Validators, and Super Validators. They are fundamentally all the same, each being a smart contract record created by network participants and validated by the Super Validators. These records consist of:

1. user
2. weight (the relative share of minting associated with this activity record)
3. round which it is part of

The weight indicates the share of total Canton Coin that can be minted that will be associated with this activity record. For example, if there were only two activity records, one with weight 2 and another with weight 3, the first record would receive ⅖ of the Canton Coin available for minting and the second would receive ⅗.

[8] Quantity of Canton Coin managed by this contract record, specified to ten decimal places.
[9] Described further in the Rounds and Activity Records section below
[10] Described further in the Fees section below.
[11] A time lock is set by the owner and includes an expiry time and a list of parties that hold the lock, and whose authority is required to unlock the lock before its expiry time. These lock holders are made signatories of the contract as well.

Activity records for application providers have an additional flag to identify whether the application provider is "featured". Activity records for Super Validators have an additional field for a "beneficiary" in case a Super Validator wants to separate out its operational and coin holding activities, or "delegate" its minting activity altogether.

Transfer Structure

Canton Coin, in line with the fundamental design of Daml[12], follows a UTXO[13] model. A transfer can have multiple input and output coin contract records. Transfers preserve the total coin amount after accounting for fees.

A transfer transaction requires five pieces of data as inputs:

1. sender[14]
2. the application provider of the application that invoked this transfer[15]
3. list of input coins[16]
4. list of output coins
5. references to other contracts that contain parameters necessary for computation of the tokenomics.

A transfer makes the following changes on the ledger:

1. input coins are archived
2. output coins are created[17]
3. activity records are created to enable the sender's Validator and the application provider to mint their Canton Coins.

Fees

As described above, Canton Coin users pay two types of fees to use the Global Synchronizer and its Canton Coin application, transfer fees and resource usage fees. The parameters below are set by vote of the Super Validators at network launch and are subject to change by subsequent votes[18]. In the event of a change in fees, the change applies only to future activities, never retroactively.

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[12] Daml is Canton's smart contract language. See Canton Network: A Network of Networks for Smart Contract Applications for more info.

[13] UTXO stands for "Unspent Transaction Output". Each transaction initiated by Daml smart contract code produces one or more distinct records (outputs) that record the result(s) of the transaction. These records are "unspent" until they are used as input to a new transaction, at which point they are archived ("spent") and can no longer be used. For more information see "Canton Network:
A Network of Networks for Smart Contract Applications".

[14] This is the user that authorized the transfer, and whose Validator node operator is eligible for Validator minting.

[15] The application provider is eligible to mint Canton Coin as discussed above.

[16] As an optimization for minting Canton Coin, and merging Canton Coin into existing positions, Canton Coins minted in previous rounds can be used as input as well, thus minting and transferring in the same transaction. All input UTXOs must be owned by the sender.

[17] There is one special output, which is "change" returned to the sender. This is an output that is automatically generated from the transaction if the inputs are greater than the outputs plus fees.

[18] See section on network governance.

Transfer Fees

parameter	value
Transfer fees are charged per output coin whose receiver is not the sender	
the first $100	1.0 %
above $100 up to $1000	0.1 %
above $1000 up to $1M	0.01%
everything above	0.001%

Resource Usage Fees

Canton Coin transfers pay resource usage fees to cover the infrastructure costs of using shared resources, regardless of the value transferred:

1. Base transfer fee - A fee applied to every new coin contract record (UTXO) created in a Canton Coin transfer transaction. Most transactions incur at least two base transfer fees.
2. Coin locking fees - A fixed fee for every holder of a lock on a coin record, since each additional signatory increases the load on the Super Validators.
3. Holding fees - A fixed fee over time per separate coin contract (UTXO) per unit of time, regardless of the coin amount. This is paid by the coin holder and incentivizes users to merge coins or pay for any additional network storage the coin contracts (UTXOs) incur.[19]
4. Synchronizer traffic fee - Amount of traffic balance deducted to have a transaction synchronized via the Global Synchronizer. Traffic balance is denominated in megabytes and is required for transactions sequenced by the Global Synchronizer[20], whether or not a transaction uses Canton Coin. To set up a traffic balance for a given Validator node, someone must burn an equivalent value of Canton Coin, based on the current USD to Canton Coin conversion rate and the USD/MB price, and assign the resulting traffic balance to that Validator node. Note that traffic is non-transferable, and traffic balances cannot be converted back to Canton Coin. Traffic balances are designed to remain relatively small.

