Simulation analysis

2025-08-08
leios-2025w32

Experiments

Draft scenarios for CIP

https://github.com/input-output-hk/ouroboros-leios/blob/main/analysis/sims/2025w32/analysis.ipynb

- Linear Leios
- Conservative allocation of resources
  - 4 vCPU/node
  - 10 Mb/s bandwidth
- 7 slot/stage, each for L_{vote} and L_{diff}
- Maximum of 12 MB of transaction references per EB
- 1500 B/Tx
- Normal frequency of Plutus

Spatial efficiency

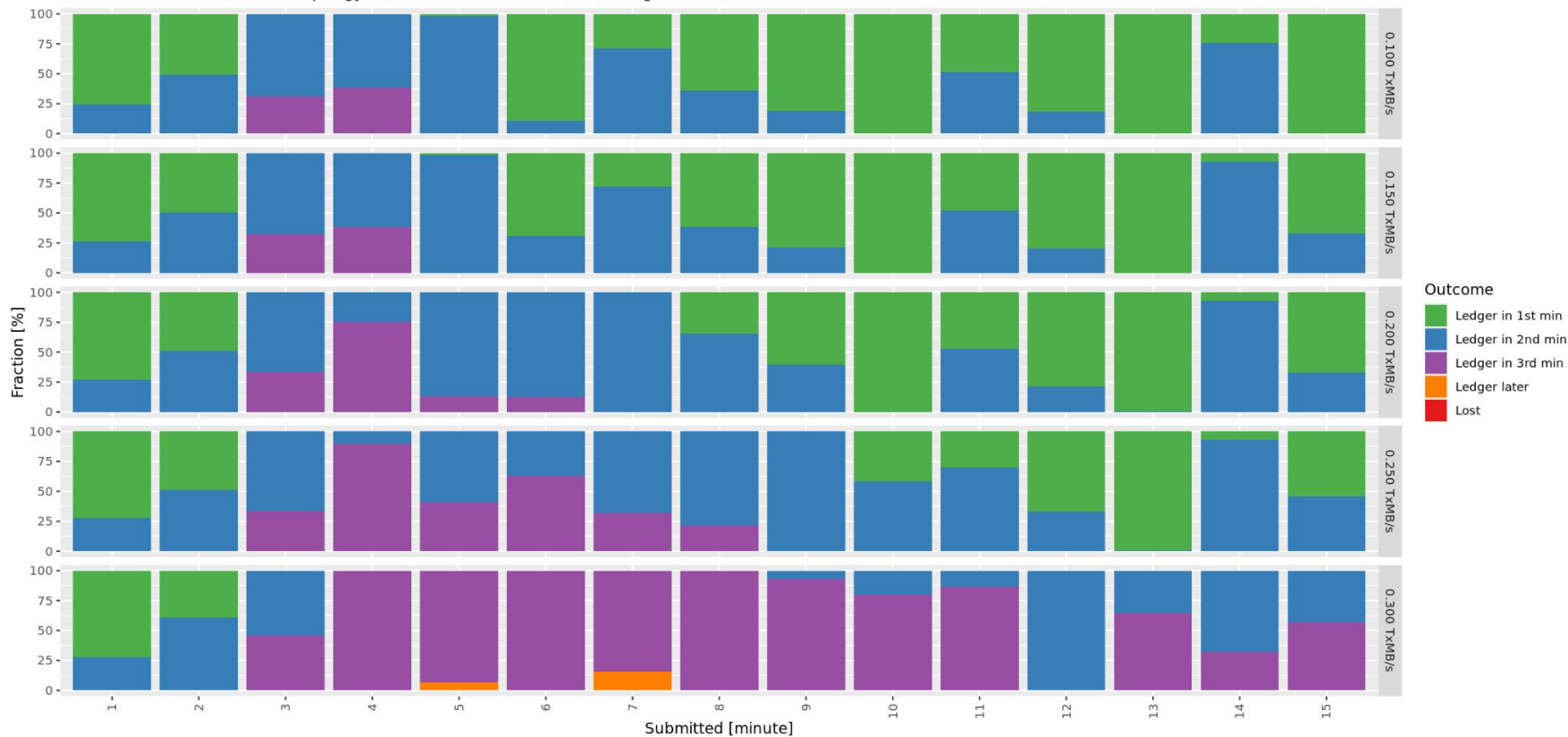Spatial efficiency (size of txs on ledger / size of non-tx persisted data)
Rust, linear-with-tx-references, topology-v2, 4 vCPU/node, 10 Mb/s, 7 slot/stage, 12 MB/EB, 1500 B/Tx
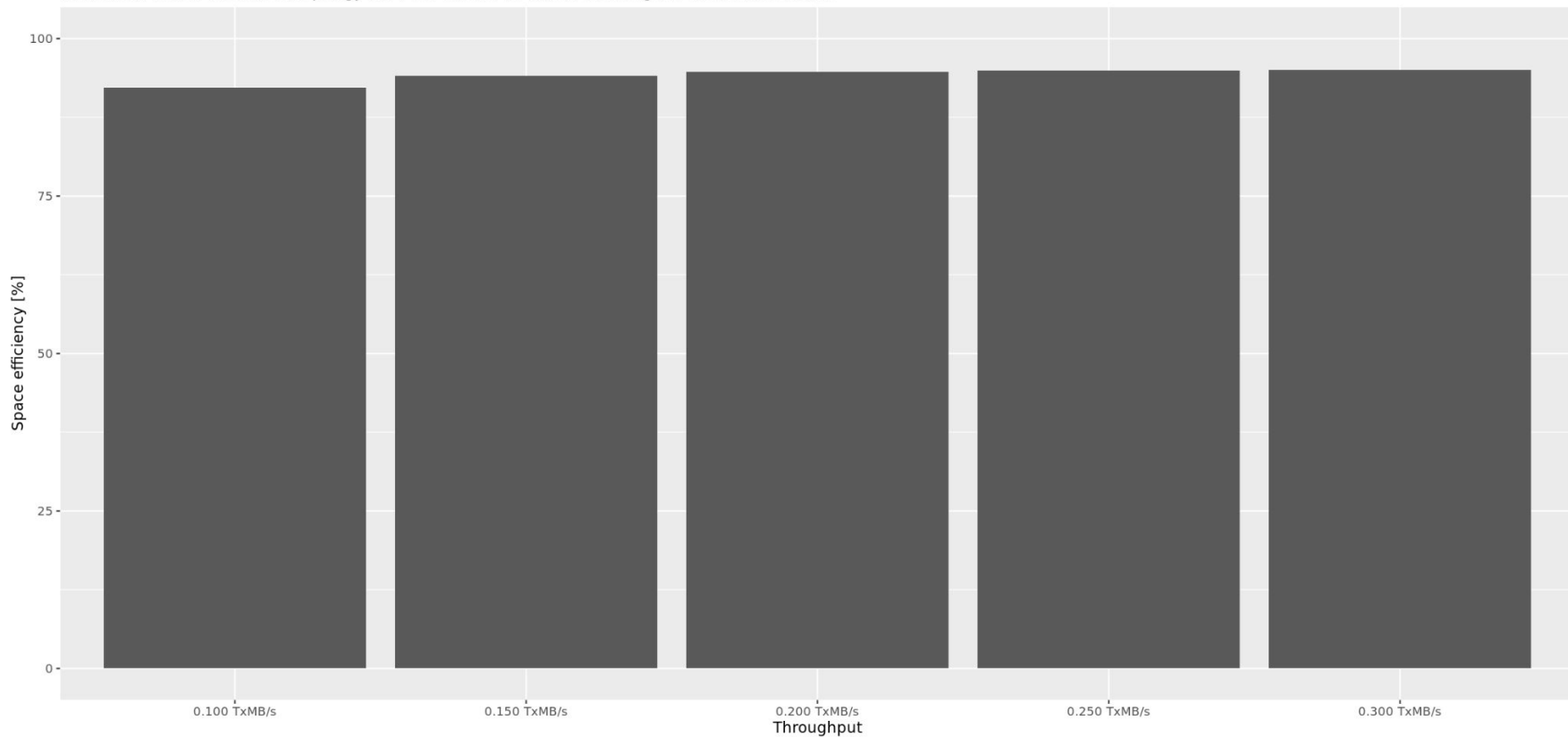
Temporal efficiency

