Understanding L2: Sequencers, Ordering, & Execution

Overview

- What are and why are L2 Sequencers?
- What’s The Current State of Things?
- How can State of Things Improve?
- Ordering vs Execution on L2 vs. L1; same challenges or nah?

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What we want from L2s

Trustless / L1-Level Security

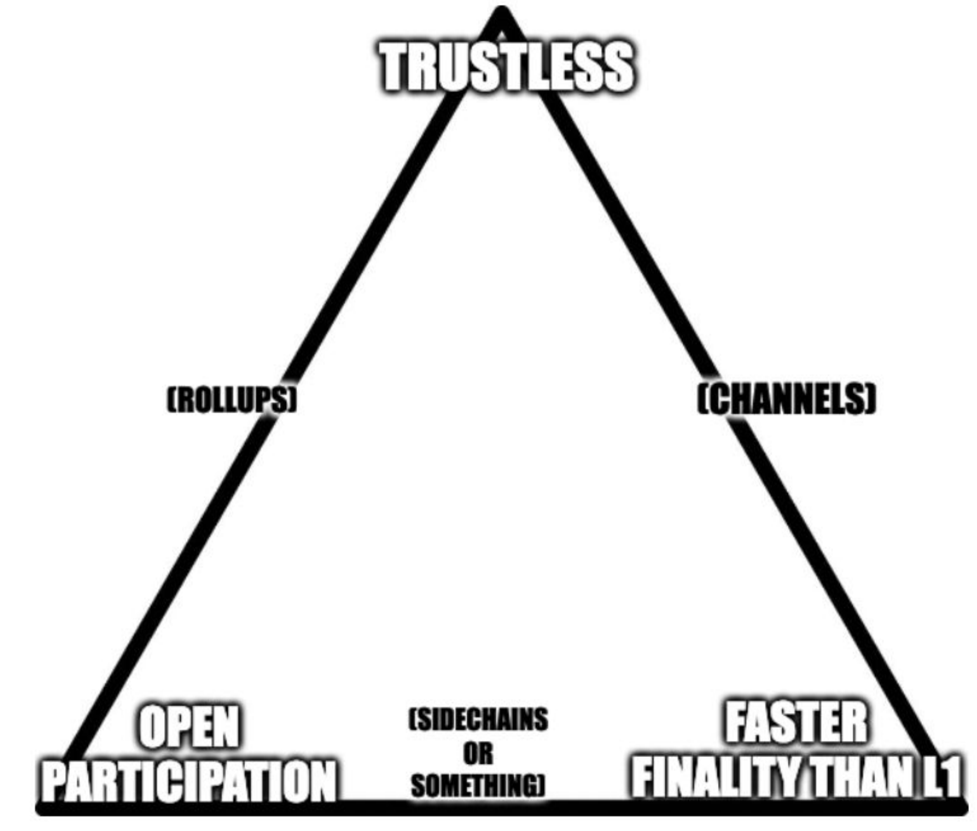
Cheap

Fast

What Rollups Give us

- L2s mostly = Rollups
  - Nice UX; familiar to L1 users
- Rollups key trick is publishing data on L1
- Trustless ✅ Cheap ✅
- Fast?... you can’t go faster than L1 if you’re…publishing data on L1