[19] When a coin UTXO's effective value reaches zero because the holding fees are higher than the coin amount, the coin expires, and the records are archived.

[20] To enable initial connection, a baseline traffic amount is provided to all Validators even without prepayment. Non-paying Validators can submit roughly one 60kB transaction per minute on average, and a ten transaction burst every few minutes.

parameter	value
Base transfer fees are charged for every output coin	
base transfer fee	$0.03
Coin locking fees are charged per lock holder on a locked output coin	
lock holder fee	$0.005
Holding fees per coin (regardless of coin amount)	
holding fee	$1/year[21]
Traffic is charged by MB of transaction size	
Traffic price beyond free tier	$17/MB[22]
Transfer limits	
maximum number of inputs	100
maximum number of outputs	100
maximum number of lock holders	10

Transfer Fees Calculation

The total fee for a transfer is calculated like this:

1. Holding fee on an input coin = min(amount on coin, rounds since creation * holding fee per round[23])
2. Effective amount on input coin = amount on coin - holding fee
3. The total holding fee burned by a transaction is the sum of holding fees over all inputs.
4. The base transfer fee total is the base transfer fee times the number of outputs other than the sender change output.
5. The lock fee total is the lock holder fee times the number of lock holders across all outputs.
6. The transfer fee total is the sum of all transfer fees across outputs with owners other than the sender.
7. The total fee is the sum of the total holding, create, lock, and transfer fees.

[21] A holding fee is charged per round such that the holding fee per contract per year totals approximately $1.
[22] Based on an assumption of 20kb of traffic per Canton Coin transfer to match $1/Canton Coin transfer.
[23] This is the holding fee per round as was recorded in the round during which the coin was created. As such, holding fees are deterministic when denominated in Canton Coin.

Activity Record Calculation

The weight on the Validator activity record is the sum of the create, lock and transfer fees, excluding the base transfer fees for the “change”.[24]

For unfeatured applications, the application provider activity record has the same weight as the Validator activity record. At the launch of the Global Synchronizer, featured applications will receive $1 worth of additional weight in their fee total, as described above. This additional weight for featured applications is configurable by vote of the Super Validators.

Transfer Fee and Activity Record Example

For example, transferring $1000 worth of Canton Coin from a single UTXO to an unfeatured application, and returning the input coin UTXO remaining balance to the sender, will result in the following, excluding holding fees, and assuming use of the free synchronizer traffic:

Fee	Amount	Explanation
transfer	$1.9	1% for first $100 = $1 0.1% for next $900 = $0.9
base transfer	$0.06	two output coins are required at a cost of $0.03 each
total	$1.96	

The sender would create a Validator activity record with weight $1.93[25], and the application provider would create an application activity record with weight $1.93. Had the application been featured, it would have created an activity record with weight $2.93.

[24] The rationale for not recording activity for holding coins and for accepting change is that this does not add value to the network and is simply the byproduct of useful activity. It also avoids the problem of issuing additional activity records just for creating activity records, and thus leading to an unproductive spend of network resources.

[25] The total fee was $1.96 but the output coin fee for the change to sender of $0.03 isn’t recorded in the activity record

Similar transfers with different US dollar values will pay the following fees[26]:

Transfer value	Total fee	Fee as a percentage of transfer
$1	$0.07	7%
$10	$0.16	1.6%
$100	$1.06	1.06%
$1,000	$1.96	0.20%
$10,000	$2.86	0.03%
$1,000,000	$101.86	0.01%
$100,000,000	$1,091.86	0.001%

In addition, the transfer will burn the accrued holding fee for the input coin. For example, if the input coin was created two years ago, the transfer will burn an additional $2 accrued holding fee[27].