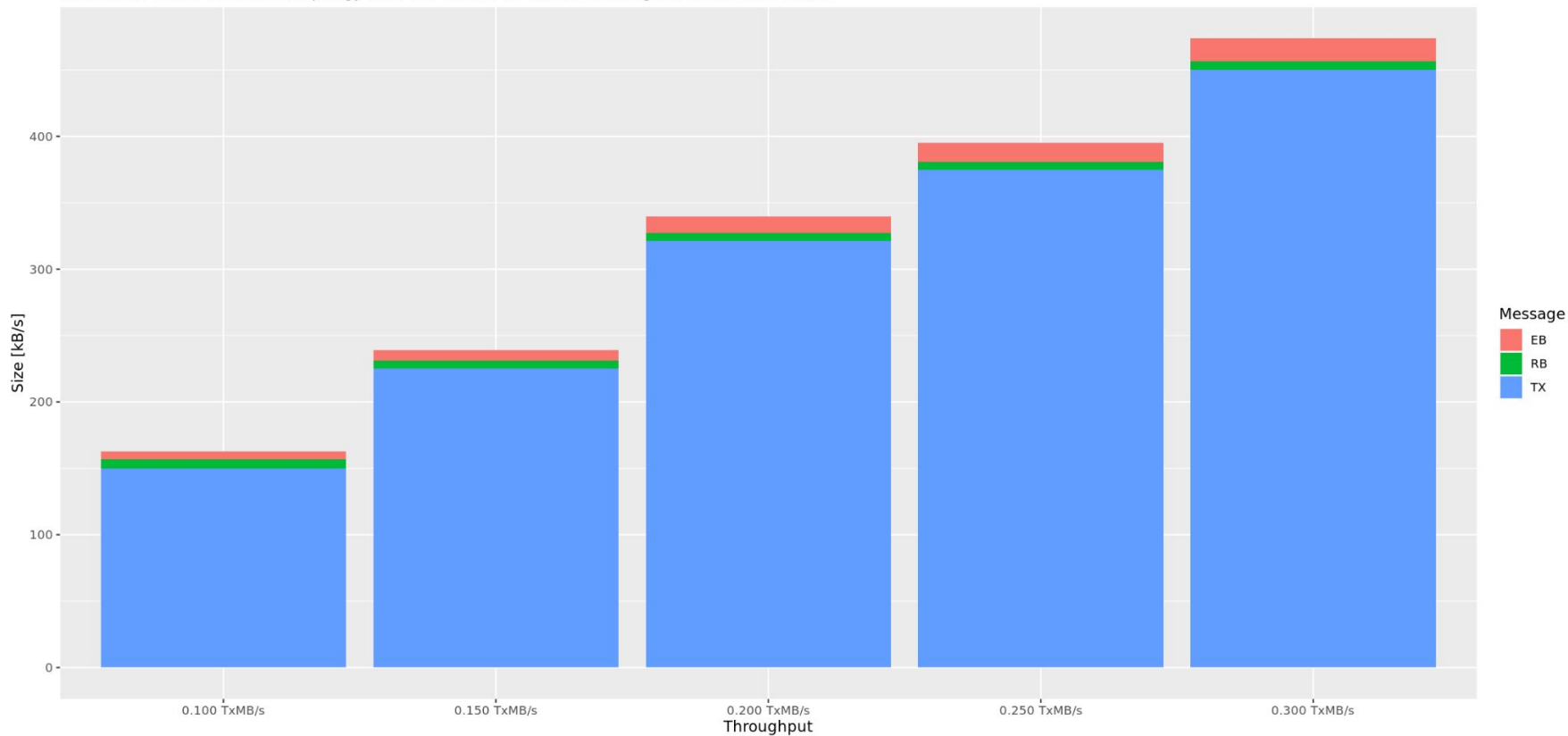Transactions reaching the ledger

Rust, linear-with-tx-references, topology-v2, 4 vCPU/node, 10 Mb/s, 7 slot/stage, 12 MB/EB, 1500 B/Tx

