Eden Network

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Abstract

Miner Extractable Value ("MEV") creates a natural tension between block producers, bots, applications, and general network users. Moreover, upcoming network level changes to Ethereum (EIP-1559, Eth 2.0) introduce significant uncertainty to block producer rewards. We propose an optional, non-consensus breaking transaction ordering protocol which allows participants to guarantee placement within blocks and protection from arbitrary reordering (e.g "frontrunning", "sandwiching"). The system offers a transparent and fair set of rules to order transactions within each block. An accompanying token reward system realizes MEV profits to block producers to maximize network security.

Introduction

In a typical blockchain network, a series of transactions which alter the global state of the network are bundled into groups ("blocks") which are then appended to the consensus chain (thus, a chain of blocks). The specific mechanism for selecting who has the right to create the block varies from network to network. In a proof-of-work system there is a competitive game to produce some computationally expensive result. In proof-of-stake, the producer of the block is probabilistically selected from a set of economically staked participants.

In both systems, the producers of blocks typically have various freedoms allowed by the network. Two common freedoms are the choice of selecting which transactions are included in the block, and the order that their state transitions take effect. Miner Extractable Value [DGK+19] refers to any benefit the block producer can realize for themselves by exercising these freedoms.

The particular type of MEV that can be realized varies from the fairly benign, e.g. taking advantage of a freely available arbitrage opportunity, to the extremely aggressive, e.g. frontrunning and sandwich attacks [ZQT+20] or malicious chain reorganizations, e.g. time bandit attacks. Ultimately, all MEV can be interpreted as a tax on network participants.

MEV Ecosystem

Under EIP-1559's base fee burn mechanism, Ethereum block producer profits may become much smaller and harder to predict. While historically block producers have realized MEV passively via transaction fees earned from bots outbidding each other for priority inclusion in the next block (so-called Priority Gas Auctions or "PGAs"), mining pools have implemented solutions to more directly extract MEV.

Services such as Flashbots, MiningDAO, and CowSwap are examples of products within the Ethereum ecosystem that either funnel MEV towards or away from block producers. In particular, as of July 21, 2021 a majority of Ethereum network hashrate has migrated to MEV-Geth, a fork of the reference go-ethereum client (a.k.a "geth") created by Flashbots. MEV-Geth allows third parties to engage in a sealed-bid auction to order mempool/privately submitted transactions with the goal of increasing the Ether balance transferred to the block producer's address, i.e. directly extracting MEV.

The four key stakeholders in the MEV ecosystem are block producers, bots, applications, and general network users. Existing approaches to MEV skew incentives in favor of some subset of these stakeholders, and as a result, there is competition among network participants around the redistribution of value extracted through on-chain ordering opportunities.

Eden Network takes a user-focused approach to the MEV problem, and includes stronger incentives for all stakeholders driven by a protocol token. It comprises a novel transaction ordering mechanism and a private relayer that any user, application, or bot can leverage in order to obtain state guarantees around submitted transactions. Honest block producers are rewarded in the protocol token for mining as per the ordering mechanism.

Eden Network

Network Objectives

The broad aims of the network are to:

1. **Protect** users from malicious MEV (frontrunning, sandwich attacks, etc.) and reduce the negative externalities MEV has on Ethereum

2. **Improve** earnings for block producers and increase consensus-level security against block reorganization

3. **Tokenize** access to MEV, and redistribute value to network stakeholders

Block Construction

The primary coordination unit among block producers, users, and bots will be the EDEN token, which is a migration of the existing ARCH token. The basic hierarchy of a transaction is as follows, and is illustrated in Figure 1:

1. Create a new class of transactions that get priority above all other transactions in Eden Network block producers' blocks

    (a) There are a set number (3^1) of "slots", each with a unique index (i.e. slot 0, slot 1, etc.) that indicates their position within blocks

        i. At any time, each slot is owned by exactly one account (the "slot tenant"), who has the right to set a "delegate address" for that slot

        ii. Transactions to (Ethereum transaction field `to`) the delegate address will be included in the slot

        iii. The delegate address may be either an EOA (a regular account) or a smart contract address

    iv. Transactions submitted directly to the Eden Network relay that revert (fail) have the option of not being included in the block, saving the sender gas fees