If Canton Coin is used for a multi-party transaction, such as an atomic settlement of a tokenized asset paid for in Canton Coin, coins are explicitly allocated to this transaction in the form of locked coins, whose lock holders are the stakeholders of the asset other than the coin owner. Thus for a two-party atomic settlement, an extra $0.035 is charged: one extra base transfer fee plus one lock holder fee.

Global Synchronizer Traffic

To have transactions sequenced by the Global Synchronizer, Validators buy Synchronizer traffic by burning Canton Coin. The process of burning Canton Coin to create a traffic balance is simpler than a general transfer. Its inputs are:

1. sender
2. node id of the Validator for which an additional traffic balance should be created.
3. list of input coins
4. balance to create, in megabytes[28]
5. references to other contracts that contain parameters necessary for computation of the tokenomics.

A traffic balance creation transaction makes the following changes on the ledger:

1. input coins are archived

[26] Excluding the accrued holding fee and the use of traffic balance.
[27] The exchange rate for holding fees was set at the time of coin creation, actual USD value may vary.
[28] This converts into an amount of Canton Coin to be burned, based on the “Traffic Price” parameter which is denominated in USD/MB

2. an output coin is created for the change due to the sender
3. a Validator activity record is created

The entire Canton Coin amount burned to create the traffic counts toward the Validator activity record. This burn produces a traffic balance denominated in MB using the traffic price and the USD conversion rate. The new traffic balance is recorded at the BFT layer of the Global Synchronizer.

Free Traffic on the Synchronizer

A small amount of free traffic is given to all Validators. This free amount is designed to allow for:

- Validator onboarding
- Recording baseline activity and minting Canton Coin in every round
- Purchasing more traffic as needed
- A trickle of business transactions on top of the above to allow for free, small-scale use of the Global Synchronizer

Featured Applications

As discussed in Featured Applications and Minting Caps, minting caps exist to prevent network users from arbitraging and gaming the Canton Coin application without adding value to the network.

For featured applications, limits on minting are lifted in two ways. First, the application can earn the ability to mint up to 100x more Canton Coin than were burned in the fees for transactions processed by that application. Second, featured apps receive extra weight on their activity equivalent to burning an additional $1 in fees for every Canton Coin transaction they facilitate. In practice, this means that given the launch configuration for the Global Synchronizer, the first featured application will earn the ability to mint a minimum $100 worth of Canton Coin for any Canton Coin transfer initiated via that application's workflows. This high starting point will decline as more applications use the synchronizer.

Rounds and Activity Records

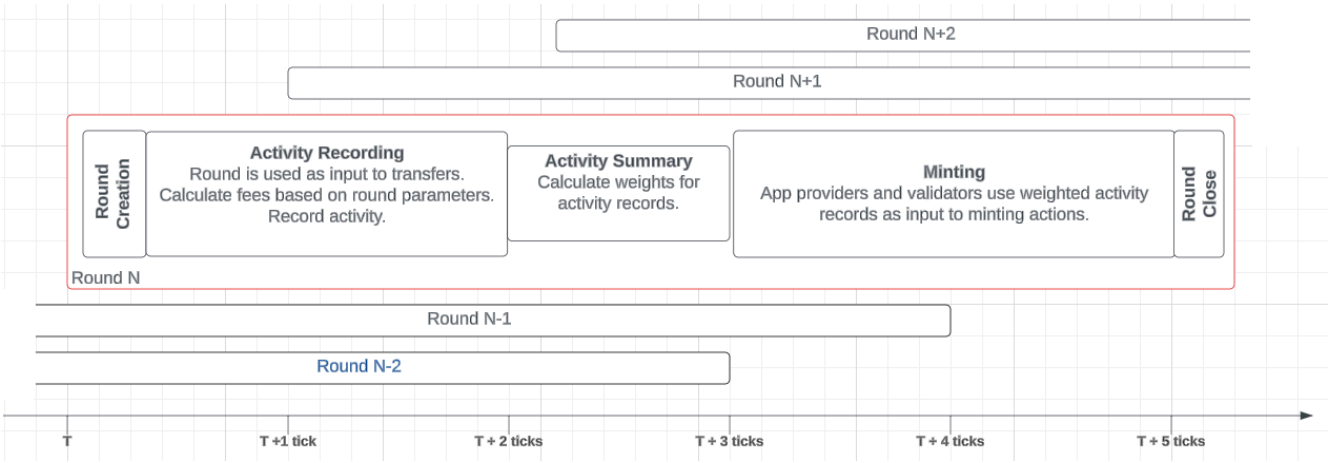
Canton Coin tokenomics are executed in discrete minting cycles called rounds[29]. A new round starts every 10 minutes, an interval called a "tick" or "round interval". Each round takes roughly 5 ticks and includes multiple phases, as described below. As such, rounds overlap and there are multiple rounds at different phases at any given point in time. The minting curve defines how many Canton Coin can be minted in each round and how this ability to mint is distributed among application providers, Validators, and Super Validators. The number of Canton Coins that can be minted in a given round is also known as that round's "tranche".