Data volume
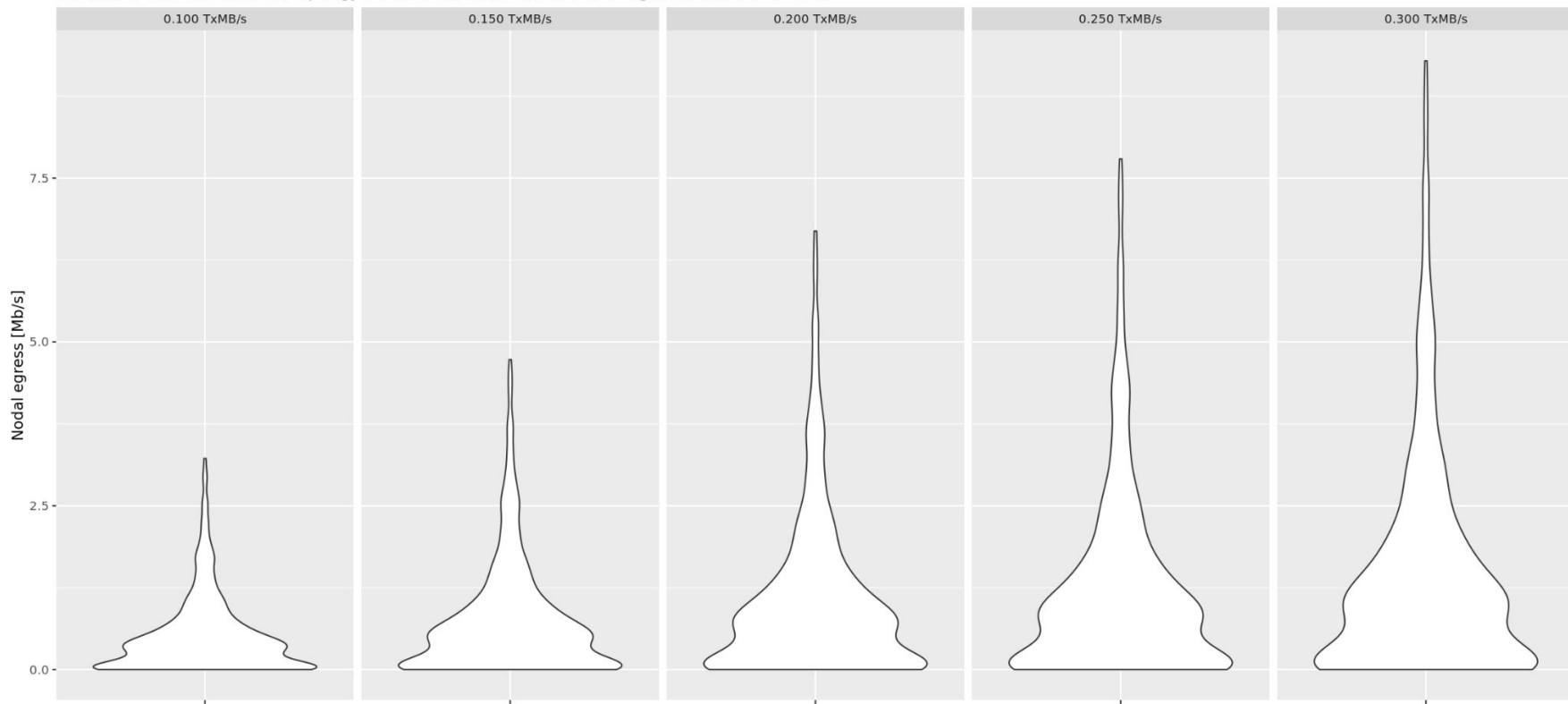

Size of diffused data

Rust, linear-with-tx-references, topology-v2, 4 vCPU/node, 10 Mb/s, 7 slot/stage, 12 MB/EB, 1500 B/Tx
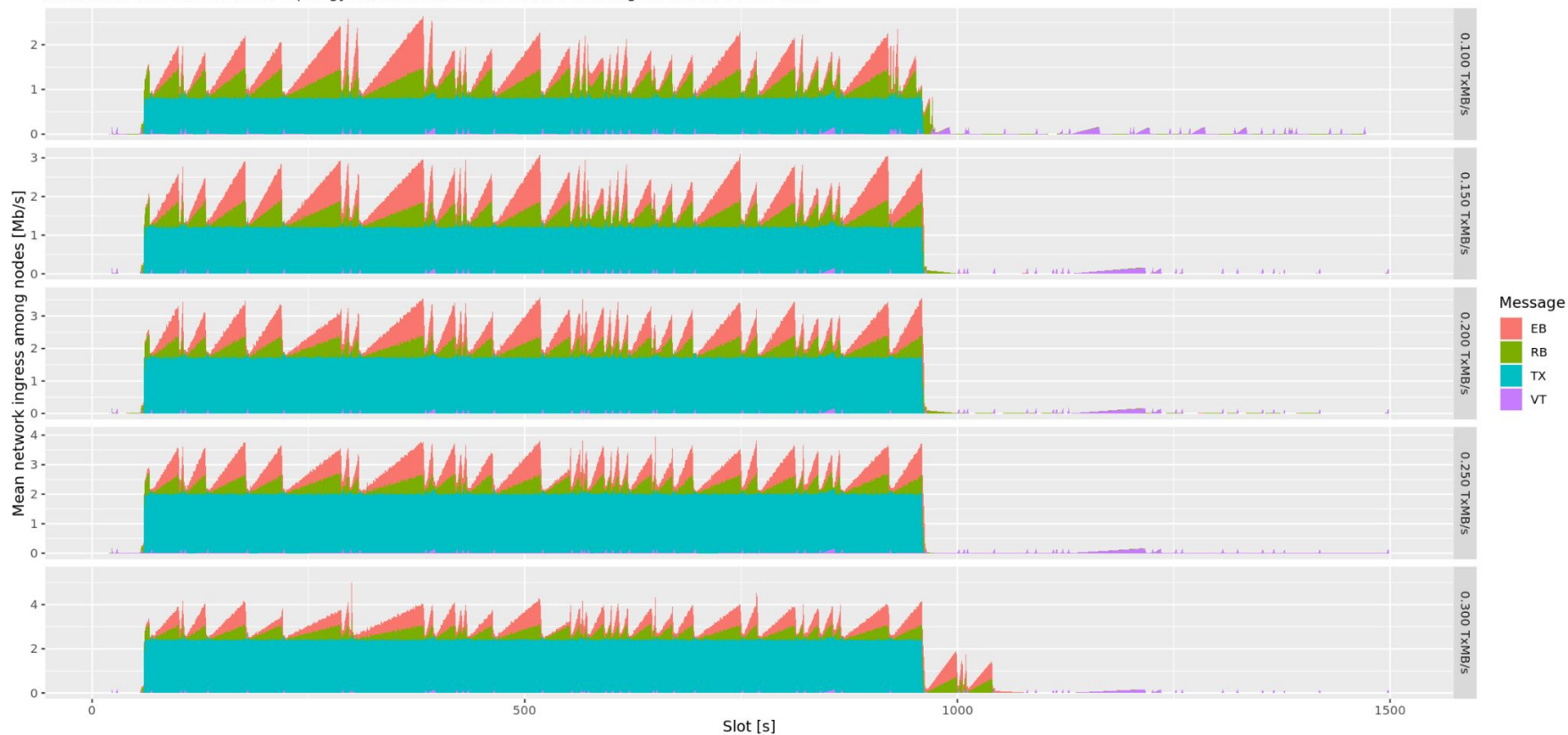
Network

Network

Rust, linear-with-tx-references, topology-v2, 4 vCPU/node, 10 Mb/s, 7 slot/stage, 12 MB/EB, 1500 B/Tx
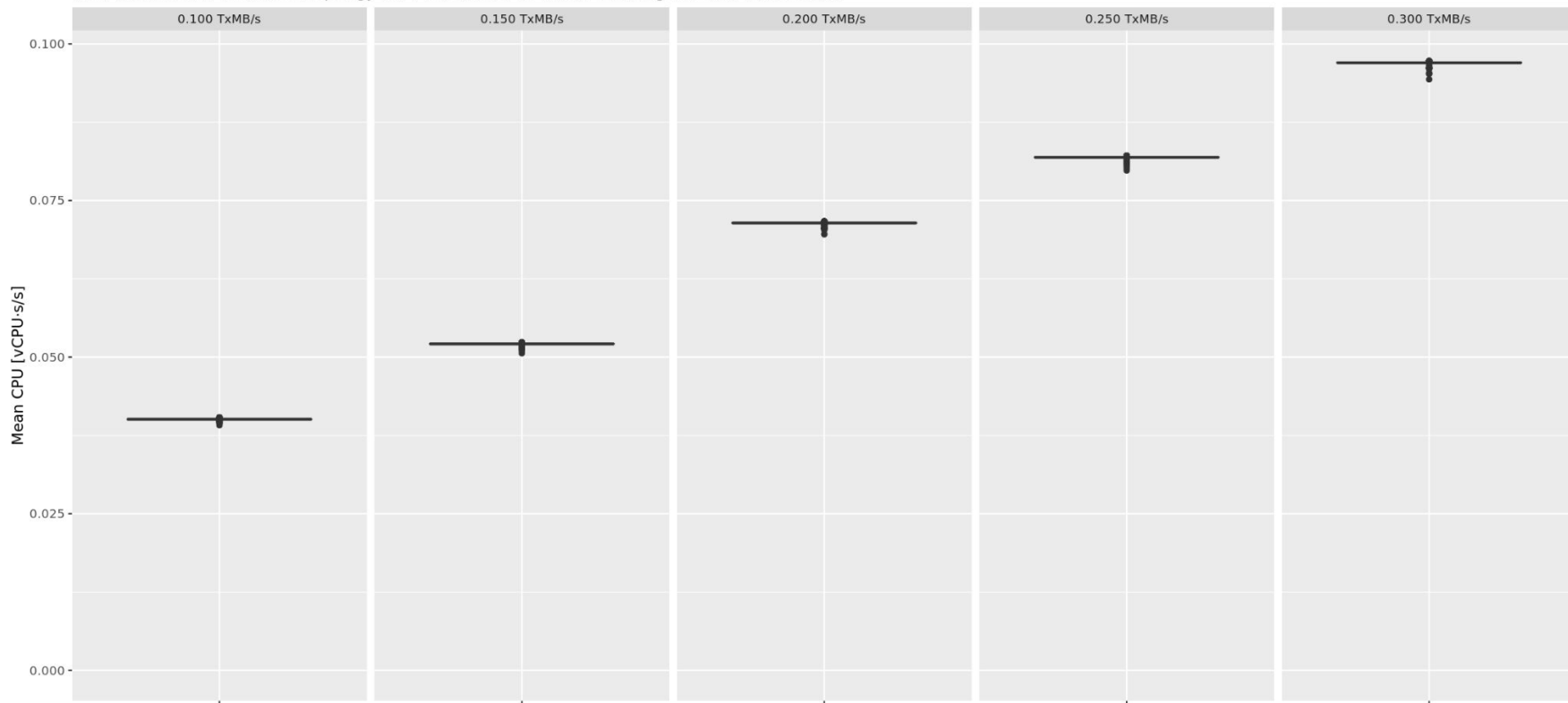
Network

