The Milton System

- Organism Economic Model -

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Version 0

Introduction

Organism aims to create a self sustaining economic life form so that it may be resilient and adaptive to its environment. To enable growth of the network there must be a sound balance between incentivizing participants to carry out the basic network functions and enabling the use of our ledger.

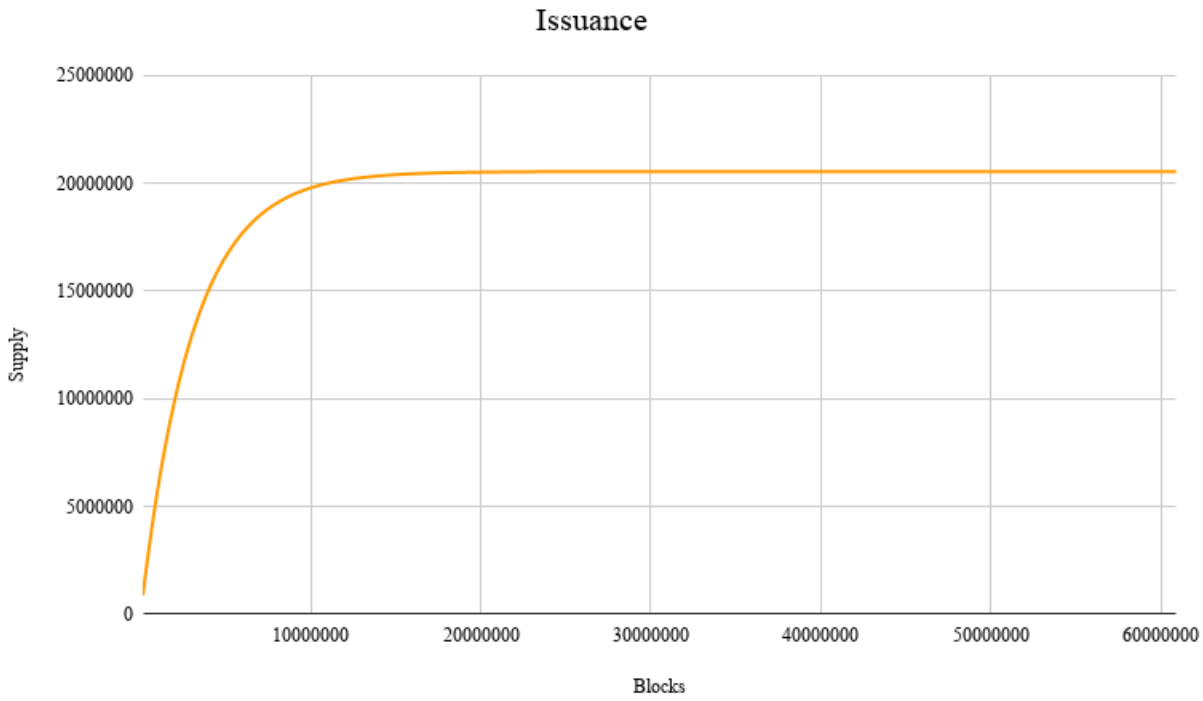
The Milton System (TMS) is an economic incentive protocol for the organism platform that aims to be fair and self sustaining. TMS can be seen as an algorithmic enforceable monetary policy that removes the need of intervention through self tuning and adaptation. TMS named after the Nobel winning economist Milton Friedman is the realization of a commodity reserve standard. We believe that unlike previous attempts at building such economic system, a core digital commodity provides a fundamentally better form than ever proposed before due to its utility and resource repurposing case.

Furthermore, due to the native smart contract (Capsule) a frictionless lending & borrowing scheme is incorporated. This enables the first time a digital commodity can separate its ownership rights from its utility rights natively. We believe this will not only decrease the cost of access to the utility, chain storage in the case of NIB, but enables the ownership right to be captured in another claim token CELL. This mechanism that is incorporated into the Capsule contract not only incentives extra liquidity for lending but also unlocks a new sybil protection mechanism that can be staked to provide alternative services to the network increasing the opportunity to collect fees.

NIB: New Internet Benzine

NIB (ꜩ) is a digital commodity.

- It has an algorithmically enforced scarcity with 21,000,000 total units.
- 1 NIB is composed of 1,000,000,000 Nibit's. A Nibit is the smallest indivisible unit.
- Each unit is equal to some amount of physical bytes on a piece of digital land.
- It places an upper-bound on the physical size of the land.
- The capacity in Nibit's accounts for the state space occupied.
- It uses the Unicode Symbol ꜩ (U+20B6) which has been available since unicode 5.2 (2009).