[29] It is important to note that Canton Coin minting rounds start every 10 minutes, but transaction processing on the Canton Network is continuous and isn't batched in "blocks" as is the case in other public blockchains such as bitcoin or ethereum. Transactions get confirmed in real time and not in blocks.

The minting process includes multiple phases for each round:

- **Phase 1: Round Creation.** The Super Validators start the minting round by writing its parameters to the ledger. The parameters include, among others, its number, tick duration, and USD to Canton Coin conversion rate.
- **Phase 2: Activity Recording**. As users transfer Canton Coin or convert Canton Coin into Global Synchronizer traffic balance, these actions record their activity by creating activity record contracts. To avoid scenarios where a user attempts to record activity just as this phase is ending and fails due to network latency, the Activity Recording phase lasts two ticks, so that there is always plenty of overlap between rounds in this phase[30].
- **Phase 3: Activity Summary**. The Canton Coin application computes and publishes the minting weights for the different kinds of activity records created in Phase 2, which determine the amount of Canton Coins that can be minted. This phase always lasts one tick.
- **Phase 4: Minting.** This phase again lasts two ticks. During this time, Super Validators, application providers, and Validators can mint the portion of new Canton Coin corresponding to their activity by supplying the published minting weights and their activity records as input to a minting transaction.
- **Phase 5: Close and Unminted Canton Coin**. The round is closed. Any Canton Coins that Validators and/or application providers do not mint are tracked in a pool of unminted Canton Coin.

Figure 5: Canton Coin tokenomics are executed in discrete minting cycles called rounds



[30] Each activity record refers to the round in which it will be counted. The user can choose one of the open rounds in the Activity Recording phase at their discretion.

The remainder of this section will detail the phases of a round.

Phase 1: Round Creation

Each round is opened with a set of parameters that determine the calculations in the latter phases. The key ones are covered here. All parameters are signed jointly by the Super Validators via an on-chain entity party called the decentralized synchronizer operations (dso) party. Super Validators enable actions by the dso party via a ⅔ majority vote.[31]

Canton Coin to USD Conversion Rate

Canton Coin's value may fluctuate, but businesses typically charge fees denominated in government-issued currencies. To make Canton Coin easily usable for payments, senders can denominate transfer amounts in USD. Each Super Validator proposes a conversion rate on-chain, either by manually entering a conversion rate or by publishing a feed to automatically update their proposal.[32] The on-chain conversion rate is the median of all conversion rates proposed by the Super Validators.

The Canton Coin resource usage fees and the Global Synchronizer's traffic fees are also denominated in USD. So the conversion rate included in round creation applies to all fee calculations in that round.

Until Super Validators propose a different value, a placeholder conversion rate of $0.005 per Canton Coin is the default conversion rate at network launch.

Usage Fee Parameters

Usage fee parameters will be used in Phase 2: Activity Recording to calculate fees for Canton Coin transfers, as well as the weights applied to the resulting activity records. The specific fees at launch are as detailed in the Fees section above.