Mean nodal ingress
Rust, linear-with-tx-references, topology-v2, 4 vCPU/node, 10 Mb/s, 7 slot/stage, 12 MB/EB, 1500 B/Tx
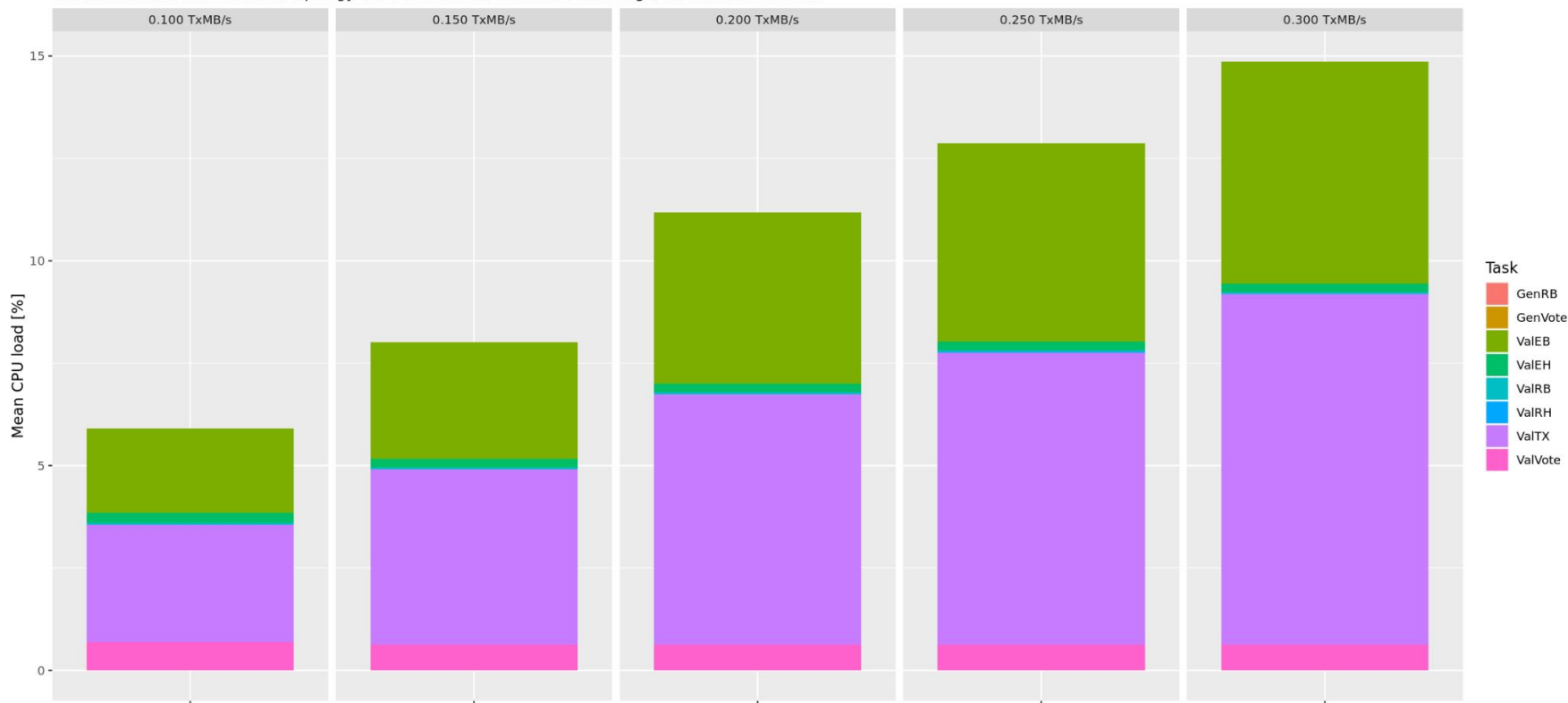
Mean CPU

Mean CPU

Rust, linear-with-tx-references, topology-v2, 4 vCPU/node, 10 Mb/s, 7 slot/stage, 12 MB/EB, 1500 B/Tx