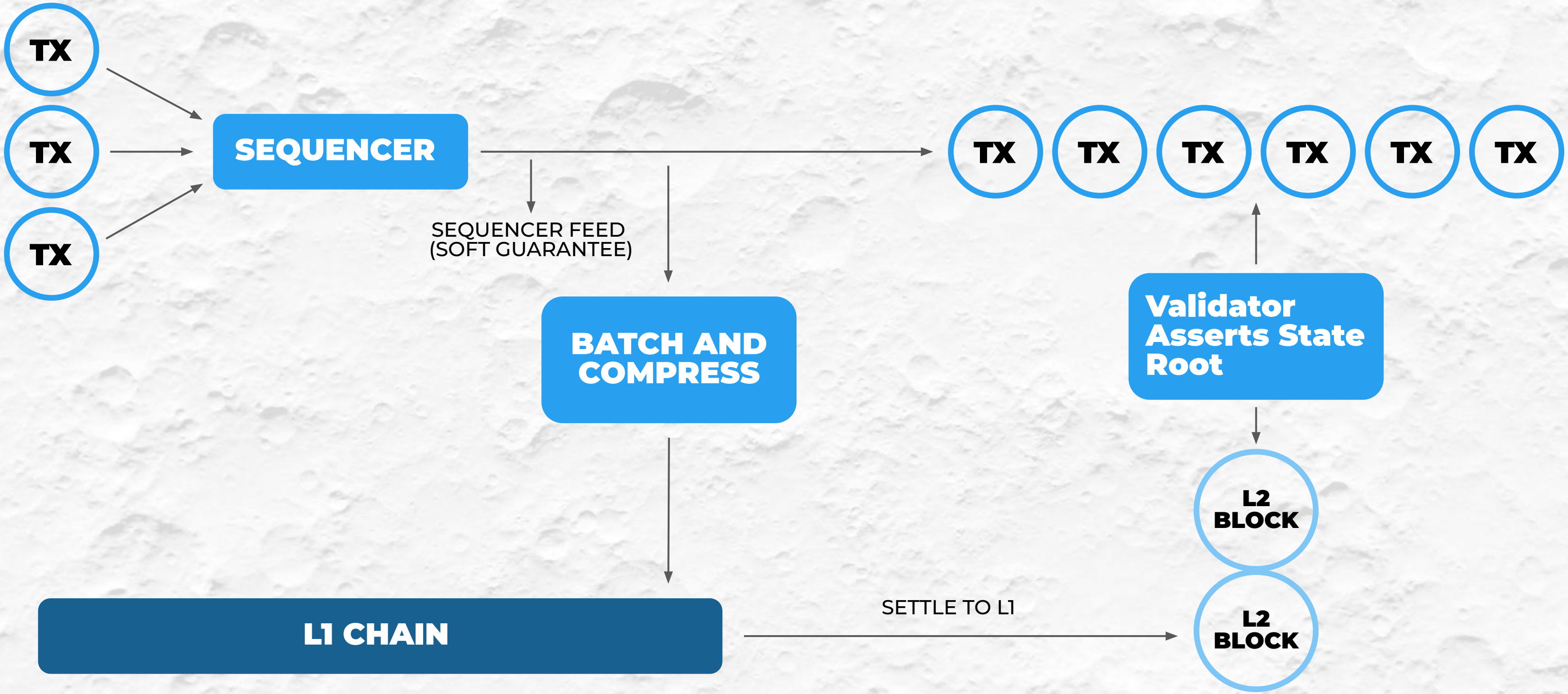
DZack Trilemma— Pick 2:



Naive Trusted Solution Vs. Sequencer

- User picks “some random dude” to trust give us fast txs
- Random dude can’t guarantee ordering even if he’s honest
- Instead we enshrine The Sequencer: Sequencer is the only party that post transactions into L2 “directly” (i.e., without a delay)

Sequencers: 3 Phases of Ordering and Execution



“Optional” Sequencer Trust

- “Optional” how?
  - Happy case: wait a bit longer for trustless finality
  - Unphappy case: alternative, fallback “slow inbox” path that circumvents the sequencer entirely

…yeah okay but what even is “the Sequencer?”

- It’s whatever entity we grant short term posting rights to / trust for fast txns
- In principle, it could use whatever mechanism we want (tho can’t interact with L1, so can’t be “truly” trustless/decentralized)
- Currently…

Currently: Sequencers Are Centralized …This is fine?

Not as bad as you (might) think!

- Limited power, i.e.,
  - Can’t rug the system
  - Can’t lock up user’s funds
- L2s currently have more centralized training wheels (Arbitrum docs, L2Beat)

Centralized Sequencers: …but it's not ideal

Risks:

- Honest sequencer
  - Downtime => worse liveness
    - ZKP generation overhead (for ZKRs)
- Malicious Sequencer
  - Equivocation
  - (Temporary) censorship
  - MEV!!!!