(b) Each slot has a maximum gas limit (**1.5M**[1])

    i. Transactions to the delegate address that do not fit in the slot due to the gas limit will be treated according to the regular transaction inclusion criteria

    ii. In the event that a slot's gas limit is not reached, the remainder of the gas space is usable by the rest of the block

(c) Users reserve these slots via a continuous auction mechanism known as a Harberger tax

    i. Slot tenants are taxed on a linear basis at some tax rate (**3.3%**[1]) per day on the initial principal of their stake. The taxed amount is burned, and the tenant loses their claim on the slot once their entire balance is depleted (**30**[1] days as per proposed tax rate)

    ii. Any user may become a slot tenant by staking a minimum of **110%**[1] the EDEN staked by the existing slot tenant at the time the existing slot tenant bid for their slot

    iii. In the event that another user outbids the current slot tenant, the original slot tenant is immediately eligible to claim any untaxed balance they have in the smart contract (or increase their stake to reclaim the slot). Being outbid is the only mechanism to recover an untaxed balance

    iv. Once a slot tenant is outbid, they simply lose the slot instead of being pushed to the following slot

2. Block producers are also allowed to accept transaction bundles. Bundles are be included after any priority queue transactions, but before transactions from regular Ethereum/Eden users. There is an overall gas limit for bundles (**4M**[1])

3. Regular users will also be able to stake EDEN in exchange for transaction ordering priority and extra transaction handling options

(a) Regular transactions (whether from the Eden network or public mempool) will be ordered first by staked EDEN balance then by ETH tip, and they will come after the priority queue transactions + transaction bundles

(b) Users must stake a minimum of **100**[1] EDEN in order to gain the benefit of special transaction handling options

    i. Transactions submitted directly to the Eden Network relay by users with at least the minimum stake will not be gossiped to other nodes to provide for enhanced privacy and attack protection

(c) In future releases of the protocol, an unbonding period will be applied to the EDEN tokens staked by any given address in this portion of the block

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[1]proposed, tunable by governance

EIP-1559 and Consensus Considerations

The ordering of transactions within a valid block is an optionality afforded to block producers under Ethereum's consensus rules. Eden Network's block production preserves the transaction fee mechanism of EIP-1559, and leaves transaction ordering to the distribution of EDEN token balances across addresses. In particular, every transaction in an Eden Network block *must* pay the Ethereum base fee, denominated in ETH, and the inclusion of such transactions participate in EIP-1559's block size and base fee recalculations. As such, Eden Network blocks are a strict subset of the set of valid, potential Ethereum blocks that are acceptable under the consensus rules for a specific block height.

The Eden Network also incentivizes block producers to not engage in network-antagonistic behavior such as time-bandit attacks or attempts to artificially reduce the base fee. Producers that engage in such behavior jeopardize all future revenue from the Eden Network, and thus greatly raises the opportunity cost of antagonistic actions.

Protocol Incentives

Block producers on the network who include transactions according to the protocol design will receive rewards at the rate of 60% issuance in monthly supply at steady state.

1. In the first month of launch, block producers receive increased rewards according to the amount noted in Appendix B

2. If a block producer does not order transactions submitted by EDEN holders in the order of their staked balances, or does not place slot transactions in their appropriate slot, the block producer will not receive their share of EDEN rewards

    (a) If an Eden block producer continuously violates the ordering rules of the protocol, they may be voted out of the network or have future rewards slashed

Block Producer Reward Procedure

For a given block producer that participated in Eden Network honestly over the course of an epoch, that block producer is "owed" some EDEN reward according to the emission schedule in proportion to their contribution to all produced Eden blocks. The exact calculation of owed balances is performed in a decentralized manner by a subgraph on The Graph.