CPU breakdown

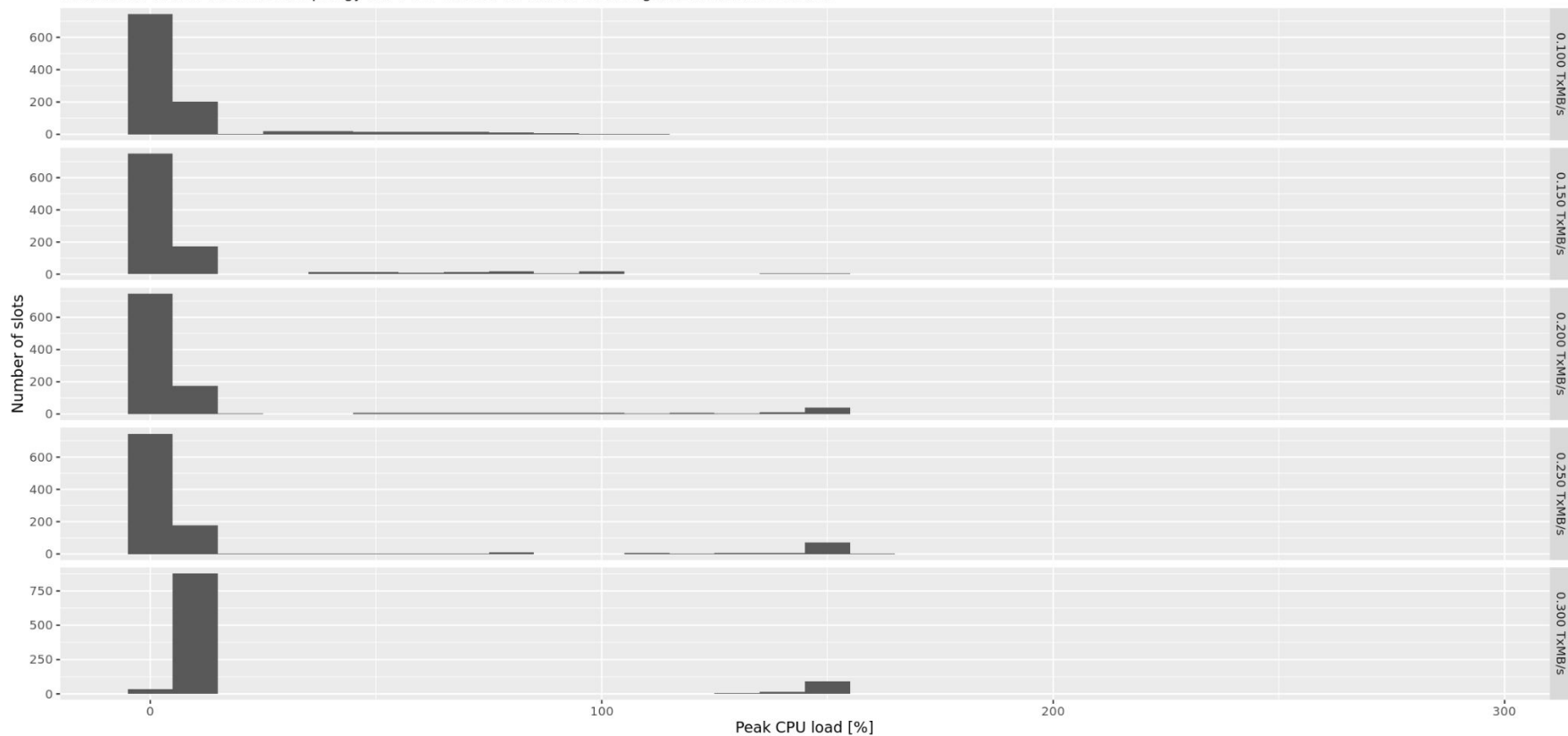Mean CPU load among all nodes

Rust, linear-with-tx-references, topology-v2, 4 vCPU/node, 10 Mb/s, 7 slot/stage, 12 MB/EB, 1500 B/Tx
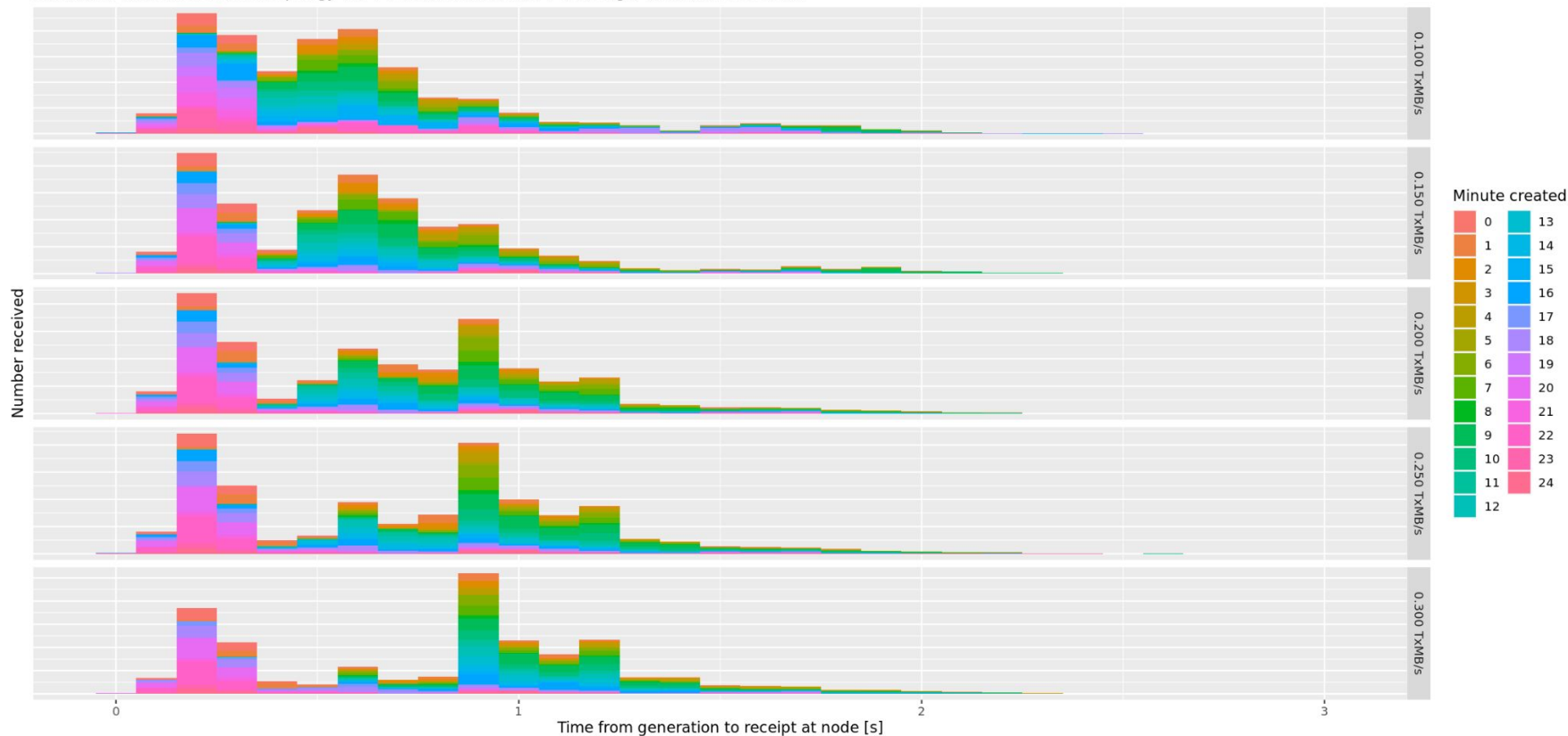
Peak CPU

Peak CPU load among all nodes

Rust, linear-with-tx-references, topology-v2, 4 vCPU/node, 10 Mb/s, 7 slot/stage, 12 MB/EB, 1500 B/Tx
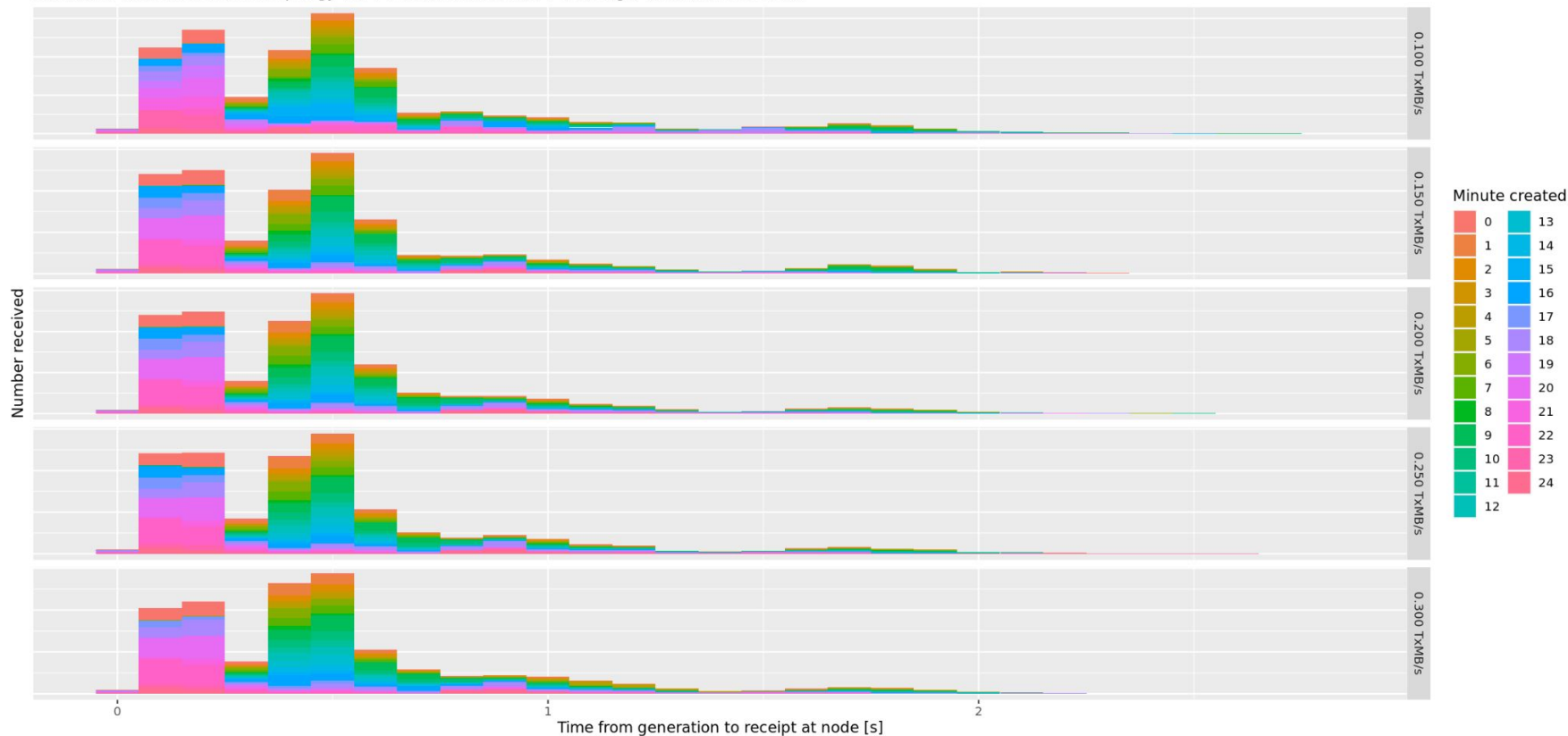
EB diffusion

Arrival delay for EB
Rust, linear-with-tx-references, topology-v2, 4 vCPU/node, 10 Mb/s, 7 slot/stage, 12 MB/EB, 1500 B/Tx