The distribution of NIB's will happen over a period of time. All capacity is defined in the chain header. The Genesis begins with

21,000,000,000,000,000 Nibit's in the Coinbase. From here it is issued based on the distribution policy. Furthermore, the transient nature of the state creates the possibility that coins may not be redeemed and fall off the chain. This could even be due to the loss of private keys. Unlike Bitcoin where coins are lost forever, we enable recycling into the coinbase and redistributed later on. As capacity is a precious resources it should be salvaged.

Over time Computational Energy will transform into potential energy as the pulse of NIB's. Unlike bitcoins step function based emission we choose to use a continuous function to provide a smoother mechanism that prevent large post-halving price swings that have been seen. During the issuance period the coins that are falling off the chain are given as an added reward to that blocks producer. With a 1 minute block interval we get:

$$Reward = \frac{21000000}{2102400} * \frac{0.693}{2^{\frac{height}{2102400}}}$$

As Capacity is denominated in NIB's it is always inspectable due to the transparent nature of the ledger. Privacy concerns are alleviated as even if capacity was confidential it could be inferred from the size of the data occupancy. The total supply is always verifiable and removes a long standing issue in the Bitcoin community towards a confidential Bitcoin and hidden inflation concerns. There is no need.

Scarcity may be quantified with stock to flow ration of an asset. Stock is the existing Supply. Flow is the supply growth rate. SF = 1/supply growth rate. A High stock to flow ration, makes something a good monetary instrument. Our commodity isn't designed to become a medium of exchange for day to day but it is a MoX for state space. Furthermore it is an unit of account of state space. Moreover we are concerned with it becoming a store of value that is an important characteristic. Gold has a stock to flow of 62 and silver 22. After bitcoins approximately May 2020 halving it will have a SF of 50. Bitcoins step function makes this not a gradual smooth curve but it is a step function as we mentioned before that shocks the system. We have chosen a smoother issuance curve that is also taking the stock to flow into account.

Rent Thy Land

The core utility of NIB's emerge not from owning but from storing information. Capital must be put to work. Due to the transient nature of the land over time the contents will change. However there is also another observation that emerges based upon the fixed supply of NIB's. If the demand increases for NIB it would mean that the storage cost increases as well. A solution to this that balances value preservation for a long term holder and someone who wants to store some state for some time is to enable native lending of state space. This would mean that you would earn interest and enable the state to fulfill its utility without having to give-up your ownership. The borrowing cost would then be the actual cost of utility and help keep usage cost down even though the underlying asset may increase in value with regard to a medium of exchange unit that is being used for example USD. A non collateralized lending scheme with frictionless borrowing is desired. We begin with a fixed baseline annualized interest rate, but due to the supply/demand curve is adjusted over time algorithmically. A native smart contract (Capsule) exists to pool resources, facilitate borrows & interest payments.

This method offers significantly more liquidity than direct lending; unless every available capacity in the market is borrowed (The contract incentives liquidity not only through increasing interest rate when supply is decreasing but also giving a use case for the claim token), users can withdraw their assets at any time, without waiting for a specific loan to mature.

Capsule has a floating interest rate, set by market forces, which determines the borrowing cost uniformly. The history of the interest rate is captured through the *Interest Rate Index* which is updated each time the rate changes due to a minting, redeeming, borrowing or returning of capacity.

CELL

A CELL is a special on chain claim token that the native smart contract Capsule can issue and burn. They can be transferred and Divided like NIB’s When NIB's are deposited into Capsule it mints CELL's proportionally. When CELL's are burned they redeem the initial amount of NIB's plus the interest acquired over the period. If CELL’s are purged from the chain state then the claim is redeemed into the Capsule Contract for increased Liquidity.

Another use of CELL is that it can be used as a sybil resistant mechanism. It can be staked in another part of the protocol if desired, and it has the benefit of not removing chain capacity from the ecosystem.

CELL's can also be an interesting form of capital for use as collateral. As it is a claim on a non-collateralized asset and has a variable interest attached, it offers this interesting property. The only caveat being that the redemption liquidity of the CELL to NIB exchange can fluctuate. Nonetheless at some point all claims is guaranteed to be redeemed and interest is accumulated in the meanwhile.