To remit payments, an admin address generates a Merkle tree of these balances and posts the root of the tree to a distributor contract. Each new distribution mints a non-transferable ERC-721 NFT owned by the distributor contract whose metadata is an IPFS URI to the full set of Merkle proofs. Any block producer (or their delegated claimer account) can present the Merkle proof for their address to the distributor to claim their rewards.

The initial epoch length will be one day.

Eden DAO

Block Producers that participate in the Eden network are the core members of Eden DAO. The aim of this DAO is to ensure that block producers submit blocks in accordance with the Eden Network implementation of geth, and do not censor, reorganize, or insert transactions in a given block.
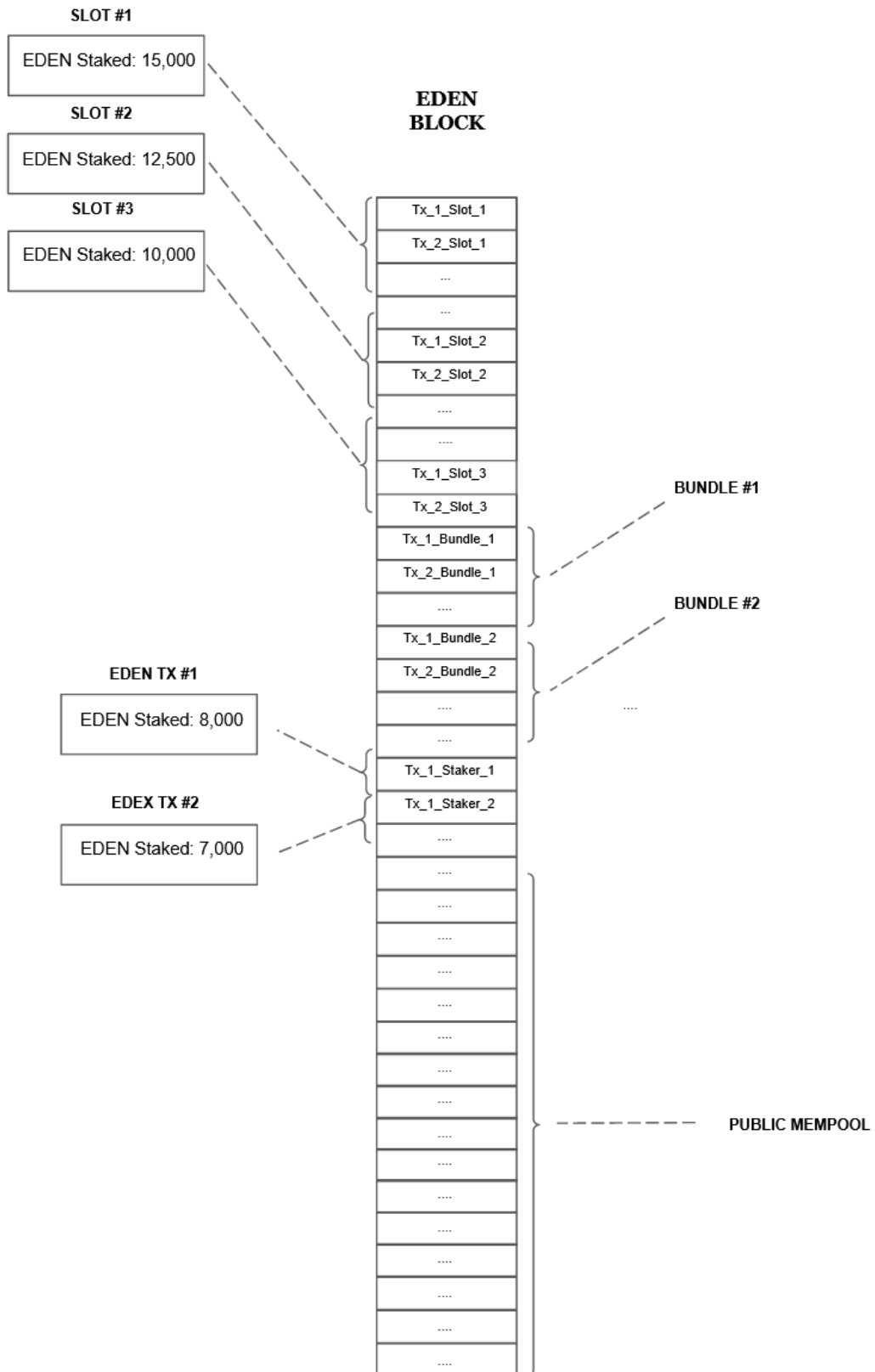
Figure 1: Block construction in Eden