Fee parameters change via the governance process. They are set per round simply to allow such a change at any point and/or to allow for dynamic ways of determining parameters for the above conversion rate.

Minting Parameters

Minting parameters specify the amount of Canton Coin that can be minted by the different stakeholder groups for each round. These will be covered in the Phase 3 section below.

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[31] Super Validators validate and confirm all Canton Coin transfers, because all Super Validators validate all transactions involving the `dso` party. A transaction is considered confirmed on behalf of the `dso` party if at least a ⅔ majority of Super Validators have confirmed it. In addition, the Super Validators can authorize additional actions by the `dso` party by ⅔ of the Super Validators signing a smart contract authorizing the action.

[32] It is trivial for users to add payments denominated in other currencies as long as there is a price feed for such currencies. At launch, the Super Validators will provide a USD conversion rate only.

Minting parameters are predetermined by the protocol governing the minting curve above. Each round makes a tranche of Canton Coin available for minting during the first tick of the round, and thus the size and split of Canton Coin available for minting depends only on the round's timings and the overall minting curve. As with Usage Fee parameters, the Minting Parameters are set per round for efficiency reasons and to allow for concurrent changes to the minting curve through governance.

Phase 2: Activity Recording

During Phase 2, application providers and Validators reference the open round for Canton Coin transfers and traffic balance creation transactions. In other words, each Canton Coin transfer references one of the open rounds that are currently in Phase 2. Transactions of both types create an output that serves as a validated record of activity, which are used in Phases 3 and beyond. This section covers the structure of these transactions, activity weighting and fee calculations, and initial parameters of Canton Coin.

Phase 3: Activity Summary

The minting tranche associated with a given round divides into three pools for that round: Application Providers, Validators, and Super Validators.

The first pool consists of Canton Coin that can be minted by application providers. This pool is split among application providers proportional to the weights they hold on activity records for that round, subject to a cap of Canton Coins that can be minted per weight. If the cap prevents the pool from being fully minted, the featured applications split the remainder proportional to their weights with a higher cap. Any remainder after that goes into the pool of unminted Canton Coin.

The second pool consists of Canton Coin that can be minted by Validators. The pool is split amongst Validators proportional to the weights they hold on coin usage activity records for that round, subject to a cap of Canton Coins that can be minted per weight. If there are Canton Coins available for minting left over after calculating the share earned through Canton Coin usage, then the remaining Canton Coins that can be minted divide equally among all active Validators up to a cap. Any remainder after that goes into the pool of unminted Canton Coin.

The third pool consists of Canton Coins that can be minted by Super Validators. This pool is split among Super Validators[33] according to the weights on the Super Validator activity records.

Summary Calculation:

First, the activity weighting and minting parameters that were determined in Phase 1 are read:

1. p = conversion from Canton Coin to USD
2. Determined from the minting curve
    - c_i = the amount of Canton Coin available to mint in round i
    - pv_i = the percentage of Canton Coin available for Validators to mint in round i

[33] Super Validators can choose to delegate the Canton Coin they can mint to others

    - pa_i = the percentage of Canton Coin available to for application providers to mint in round i
    - psv_i = the percentage of Canton Coin available for Super Validators to mint in round i
3. Cap parameters determined through governance:
    - cap_v = the maximal amount of Canton Coins that can be minted per weight in Validator activity records
        - set to 0.2 at network start
    - cap_vl = the maximal amount of Canton Coins that can be minted per Validator liveness activity records
        - computed as ‘cap_vl_usd / p’ so that it scales with the coin conversion rate
        - cap_vl_usd is set to $2.85 at network start corresponding to ~$150,000 per annum at 10 minute ticks.
    - cap_fa = the maximal amount of Canton Coins that can be minted per weight in a featured app activity record
        - set to 100.0 at network start
    - cap_ua = the maximal amount of Canton Coins that can be minted per weight recorded in an unfeatured app activity record
        - set to 0.6 at network start

Then, the pool sizes and total weights are then calculated.