Borrowed NIB (BNIB)

When one desires to borrow some NIB from the Capsule it does so by opening a borrow claim with the desired capacity. Once some NIB is added into a Deposit Token to cover interest it become the borrowers responsibility to make sure that there is enough NIB's covering the interest payments. If there is not enough balance then there is an automatic default of the capacity and it is purged from the chain and added back into the Capsule. The Capsule tracks the amount of outstanding borrows, manages the interest deduction from deposit accounts and recouped the lent capacity from defaults. It should be noted that any coins left within the deposit token is forfeited and belongs to the Capsule for added liquidity. However to incentives the network to perform and enforce this the capsule splits this in half with the miner who has liquidated a default. However if a borrower returns the capacity and all outstanding interest is paid then they are returned the remains of the deposit token. If for example the interest cost has risen beyond a point that is economical for that state the borrower might deem it necessary to return back the capacity.

The Consensus rules dictate that certain information be tracked and updated after each block. Certain Parameters are constant and are part of the active chain policy

Active Chain Policy	Description
Base Interest Rate	The baseline annual interest rate paid for borrowing.
Curve Slope	This factor determines how quickly the interest rate should rise based on Supply/Demand. It allows to determine how reactive the rate should be to the conditions.
Bits per Nibit	The conversion amount given between a Nibbit and Bits. This sets the physical Limits of the chain and
Initial Block Reward (Post Genesis Period)	The Initial Reward For a block in the Eternity Era
Block Reward Reducer	The Block Reward is multiplied by this factor every reward cycle to reduce it by a chosen factor.
Block Reward Adjustment Period	The Block Count between Reward Deductions
Genesis Target Block Interval	The Wall Clock Mining Rate in seconds for Genesis Period
Eternal Target Block Interval	The Wall Clock Mining Rate in seconds for Live Transaction System

Capacity Chain Header	Description
Coinbase	Issuable NIB
Occupied Capacity	Amount of Nibits that are being used in storage
Borrow Rate	Last Interest Rate Used
Cell Supply	CELL circulation, also equals total NIB's deposited

The interest rate model is designed to achieve an interest rate equilibrium based on supply and demand. The interest rate, price of utility, should increase as a function of demand; when demand is low, rates should be lower than when demand is high. The Utilization ratio (U) captures this relationship in one variable.

$$U = \frac{BorrowedCapacity}{FreeCapacity + BorrowedCapacity}$$

The demand curve is based on the Active Chain Policy and is expressed as a function of utilization.

$$BorrowingInterestRate = BaseInterest + U * CurveSlope$$

The constant variables *BaseInterest%* and the *CurveSlope%* are defined to achieve the interest goals desired. This makes interest earned implicit by suppliers. A base interest is desired because it places a bottom line incentive to bring supply but also setting the entry point for borrowing.

As the Capsule contract can not guarantee liquidity, it relies on the interest rate models to incentivize it. During periods of high demand as liquidity decreases the interest rate will increase which incentivizes supply but also disincentives borrowing.

The exchange rate between NIB & CELL increases overtime as interest is accrued by borrowers and can be calculated by:

$$exchangeRate = \frac{BorrowedCapacity + FreeCapacity}{CellSupply}$$

As the total borrowed capacity increases the exchange rate also increases.

The Capsule Contract has the following interface:

Function	Description
mint(DepositToken) -> CELL	Supply a deposit Token to Capsule and get your issued CELL'
burn(CELL) -> NIB	Return CELLs to be burned and redeem the NIB's given with any applicable interest back.
borrow(DepositToken) -> BNIB	Check to see if there is enough NIB's in the Deposit token to pay the next interest rate. If not return back to sender. If there is enough return back borrowed Capacity in the form of BNIB.
repayBorrow(DepositToken, amount) -> NIB	Return The borrowed Capacity and get back any remains in the Deposit Token.

Borrowed NIB's cannot be transferred directly as the DepositToken Holder holds the utilization rights. It is a covenant with the Capsule Contract. We desire that anyone who needs capacity should borrow straight from Capsule. Out of band sales of private keys can be done but it requires trust to be placed and is less desirable even for users. In the event that the keys to a Deposit Token is lost it will eventually default on Interest Payments and be taken back by the contract.

