Simulation analysis

2025-07-16

Experiments @ 0f74d79b

- Linear Leios
 - o <u>linear.ipynb</u>
- Linear Leios with full RBs and EBs but no transactions
 - o <u>notxs.ipynb</u>
- Linear Leios with transaction references
 - txrefs.ipynb
- Stracciatella
 - stracciatella.ipynb

TPS

Stage length	Max EB size	Demand [tx/s]	Demand [MB/s]	Demand [Mb/s]	Time to full EB [s]	Transaction size [B/tx]
<fct></fct>	<fct></fct>	<dbl></dbl>	<dbl></dbl>	<dbl></dbl>	<dbl></dbl>	<dbl></dbl>
5 slot/stage	0.5 MB/EB	6.976667	0.01183958	0.09471661	42.23124	1697.025
5 slot/stage	1.0 MB/EB	12.478333	0.02129649	0.17037196	46.95608	1706.678
5 slot/stage	2.0 MB/EB	28.155000	0.04781171	0.38249368	41.83076	1698.161
5 slot/stage	5.0 MB/EB	41.850000	0.07115336	0.56922689	70.27075	1700.200
8 slot/stage	0.5 MB/EB	6.976667	0.01183958	0.09471661	42.23124	1697.025
8 slot/stage	1.0 MB/EB	12.478333	0.02129649	0.17037196	46.95608	1706.678
8 slot/stage	2.0 MB/EB	28.155000	0.04781171	0.38249368	41.83076	1698.161
8 slot/stage	5.0 MB/EB	41.850000	0.07115336	0.56922689	70.27075	1700.200

Utilization

5 slot/stage	<fct> 0.5 MB/EB</fct>	<dbl> 93.51965</dbl>	<dbl></dbl>
5 slot/stage	0.5 MB/EB	93.51965	
-			45.36436
5 slot/stage	1.0 MB/EB	103.13807	52.84950
	2.0 MB/EB	103.87705	67.03065
5 slot/stage	5.0 MB/EB	97.05041	44.92727
8 slot/stage	0.5 MB/EB	94.82774	70.49314
8 slot/stage	1.0 MB/EB	101.83644	75.41172
8 slot/stage	2.0 MB/EB	120.36983	110.11028
8 slot/stage	5.0 MB/EB	96.51464	56.58345

Key

Linear Leios with txs references

Stracciatella

Linear Leios

Linear Leios without txs

Spatial efficiency

Stage length	Max EB size	Space efficiency [%	
<fct></fct>	<fct></fct>	<dbl></dbl>	
5 slot/stage	0.5 MB/EB	71.37025	
5 slot/stage	1.0 MB/EB	82.17250	
5 slot/stage	2.0 MB/EB	87.98849	
5 slot/stage	5.0 MB/EB	90.25717	
8 slot/stage	0.5 MB/EB	71.98486	
8 slot/stage	1.0 MB/EB	81.96673	
8 slot/stage	2.0 MB/EB	86.37431	
8 slot/stage	5.0 MB/EB	89.52475	

Stage length	Max EB size	Space efficiency [%	
<fct></fct>	<fct></fct>	<dbl></dbl>	
5 slot/stage	0.5 MB/EB	79.87590	
5 slot/stage	1.0 MB/EB	63.16012	
5 slot/stage	2.0 MB/EB	61.49854	
5 slot/stage	5.0 MB/EB	64.15788	
8 slot/stage	0.5 MB/EB	56.79223	
8 slot/stage	1.0 MB/EB	46.42267	
8 slot/stage	2.0 MB/EB	43.53820	
8 slot/stage	5.0 MB/EB	51.35062	

Stage length	Max EB size	Space efficiency [%]	
<fct></fct>	<fct></fct>	<dbl></dbl>	
5 slot/stage	0.5 MB/EB	64.13165	
5 slot/stage	1.0 MB/EB	74.57606	
5 slot/stage	2.0 MB/EB	85.38662	
5 slot/stage	5.0 MB/EB	88.69461	
8 slot/stage	0.5 MB/EB	72.36576	
8 slot/stage	1.0 MB/EB	81.66809	
8 slot/stage	2.0 MB/EB	89.55633	
8 slot/stage	5.0 MB/EB	91.91031	