RB diffusion
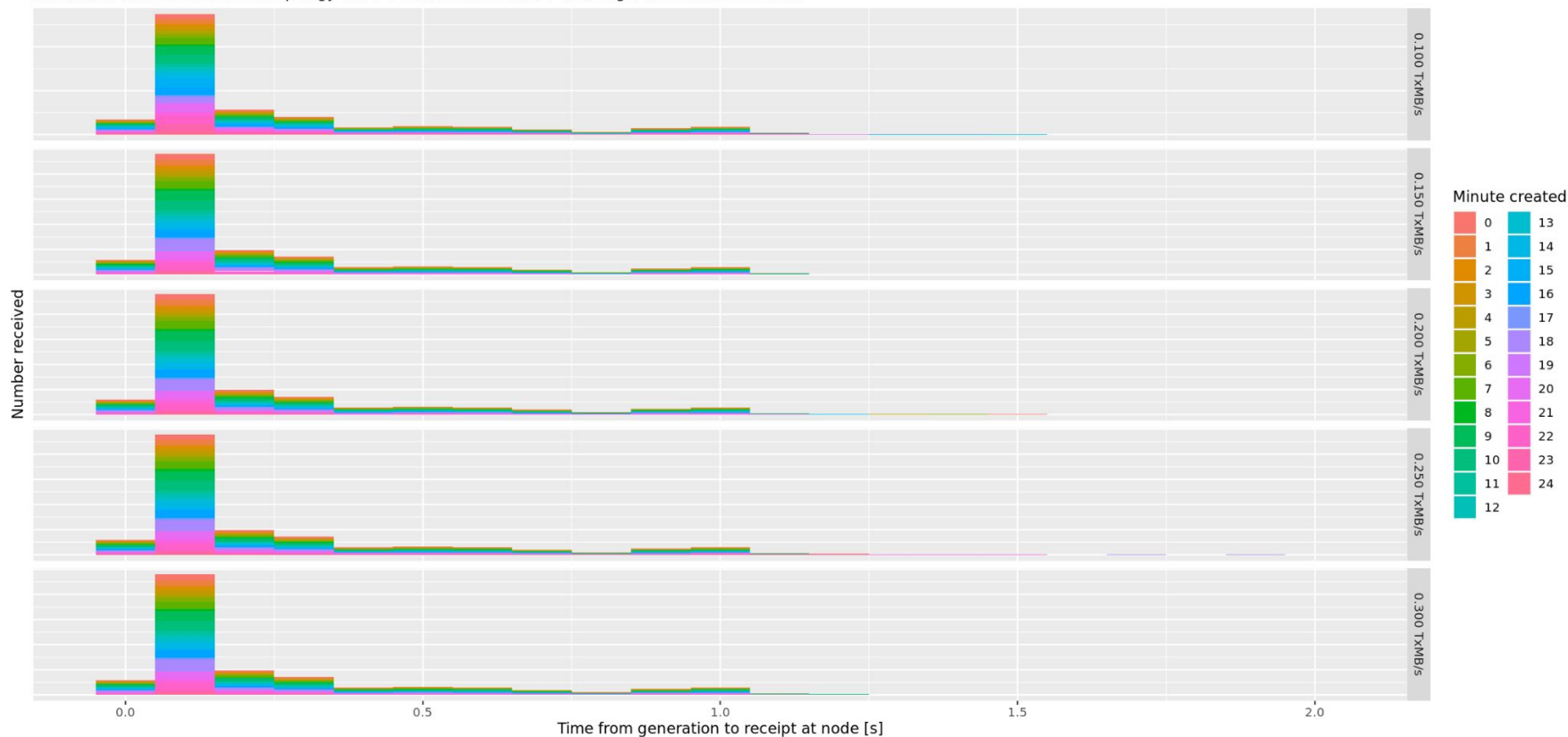

Arrival delay for RB
Rust, linear-with-tx-references, topology-v2, 4 vCPU/node, 10 Mb/s, 7 slot/stage, 12 MB/EB, 1500 B/Tx

Vote diffusion
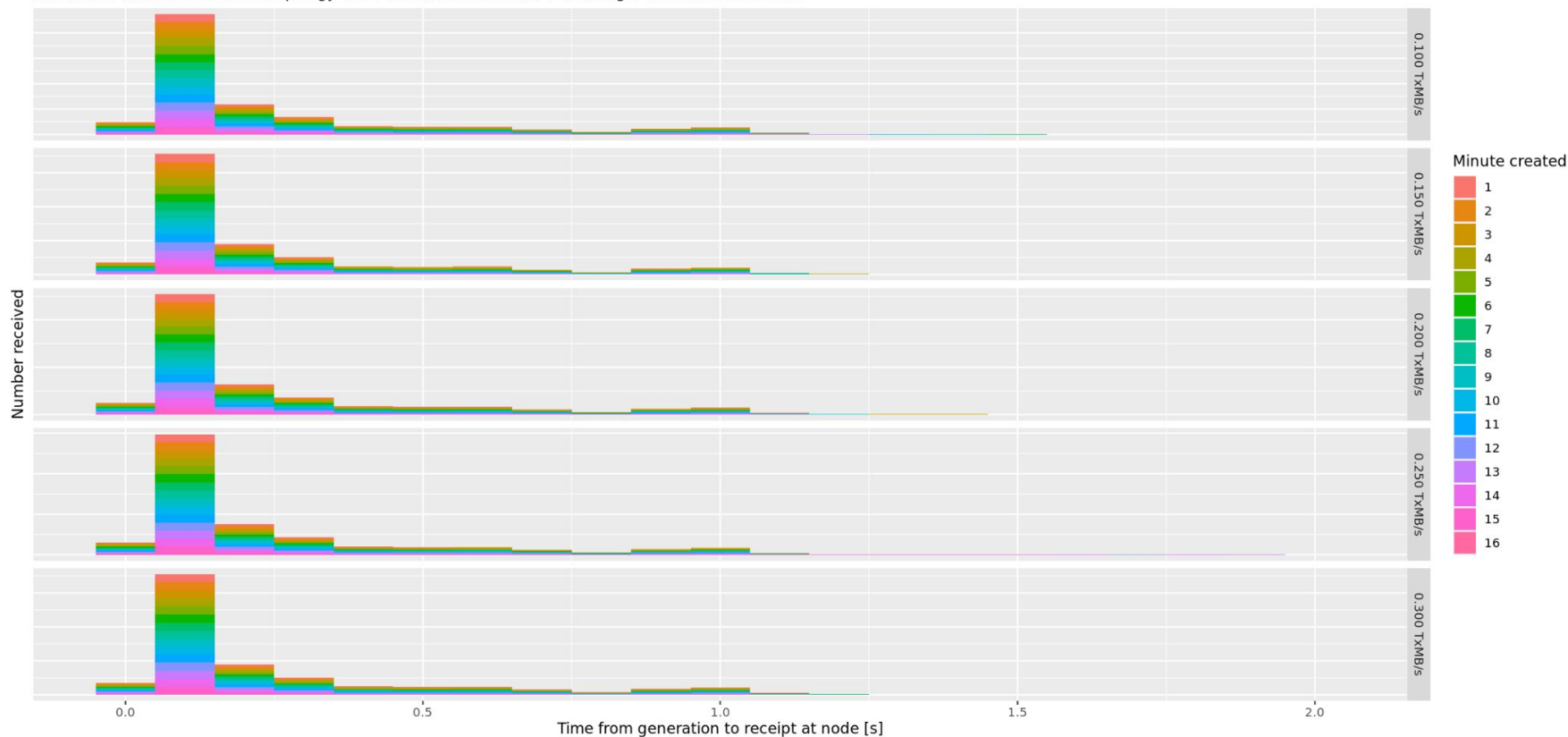

Arrival delay for VT
Rust, linear-with-tx-references, topology-v2, 4 vCPU/node, 10 Mb/s, 7 slot/stage, 12 MB/EB, 1500 B/Tx