The Interest Rate Index is updated after each event in the Capsule Contract. A per block interest rate is updated.

$$Index_n = Index_{n-1} * (1 + rate * \Delta Blocks)$$

Not every block may update the state of the contract so we apply the rates over the period that was idle.

The total borrowing outstanding is updated to include interest accrued since the last index.

$$totalBorrowBalance_n = totalBorrowBalance_{n-1} * (1 + r * t)$$

Backbone

Organism takes a simple and pragmatic approach to its consensus mechanism. We believe that the economic model is the core notion that is not tied eternally to the underlying mechanism that manifests The Milton System. Technology advances and over time like a living organism it should evolve to suit the needs of the ecosystem. Evolution is beautiful and should be embraced.

Transaction Fees

Fees are a crucial component of a crypto economic system because it ultimately helps to pay for security. The fee income must offset not only the cost of validating but also provide enough incentive not to attack the chain. An offset is provided by block issuance with the current consensus mechanism tying issuance as a reward to block producers.

Fee rate is expressed in Nibits as a percentage of transaction capacity based on the free market. There is no fixed or minimum fee set at the protocol level. Over time a fee market will evolve as activity increases on the chain. This chain’s main aim is not high rate transaction processing but high value information processing and second layer solutions can make the fees much less.

TODO: Provide fee analysis.

Governance

The Active Chain Policy will begin with the following parameters.

Active Chain Policy	Value
Base Interest Rate	1%
Curve Slope	20%
Bits per Nibbit	1 bit
Initial Block Reward (Post Genesis Period)	50 NIB
Block Reward Adjustment Period	A Function of time

Based on these values we can compute the borrowing cost rate as a percentage of borrowed value depending on the utilization ratio. Please see the Appendix for some simulated calculations.

However, it should be noted that over time these may be changed if the economic fabric is not maintainable or needs tuning based on empirical evidence. This would require a chain wide upgrade as these are consensus depended values. It is ultimately up to the communities needs but it should always be considerate of the entire ecosystem.

Supporting ecosystem development is an important factor as well. One potential way that can occur is to dedicated the interest earned towards this cause. Incorporating a development tax into the protocol is one path but it changes the economics of the system. A one time cost or a fixed portion does not provide a long term solution so it doesn’t make sense to impose such a cost. However as Bitcoin has shown it is still feasible to build a community of supporters both technical and non technical.

Bits Per Nibbit	Total Space Bits	Total Space GB	Total Space TB
1	21000000000000000	2625000	2625

The total state space is bound by the active chain policy. 1 Nibit is equal to one bit. Over time as storage capacity economics change this can be doubled to 2 bits and beyond.

Hello

It is an exciting time for technology as we see the emergence of an era of infrastructure. Society is evolving and our understanding of value is not idle either. The merging of software with biological life is on the brink and the digital revolution is paving its own enlightenment with new forms of capital. Value capture is changing due to new capabilities we have access to. Transparent and transient nature of time is not changing however. The importance of physical resources and value is neither disappearing. The importance of hard assets is becoming clearer each day. However a complementary and evolutionary ecosystem of economics defined in software has already arrived.

Bitcoin composes a ledger of transactions that charges a one time fee for storage in its immutable record with the expectation of eternal storage with a one time fee. It has a fixed supply that is enforced in its governing rules. Borrowing the core notions we believe we present an evolution to pure digital long term value preservation through enhanced economic sustainability accompanied with greater utility. The value of satoshi are merely engraved in the latest set of outputs while we believe the engraved data should be absence to its content but rather provide a shell with immutable resilience.

Compared to other systems that have come before, exploration and experimentation in new models should be encouraged. We hope the design approach we have taken will inspire others to seek novel compositions of economic tools to create sustainable digital assets which are a new vertical of value declaration within society and enable new forms of capital. We believe the algorithmic economic enforcement presented here is an interesting experiment to give life to the digital *Organism*.

References

- Robert Leshner and Geoffrey Hayes. Compound: The Money Market Protocol. Feb. 2019. url: https://compound.finance/documents/Compound. Whitepaper.pdf.
- Modeling Bitcoin Value with Scarcity by PlanB
- Nakamoto, S. (2008), 'Bitcoin: A peer-to-peer electronic cash system'.
- **TODO: ADD ALL REFERENCES**

Appendix

Interest Rate examples with genesis ActiveChainPolicy

Utilization Ratio (%)	Borrowing Cost (%)
1	1.2
5	2
10	3
15	4
25	6
35	8
50	11
60	13
75	16
100	21

Various examples, cost is annualized. Also a per NIB dollar exchange rate is used to show cost in USD.