4. Calculate the pool/tranche sizes
    - Validator minting pool
      cv_i = pv_i * c_i
    - app minting pool
      ca_i = pa_i * c_i
    - Super Validator minting pool
      csv_i = psv_i * c_i = c_i - cv_i - ca_i
5. Sum up all the activity record weights:
    - tv_i = the sum of all Validator activity record weights for round i
    - tvl_i = the number of all Validator liveness activity records created for round i
    - tfa_i = the sum of all app activity records for featured apps for round i
    - tua_i = the sum of all app activity records for unfeatured apps for round i
    - tsv_i = the sum of the weights on the Super Validator activity records created for round i

The Canton Coin application then uses these totals to calculate the amount of Canton Coin that can be minted per weight recorded against the different kinds of activity records as follows:

6. For Validator activity records: either pro rata to weights, or the cap, whichever is smaller:
    - stv_i = cap_v * tv_i
        - total of Validator activity records weights scaled by corresponding cap
    - capped_cv_i = min(cv_i, stv_i)

        - actual amount of minting available in total for Validators
    - cpvc_i = capped_cv_i / tv_i
        - amount of Canton Coin that can be minted per weight on a Validator activity record
7. For Validator liveness activity records, minting is available either in an even split, or up to the cap, whichever is smaller:
    - cvl_i = cv_i - capped_cv
        - amount of Canton Coin that can be minted available for Validator liveness, which is the remainder of the Validator pool after deducting Canton Coins that can be minted due to Validator activity records
    - stvl_i = cap_vl * tvl_i
        - total of Validator liveness activity records scaled by their cap
    - capped_cvl_i = min(cvl_i, stvl_i)
        - actual amount of minting available in total for Validators
    - cpvl_i = capped_cvl_i / tvl_i
        - amount of Canton Coin that can be minted per Validator liveness activity record
8. For unfeatured app activity records, minting are available either pro rata to weights amongst all apps, or the cap, whichever is smaller:
    - ta_i = tfa_i + tua_i
        - total of all app activity record weights, which is required as the Canton Coin application first allows minting at the unfeatured app activity level to all app providers, and then allows the minting of the remaining Canton Coin to the featured app providers
    - sta_i = cap_ua * ta_i
        - total of all app activity record weights scaled by the cap on minting for unfeatured applications
    - capped_ca_i = min(ca_i, sta_i)
        - amount of Canton Coins that can be minted by all apps up to the unfeatured app cap.
    - cpuac_i = capped_ca_i / ta_i
        - amount of Canton Coin that can be minted per weight on an app activity record for an unfeatured app.
9. For featured apps, the amount of Canton Coin that can be minted is the same as for unfeatured ones, plus a pro rata split of the remainder of the application pool, or the featured app cap, whichever is smaller:
    - cfa_i = ca_i - capped_ca_i
        - extra Canton Coin that can be minted by featured apps, which is the remainder of the pool of Canton Coin that can be minted by app providers after deducting the amount of Canton Coin that can be minted, up to the unfeatured app cap.
    - cap_fa_adjusted = cap_fa - cap_ua
        - cap for featured apps *on top of* the cap for unfeatured apps.
    - stfa_i = cap_fa_adjusted * tfa_i

        - total of all weights on app activity records for featured apps scaled by the adjusted cap for Canton Coin that can be minted by featured applications
    - capped_cfa_i = min(cfa_i, stfa_i)
        - amount of Canton Coin that can be minted in total for featured apps in addition to what they already get from their unfeatured portion
    - cpfac_i = capped_cfa_i / tfa_i + cpuac_i
        - amount of Canton Coin that can be minted per CC usage fee on a featured app activity record
10. Compute the amount of Canton Coins that can be minted by Super Validators per SV minting weight:
    - cpsv_i = csv_i / tsv_i
        - amount of Canton Coins that can be minted per SV minting weight on an SV activity record

Lastly, compute the amount of unminted Canton Coint:

11. unminted_coin = c_i - capped_cv_i - capped_cvl_i - capped_ca_i - capped_cfa_i - csv_i

The minting per activity weight values (cpvc_i, cpvlc_i, cpvc_i, cpuac_i, cpfac_i, cpsv_i) are now written back to the ledger as the summary to be used in phase 4.