Ahhhhh MEV

- Side effect of fast txs: Sequencer (by default) has full ordering power
- Philosophical debate — Feature? bug? Somewhere in between?
- Designs for handling MEV at L2 either seek to minimize it or capture it in better ways

Cryptoeconomic Penalties

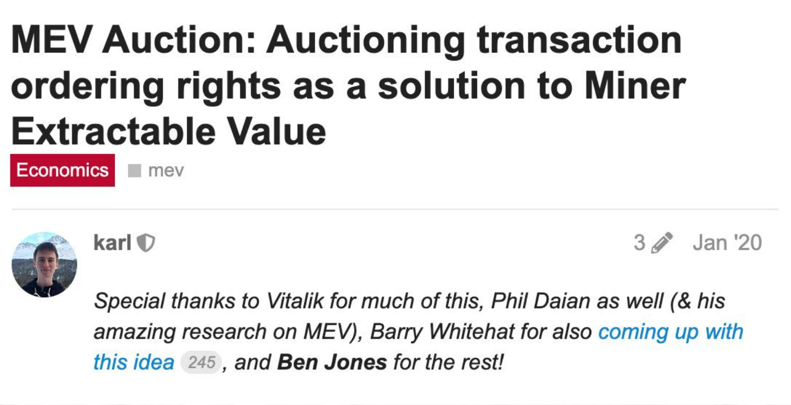
- Sequencer posts bond; equivocate and bond is slashed
- Helps mitigate equivocation (only)
- Can only punish, not rectify
- Implementation details get a bit messy r.e. L1 reorgs, but doable in principle

Threshold Encryption

- Mitigates Sequencer MEV power (only)
- Keypers: Distributed Key Generation (DKG)
  - Encrypt input data, send to Sequencer, decrypt only after Sequencer commits to ordering
- Potential increased latency / delay attacks
  - "Keypers" need to generate new keys for each round, communicate overhead with clients
  - Keypers semi-trusted (not to withhold key data etc.)
- (See Shutter network)

MEV Auctions

- Periodically auctions off sequencing rights over some fture interval of time to highest biddder
- Incentive to be sequencer = MEV extraction
- Auctions are infrequent; bidding on predicted "future MEV"



MEV Auction: Auctioning transaction ordering rights as a solution to Miner Extractable Value

Economics mev

karl 3 Jan '20

*Special thanks to Vitalik for much of this, Phil Daian as well (& his amazing research on MEV), Barry Whitehat for also coming up with this idea 245, and **Ben Jones** for the rest!*

https://ethresear.ch/t/mev-auction-auctioning-transaction-ordering-rights-as-a-solution-to-miner-extractable-value/6788

MEV Auctions (cont.)

Potential Downsides

- Latency vs MEV power
- Temporary centralization (Liveness risk / griefing attack)
- Expect practical centralization in practice
- “Ideological” MEV questions: *should* it be captured by the underlying protocol?

Fair Ordering

- Distributed, sequencer committee
- Ordering part is enforced within consensus
- Strict improvement over status quo
- No single-point-of-liveness failure
- Low latency

Potential Downsides

- Honest threshold assumption
- Benefits sophisticated network actors…

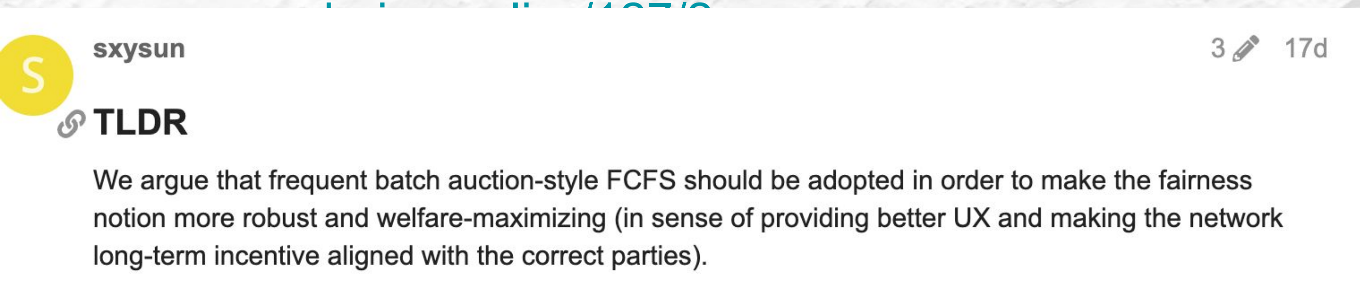
…ordering how? (fair ordering cont.)