With 10% Utilization.

NIB Borrowed	Borrowing Cost (NIB)	Capacity in MB	$10	$25	$50	$100	$500	$1000	$10000
0.001	0.00003	1	$0.0003	$0.00075	$0.0015	$0.003	$0.015	$0.03	$0.3
0.01	0.0003	10	$0.003	$0.0075	$0.015	$0.03	$0.15	$0.3	$3
0.1	0.004	100	$0.04	$0.1	$0.2	$0.4	$2	$4	$40
0.25	0.015	250	$0.15	$0.375	$0.75	$1.5	$7.5	$15	$150
0.5	0.04	500	$0.4	$1	$2	$4	$20	$40	$400
0.75	0.0825	750	$0.825	$2.0625	$4.125	$8.25	$41.25	$82.5	$825
1	0.13	1000	$1.3	$3.25	$6.5	$13	$65	$130	$1300
5	0.55	5000	$5.5	$13.75	$27.5	$55	$275	$550	$5500

With 25% Utilization.

NIB Borrowed	Borrowing Cost (NIB)	Capacity in MB	$10	$25	$50	$100	$500	$1000	$10000
0.001	0.00006	1	$0.0006	$0.0015	$0.003	$0.006	$0.03	$0.06	$0.6
0.01	0.0006	10	$0.006	$0.015	$0.03	$0.06	$0.3	$0.6	$6
0.1	0.006	100	$0.06	$0.15	$0.3	$0.6	$3	$6	$60
0.25	0.015	250	$0.15	$0.375	$0.75	$1.5	$7.5	$15	$150
0.5	0.03	500	$0.3	$0.75	$1.5	$3	$15	$30	$300
0.75	0.045	750	$0.45	$1.125	$2.25	$4.5	$22.5	$45	$450
1	0.06	1000	$0.6	$1.5	$3	$6	$30	$60	$600
5	0.3	5000	$3	$7.5	$15	$30	$150	$300	$3000

With 50% Utilization.

NIB Borrowed	Borrowing Cost (NIB)	Capacity in MB	$10	$25	$50	$100	$500	$1000	$10000
0.001	0.00011	1	$0.0011	$0.00275	$0.0055	$0.011	$0.055	$0.11	$1.1
0.01	0.0011	10	$0.011	$0.0275	$0.055	$0.11	$0.55	$1.1	$11
0.1	0.011	100	$0.11	$0.275	$0.55	$1.1	$5.5	$11	$110
0.25	0.0275	250	$0.275	$0.6875	$1.375	$2.75	$13.75	$27.5	$275
0.5	0.065	500	$0.65	$1.625	$3.25	$6.5	$32.5	$65	$650
0.75	0.0825	750	$0.825	$2.0625	$4.125	$8.25	$41.25	$82.5	$825
1	0.11	1000	$1.1	$2.75	$5.5	$11	$55	$110	$1100
5	0.3	5000	$3	$7.5	$15	$30	$150	$300	$3000

With 75% Utilization.

NIB Borrowed	Borrowing Cost (NIB)	Capacity in MB	$10	$25	$50	$100	$500	$1000	$10000
0.001	0.00016	1	$0.0016	$0.004	$0.008	$0.016	$0.08	$0.16	$1.6
0.01	0.0016	10	$0.016	$0.04	$0.08	$0.16	$0.8	$1.6	$16
0.1	0.016	100	$0.16	$0.4	$0.8	$1.6	$8	$16	$160
0.25	0.04	250	$0.4	$1	$2	$4	$20	$40	$400
0.5	0.08	500	$0.8	$2	$4	$8	$40	$80	$800
0.75	0.12	750	$1.2	$3	$6	$12	$60	$120	$1200
1	0.16	1000	$1.6	$4	$8	$16	$80	$160	$1600
5	0.8	5000	$8	$20	$40	$80	$400	$800	$8000

Based on the current market price the rent of 1GB on Google Cloud as of September 2019 is $0.24. This is expected to decrease over time. To compare at 50% utilization and a market price of $100 per NIB this would cost approximately $11. This is 45.83 times more than google. The actual borrowing cost depends on the rates that are occurred based on market conditions. But the multiple compared to Cloud Storage will be for the resilient and integrity preservation provided by the network.