Phase 4: Minting

During phase 4, active Validators, applications, and Super Validators can use their activity records as inputs to transfers. Their value is determined by their weights, times the minting per activity record weight values above. A simple minting action would be a transfer with only weighted activity records as inputs and a single “change” output to oneself.

Phase 5: Closing the Round

Any activity records still open after phase 4 are reassigned to the pool of unminted Canton Coin.

Activity and Minting Examples

First Applications After Launch

The first applications using the Global Synchronizer will be able to capture the full allocation of Canton Coin available for minting by maintaining a low but steady transaction rate. During the first six months after launch, each ten minute round makes 114,155 Canton Coin available for minting by application providers, or just over $570 at the launch conversion rate of $0.005 per Canton Coin. Six Canton Coin transfers due to a featured application provider in the activity phase of a single round would generate activity records with total weight >$6, and thus entitle the application provider to mint Canton Coin up to that total of $570. If there are no other applications competing for the allocation of Canton Coin available for minting by application providers, this application provider can thus capture 100% of the allocation available to application providers.

An Easy Application Minting Example with Multiple Applications

For an example of application minting during a stage of active network use, consider three example applications that use Canton Coin as part of their workflows. Let's imagine for this example that the tranche of Canton Coin available for minting by application providers totals 1000 coins and that the current Canton Coin conversion rate is $1 USD, for a total of $1000 worth of Canton Coin available for minting. We'll also assume that users of these apps burn a total of $10 worth of Canton Coin in application fees.

App 1:

Not a featured application.
In a given round 1, $2 worth of Canton Coin are burned as fees to App 1's operator, so the application creates activity records with weight 2 Canton Coin

App 2:

A featured application
In the same round 1, creates activity records with weight 2 Canton Coin

App 3:

A featured application
In the same round 1, creates activity records with weight 6 Canton Coin

Before going into the specific calculation of Canton Coin that can be minted, intuitively, the operator of App 1 should be able to mint Canton Coin worth slightly less than $2. The operators of Apps 2 and 3 should participate in the application rewards for featured apps, and given they are early applications on the network they should receive up to 100x of the fees burned, or be able to mint roughly $200 and $600 worth of Canton Coin at the example prices. As the sum of $800 is less than the $1000 of Canton Coin available for minting, we expect both operators to get the full allocation, and the remaining Canton Coin available for minting will be recorded in the unminted Canton Coin pool.

Below is the specific minting calculation:

The activity record weights for all three applications add up to 10 Canton Coin. Applying the 0.6 application minting capping factor, the total amount of Canton Coin available for minting across all three applications under that cap is 6:

App 1 can mint 2 * 0.6 = 1.2 Coin
App 2 can mint 2 * 0.6 = 1.2 Coin
App 3 can mint 6 * 0.6 = 3.6 Coin

Since the tranche originally included the ability to mint up to 1000 coins, 994 coins will be recorded in the unminted Canton Coin pool.

Now the featured application calculation looks at the activity records held by the featured applications:

> App 1: Not a featured application, so it can mint no additional Canton Coin
> App 2: A featured application with an activity record of weight 2.
> App 3: A featured application with an activity record of weight 6.

The total activity record weights for featured applications map to minting 8 Canton Coin. The cap beyond unfeatured applications is 100-0.6 = 99.4, so the capped remaining pool for minting is min(994, 99.4 * 8) = 795.2. In other words, the cap of 99.4 applies as the overall pool is sufficiently large.

> App 2 earns the ability to mint an additional 2 * 99.4 = 198.8 Coin. Combined with the 1.2 Coin already received, it can mint a total of 2 * 100 = 200 Coin.
> App 3 earns the ability to mint an additional 6 * 99.4 = 596.3 Coin. This combines with the 3.6 minting already earned, for a total right to mint 6 * 100 = 600 Coin.

A Full Example

For ease of understanding, this example will denominate all Canton Coin amounts here in USD, assuming the initial conversion rate of $0.005/Canton Coin.