Eden takes an optimistic approach towards the problem of block producer deviation. The network will vote to include or exclude block producers from the network, where inclusion is defined as being included in the whitelist of Eden block producers eligible for mining rewards, and exclusion is defined as removal from the whitelist.

Any block producer is eligible to join the Eden Network, and become a voting member of Eden DAO by procuring EDEN tokens. Over time, the block producer onboarding process will decentralize via DAO governance.

EDEN Token

Overall Distribution

The total supply of EDEN is set to a maximum of 250,000,000 tokens[2]. The inflation parameter is given by the following curve

$$\text{Monthly Inflation} = \max\left\{\left(5.595 \times 10^6\right) - \left(1.5 \times 10^6\right) \times \left(\log_{10} M^{1.797}\right), 0\right\}$$

Since the Harberger tax implementation creates perpetual deflationary pressure on the circulating supply of EDEN, and the network mints new tokens at an exponentially decreasing rate, we can counteract the implied scarcity through a net emissions mechanism. In a future release of the protocol, the network will mint additional tokens equal to the minimum tokens burnt in a given day or 66,000 tokens as part of a net issuance mechanism.

Monthly inflation is distributed as follows:

1. Block producers: 60%

2. Liquidity Providers: 30%

3. EDEN Treasury: 10%

Initial Distribution

In order to incentivize block producer onboarding in the initial phases of the network, 10,000,000 EDEN tokens will be dispensed by the EdenDAO treasury in the first month. The amount is segmented as follows:

1. 8,100,000 EDEN tokens distributed via daily emissions to validators and liquidity providers

    (a) 5,400,000 tokens allocated for validators

    (b) 2,700,000 tokens allocated for liquidity providers

2. 1,000,000 EDEN tokens airdropped to key bots, validators, and users

3. 900,000 tokens are returned to the treasury as per emission schedule

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[2]The full issuance schedule is outlined in Appendix A

Conclusion

Eden Network's transaction ordering protocol for Ethereum allows free markets to dictate ownership of blockspace over a continuous time period. The network uses a private relayer to allow users, applications, and bots to guarantee placement and protection from arbitrary reordering of transactions. The coordination unit of the network, EDEN token, doubles as a tokenization of future blockspace demand. This effectively providers synthetic exposure to MEV that any network participant can get access to. The mechanisms core to the network are designed to serve the long term interests of applications, users and block producers, and increase the utility of the Ethereum network as a whole.

References

[DGK+19] Philip Daian, Steven Goldfeder, Tyler Kell, Yunqi Li, Xueyuan Zhao, Iddo Bentov, Lorenz Breidenbach and Ari Juels. Flash Boys 2.0: Frontrunning, Transaction Reordering, and Consensus Instability in Decentralized Exchanges. *arXiv:1904.05234 [cs.CR]*, April 2019.

[ZQT+20] Liyi Zhou, Kaihua Qin, Christof Ferreira Torres, Duc V Le and Arthur Gervais. High-Frequency Trading on Decentralized On-Chain Exchanges *arXiv:2009.14021 [cs.CR]*, September 2020.