Transaction diffusion
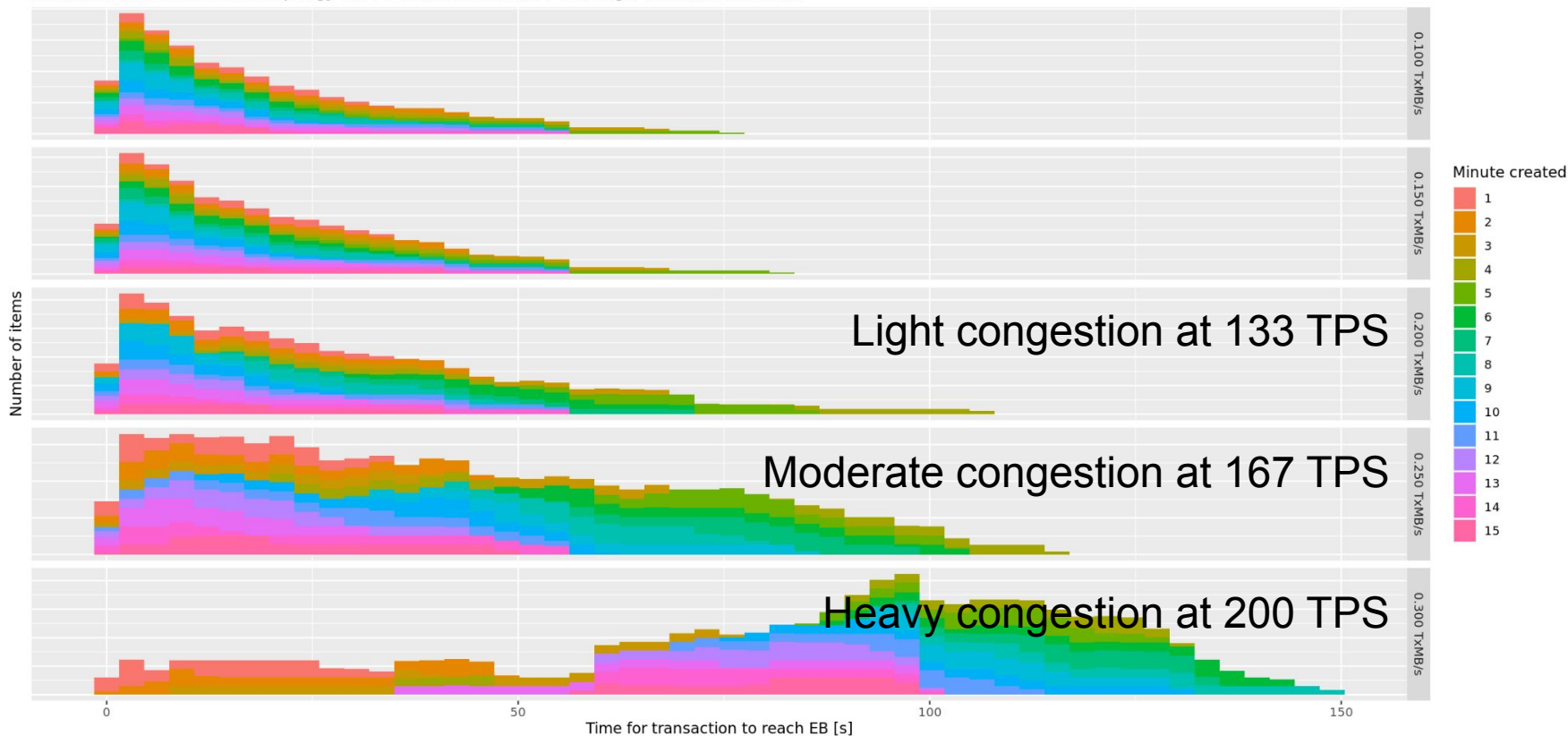

Arrival delay for TX
Rust, linear-with-tx-references, topology-v2, 4 vCPU/node, 10 Mb/s, 7 slot/stage, 12 MB/EB, 1500 B/Tx

Mempool to EB

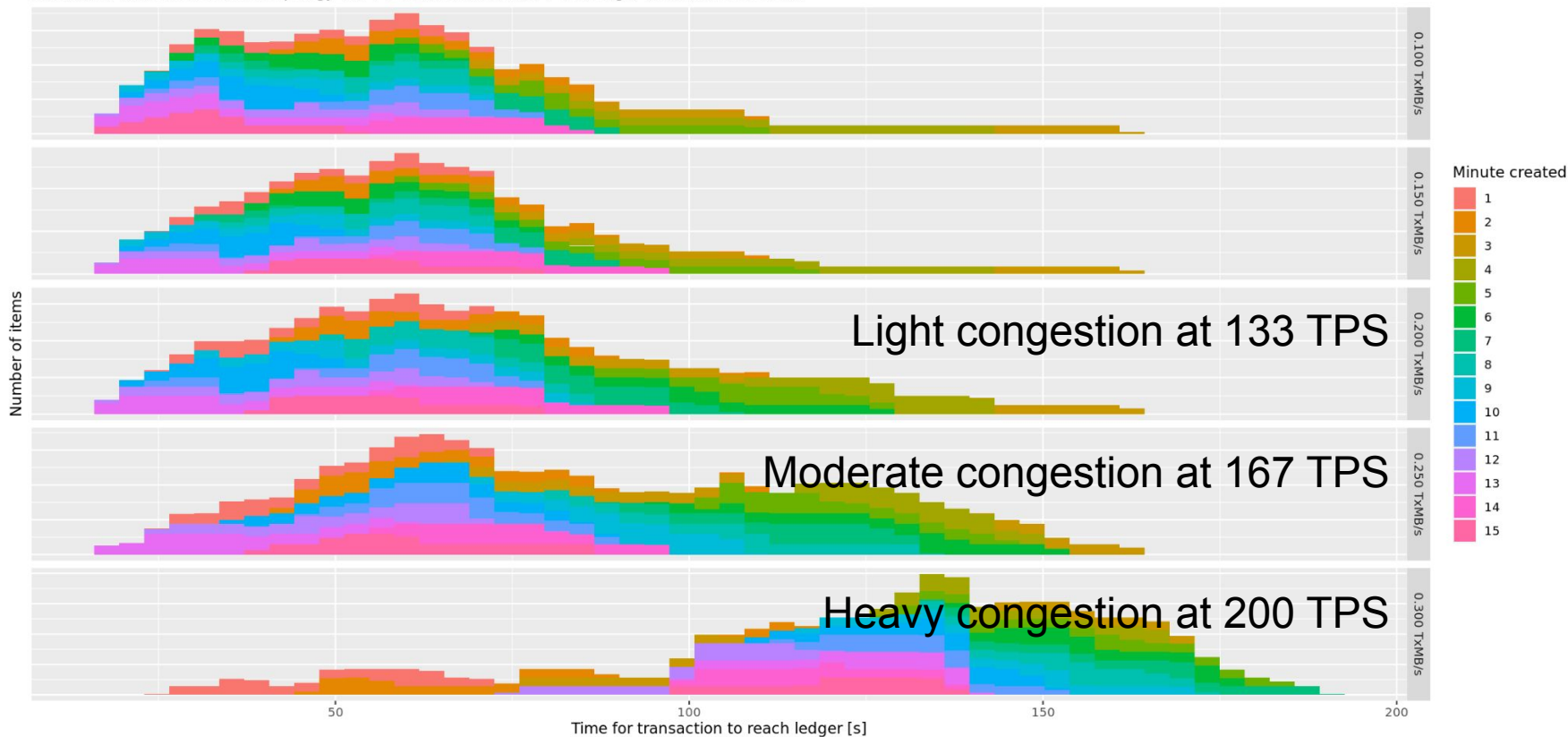Time for transaction to reach an EB

Rust, linear-with-tx-references, topology-v2, 4 vCPU/node, 10 Mb/s, 7 slot/stage, 12 MB/EB, 1500 B/Tx

Light congestion at 133 TPS

Moderate congestion at 167 TPS

Heavy congestion at 200 TPS

Minute created
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15

Number of items

Time for transaction to reach EB [s]