Let's look at a single round during which the following activity takes place associated with the Open Round:

- 200 Canton Coin transfers facilitated by featured applications resulting in:
  - Validator activity records with total weight $150
  - Application activity records with total weight $350 ($150 + 200 * $1 burn to topup traffic balance)
- Some number of Canton Coin transfers facilitated by unfeatured applications resulting in:
  - Validator activity records with total weight $300
  - Application activity records with total weight $300
- $200 worth of synchronizer traffic balance creation resulting in:
  - Validator activity records with total weight $200
- 30 Validator Liveness activity records
- Super Validator activity records with total weight 100

Based on this, it is possible to calculate the resulting summary at different points on the minting curve as follows.

years	**0-0.5**	**0.5-1.5**	**1.5-5.0**	**5.0-10**	**10+**
Assumed conversion (p)	0.005				
Minting Curve Parameters					
tranche (c_i)	$3,805	$1,903	$951	$476	$238

SV % (psv_i)	80%	48%	20%	10%	5%
Validators % (pv_i)	5%	12%	18%	21%	20%
Application % (pa_i)	15%	40%	62%	69%	75%
Pool Sizes					
SV pool (csv_i)	$3,044	$913	$190	$48	$12
Validator Pool (cv_i)	$190	$228	$171	$100	$48
Application Pool (ca_i)	$571	$761	$590	$328	$178
Activity Record Weights					
Validator (tv_i)	$650				
Validator Liveness (tvl_i)	30				
Featured App (tfa_i)	$350				
Unfeatured App (tua_i)	$300				
SVs (tsv_i)	100				
Validator Minting					
Capped (capped_cv_i)	$130	$130	$130	$100	$48
Minting per weight (cpvc_i)	$0.20	$0.20	$0.20	$0.15	$0.07
Validator Liveness					
Pool (cvl_i)	$60	$98	$41	$0	$0
Capped (capped_cvl_i)	$60	$86	$41	$0	$0
Minting per weight (cpvl_i)	$2.01	$2.85	$1.37	$0.00	$0.00
Unfeatured App					
Total weight (ta_i)	$650				
Capped (capped_ca_i)	$390	$390	$390	$328	$178
Minting per weight (cpuac_i)	$0.60	$0.60	$0.60	$0.50	$0.27
Featured App					
Pool (cfa_i)	$181	$371	$200	$0	$0
Capped (capped_cfa_i)	$181	$371	$200	$0	$0
Minting per weight (cpfac_i)	$1.12	$1.66	$1.17	$0.50	$0.27
Super Validators					
Minting per weight (cpsv_i)	$30.44	$9.13	$1.90	$0.48	$0.12
Unminted Canton Coin	$0	$13	$0	$0	$0

This summary illustrates the fees and minting for an isolated transaction during such a round in the first half year of the network. Let's use the transaction from the Fees Example. The user paid $1.96 in fees and the Validator node operator hosting that user created a Validator activity record with weight $1.93. An unfeatured application created an application activity record with

weight $1.93. A featured application would have received an application activity record with weight $2.96. If the user had burned $1 of Canton Coin to update their traffic balance, the Validator node operator would also have received an additional Validator activity record with weight $1.

	Excluding Traffic	**Including Traffic**
User (/Validator)		
Fee Paid	$1.96	$2.96
Activity Record Weight	$1.93	$2.93
Minting	$0.39	$0.59
Net Fee	$1.57	$2.37
Unfeatured App		
Activity Record Weight	$1.93	
Minting	$1.16	
Combined Net Fee/Burn	$0.42	$1.22
Featured App		
Activity Record Weight	$2.93	
Minting	$3.27	
Combined Net Fee/Burn	-$1.70	-$0.90

With these particular assumptions on network state, a transfer of $1000 facilitated by an unfeatured application results in an overall burn of $0.42/$1.22, whereas such a transfer facilitated by a featured application results in an overall mint of $1.70/$0.9. However, the Validator node operator is also eligible for $2.01 in Validator liveness minting, so at low transaction rates (1/tick average), the overall result is a net mint in all cases.