- “Fair ordering” still leaves open the question of ordering algo
- Simple FIFO incentivizes actors to optimize on the network level, non-ideal
- Can we do better?

Hybrid Ordering Policy: FBA FCFS:

(fair ordering cont.)

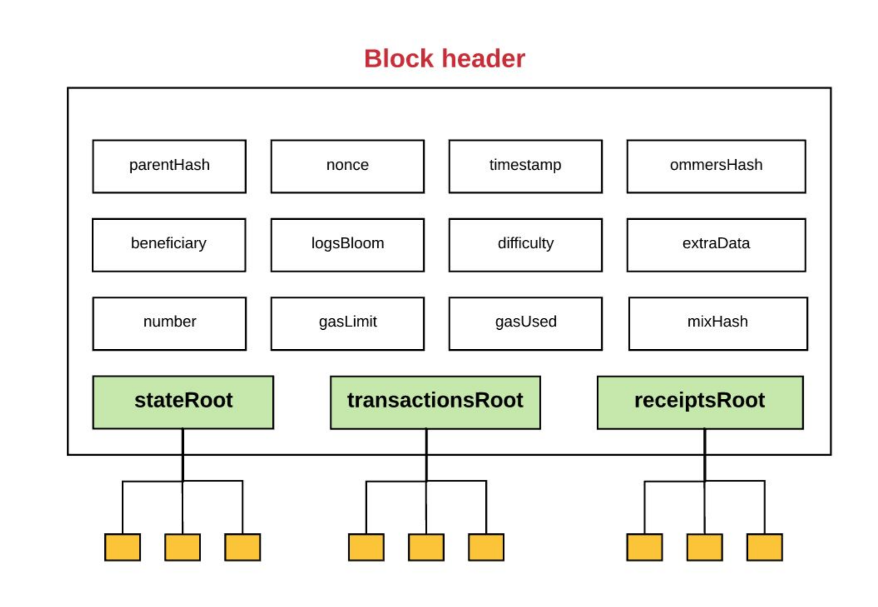
- Separate inputs into discrete time intervals (“fairness granularity”)
- Fair ordering / FIFO of intervals, priority fee within intervals
- Active area of research and inquiry!
  - https://research.arbitrum.io/t/hybrid-transaction-ordering-policy/155/1
  - https://research.arbitrum.io/t/transactio



TLDR

We argue that frequent batch auction-style FCFS should be adopted in order to make the fairness notion more robust and welfare-maximizing (in sense of providing better UX and making the network long-term incentive aligned with the correct parties).

L1 Status Quo: Ordering 🤝 Execution



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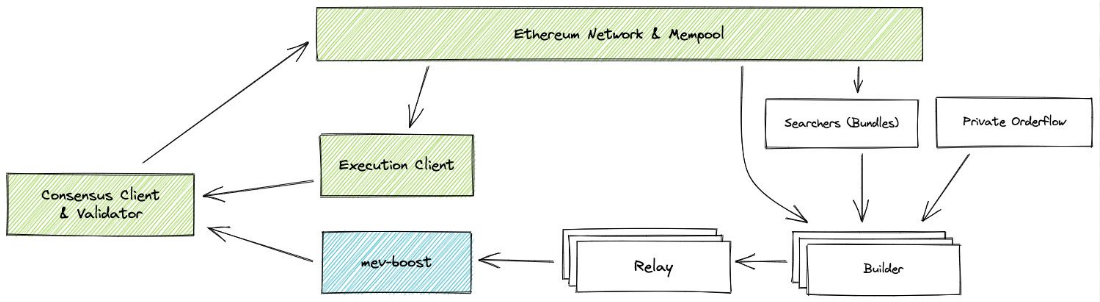
Separating Ordering & Execution on L1