A Supply Schedule (48 Months)

Month	Supply	Inflation Amount
0	100,000,000	
1	120,000,000	20,000,000
2	124,783,574	4,783,574
3	129,092,493	4,308,920
4	133,064,641	3,972,147
5	136,775,567	3,710,926
6	140,273,060	3,497,493
7	143,590,098	3,317,038
8	146,750,819	3,160,721
9	149,773,659	3,022,839
10	152,673,159	2,899,500
11	155,461,085	2,787,926
12	158,147,152	2,686,067
13	160,739,517	2,592,366
14	163,245,129	2,505,612
15	165,669,975	2,424,846
16	168,019,270	2,349,295
17	170,297,595	2,278,325
18	172,509,008	2,211,413
19	174,657,127	2,148,120
20	176,745,201	2,088,074

21	178,776,159	2,030,958
22	180,752,659	1,976,500
23	182,677,121	1,924,463
24	184,551,762	1,874,641
25	186,378,615	1,826,853
26	188,159,554	1,780,939
27	189,896,313	1,736,759
28	191,590,498	1,694,186
29	193,243,605	1,653,106
30	194,857,024	1,613,420
31	196,432,059	1,575,035
32	197,969,927	1,537,868
33	199,471,773	1,501,846
34	200,938,671	1,466,899
35	202,371,636	1,432,965
36	203,771,623	1,399,987
37	205,139,535	1,367,912
38	206,476,228	1,336,693
39	207,782,513	1,306,285
40	209,059,161	1,276,647
41	210,306,902	1,247,741
42	211,526,433	1,219,532
43	212,718,419	1,191,986
44	213,883,492	1,165,073
45	215,022,258	1,138,766
46	216,135,294	1,113,036
47	217,223,155	1,087,860
48	218,286,369	1,063,214

B First Month Issuance (Cumulative)

Day	Total	Block Producer	LP Incentives	Treasury	Airdrop
0					1,000,000
1	3,000,000	1,200,000	325,714	1,132,000	1,000,000
2	5,564,103	2,738,462	651,429	1,252,000	1,000,000
3	7,360,510	3,816,306	977,143	1,334,500	1,000,000
4	8,742,998	4,645,799	1,302,857	1,397,357	1,000,000
5	9,866,594	5,319,956	1,628,571	1,448,126	1,000,000
6	10,812,966	5,887,780	1,954,286	1,490,707	1,000,000
7	11,630,405	6,378,243	2,280,000	1,527,374	1,000,000
8	12,349,829	6,809,897	2,524,286	1,559,569	1,000,000
9	12,992,227	7,195,336	2,768,571	1,588,264	1,000,000
10	13,572,498	7,543,499	3,012,857	1,614,147	1,000,000
11	14,101,599	7,860,959	3,257,143	1,637,718	1,000,000

Table 2 continued from previous page

12	14,587,822	8,152,693	3,501,429	1,659,358	1,000,000
13	15,037,598	8,422,559	3,745,714	1,679,358	1,000,000
14	15,456,008	8,673,605	3,990,000	1,697,949	1,000,000
15	15,847,142	8,908,285	4,152,857	1,715,318	1,000,000
16	16,214,339	9,128,603	4,315,714	1,731,614	1,000,000
17	16,560,360	9,336,216	4,478,571	1,746,963	1,000,000
18	16,887,513	9,532,508	4,641,429	1,761,468	1,000,000
19	17,197,751	9,718,651	4,804,286	1,775,218	1,000,000
20	17,492,737	9,895,642	4,967,143	1,788,287	1,000,000
21	17,773,899	10,064,339	5,130,000	1,800,740	1,000,000
22	18,042,475	10,225,485	5,187,000	1,812,632	1,000,000
23	18,299,545	10,379,727	5,244,000	1,824,012	1,000,000
24	18,546,052	10,527,631	5,301,000	1,834,921	1,000,000
25	18,782,832	10,669,699	5,358,000	1,845,397	1,000,000
26	19,010,623	10,806,374	5,415,000	1,855,473	1,000,000
27	19,230,081	10,938,049	5,472,000	1,865,179	1,000,000
28	19,441,796	11,065,078	5,529,000	1,874,541	1,000,000
29	19,646,295	11,187,777	5,586,000	1,883,582	1,000,000
30	19,844,054	11,306,432	5,643,000	1,892,324	1,000,000
31	20,000,000	11,400,000	5,700,000	1,900,000	1,000,000