Mempool to ledger

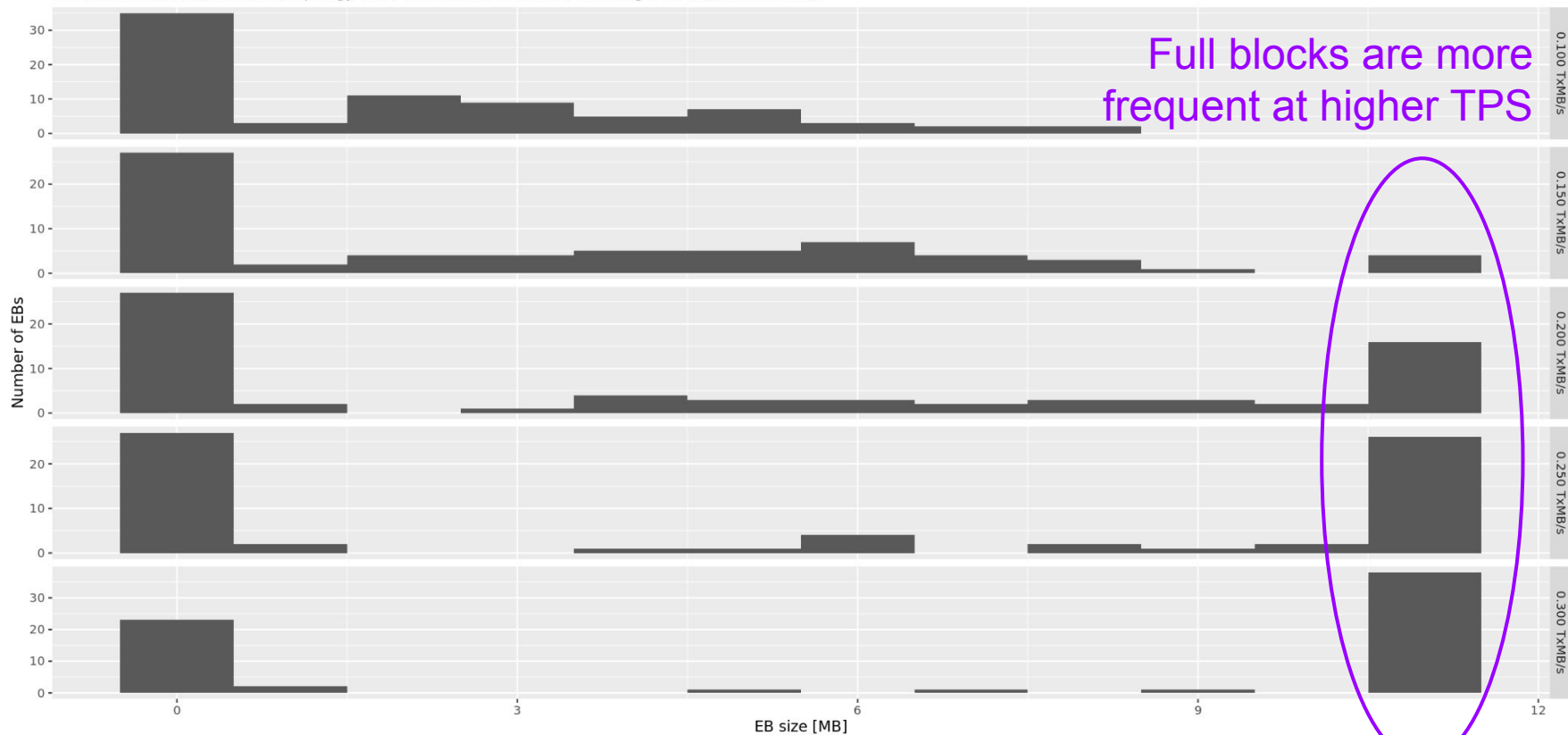

Time for transaction to reach the ledger
Rust, linear-with-tx-references, topology-v2, 4 vCPU/node, 10 Mb/s, 7 slot/stage, 12 MB/EB, 1500 B/Tx

Light congestion at 133 TPS

Moderate congestion at 167 TPS

Heavy congestion at 200 TPS

EB size

Size of transactions in EBs
Rust, linear-with-tx-references, topology-v2, 4 vCPU/node, 10 Mb/s, 7 slot/stage, 12 MB/EB, 1500 B/Tx

Full blocks are more frequent at higher TPS

Included vs discarded blocks

Disposition of transactions in blocks
Rust, linear-with-tx-references, topology-v2, 4 vCPU/node, 10 Mb/s, 7 slot/stage, 12 MB/EB, 1500 B/Tx
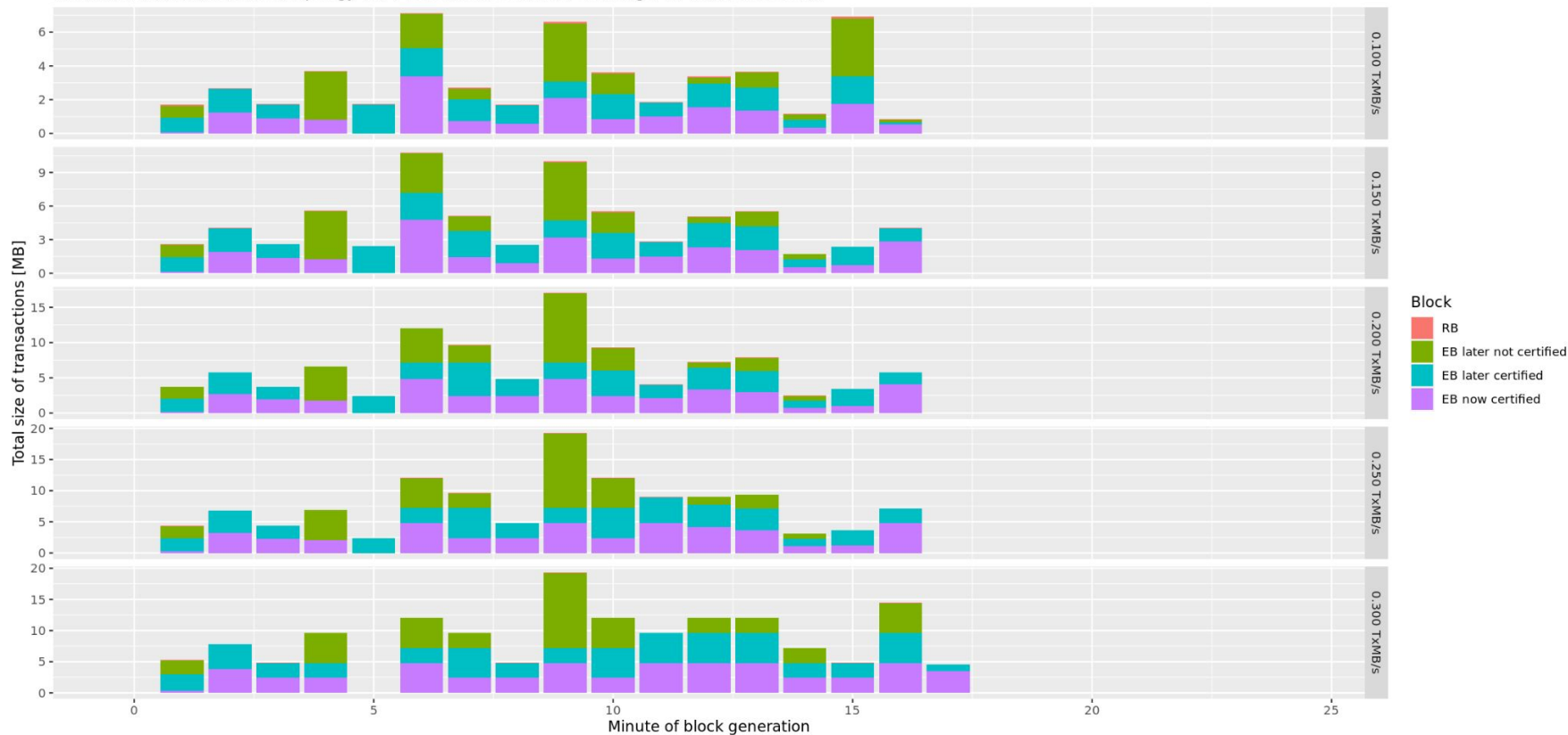
Findings

- Modest resources (4 vCPU/node, 10 Mb/s bandwidth) are adequate up to at least 0.3 TxMB/s.
  - It wasn't studied here, but it is likely that Plutus-heavy workloads could also be supported.
- Stage length of 7 slots allows for diffusion while having a low probability of discarding an EB.
- Maximum of 12 MB of transactions in an EB allows for occasional fully utilized EBs to "catch up" on throughput when sortition is unlucky.
  - At lower TPS, most of these blocks are small.
  - Maximum block size could be reduced at the expense of longer waits when sortition is unlucky.
- This experiment raised questions about whether the mempool rules are adequate.