- Different motivation than in L2 world; not interested in faster finality
- Separating transaction ordering => democratizing MEV
- Less economy of scale / pull towards staker centralization

Network Level Ordering / Execution Separation

- MEV-boost!
- De facto separation of tx ordering (builders) and block proposers
- Per-block MEV auctions (sort of)
- Separation of concerns = good for decentralization
- *Not* logically enshrined in consensus (..yet?)



In-protocol Ordering/Execution Separation PBS

- Proposer builder separation!
- MEV boost - style, but consensus protects builders/proposers from each other via fancy fork choice rule
- Open research questions remain

More In-protocol Ideas For L1

- Censorship resistant backup path for centralized block builder?
- Threshold commit/reveal for L1?
- …Fair ordering?
- …ZK proofs in L1 consensus?

Fin:

- Sequencers give us fast transactions = cool
- Centralized sequencers not terrible but not ideal, trust-minimizing sequencers = cooler
- L1 r&d 🤝 L2 r&d

Thank you!

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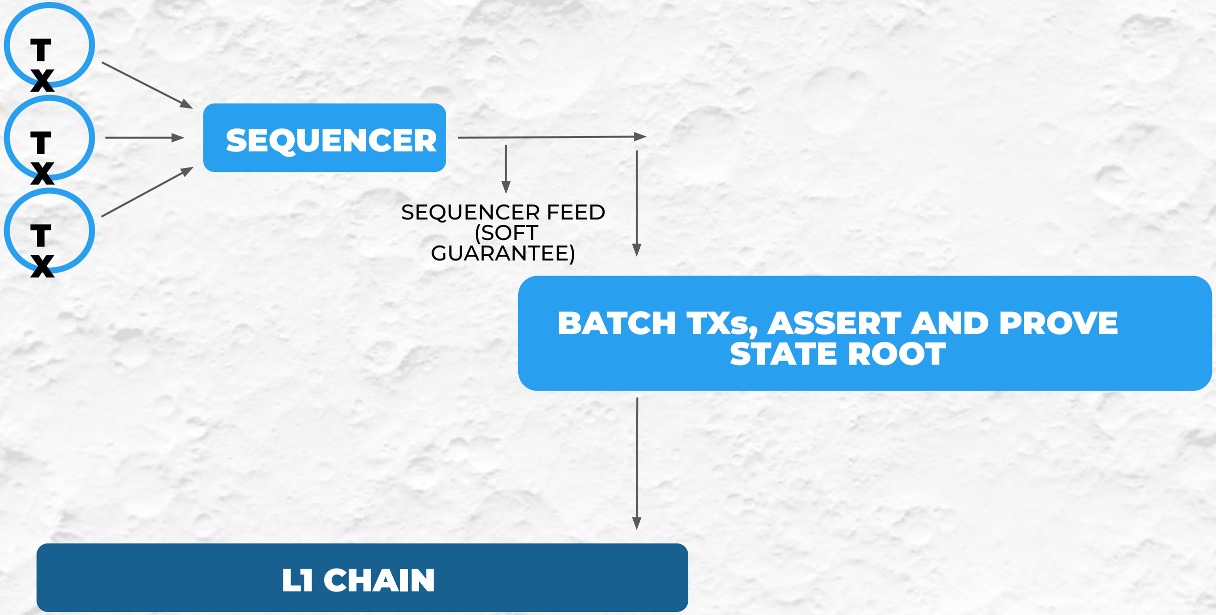
orphaned slides:

Alt: Zk-Rollups (usually): Two phases



TX
TX
TX
SEQUENCER
SEQUENCER FEED (SOFT GUARANTEE)
BATCH TXs, ASSERT AND PROVE STATE ROOT
L1 CHAIN

POS Sequencer (remove?)

- Decentralized, but doesn’t

Techniques not mutually exclusive

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