Temporal efficiency

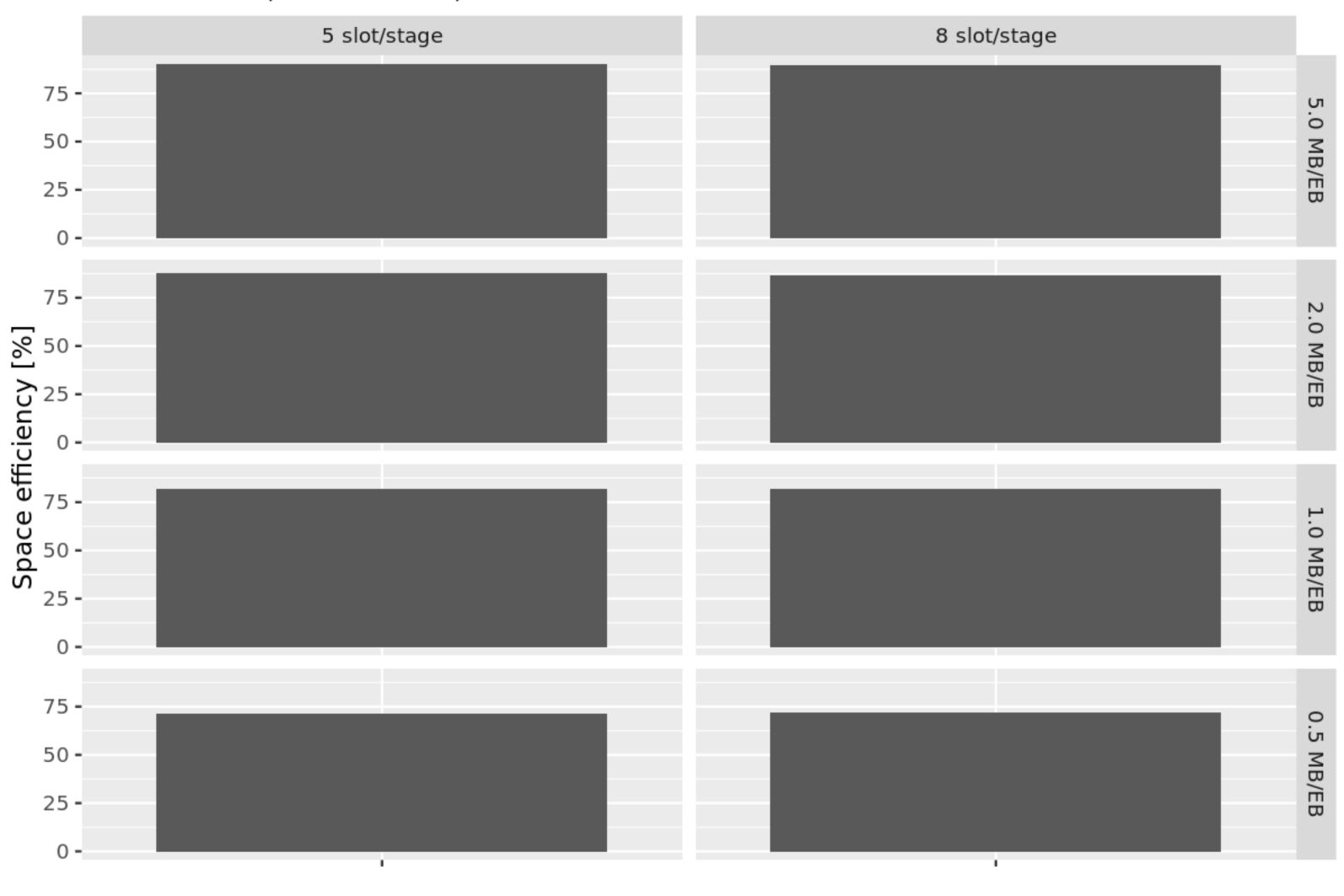
Stage length	Max EB size	Time to reach EB [s]	
<fct></fct>	<fct></fct>	<dbl></dbl>	
5 slot/stage	0.5 MB/EB	20.30026	
5 slot/stage	1.0 MB/EB	19.45941	
5 slot/stage	2.0 MB/EB	20.29574	
5 slot/stage	5.0 MB/EB	21.56344	
8 slot/stage	0.5 MB/EB	20.63884	
8 slot/stage	1.0 MB/EB	19.17753	
8 slot/stage	2.0 MB/EB	49.64374	
8 slot/stage	5.0 MB/EB	24.58151	

Stage length	Max EB size	Time to reach EB [s]
<fct></fct>	<fct></fct>	<dbl></dbl>
5 slot/stage	0.5 MB/EB	24.07720
5 slot/stage	1.0 MB/EB	18.90843
5 slot/stage	2.0 MB/EB	20.25911
5 slot/stage	5.0 MB/EB	22.93963
8 slot/stage	0.5 MB/EB	30.81804
8 slot/stage	1.0 MB/EB	26.57588
8 slot/stage	2.0 MB/EB	57.42223
8 slot/stage	5.0 MB/EB	23.01206

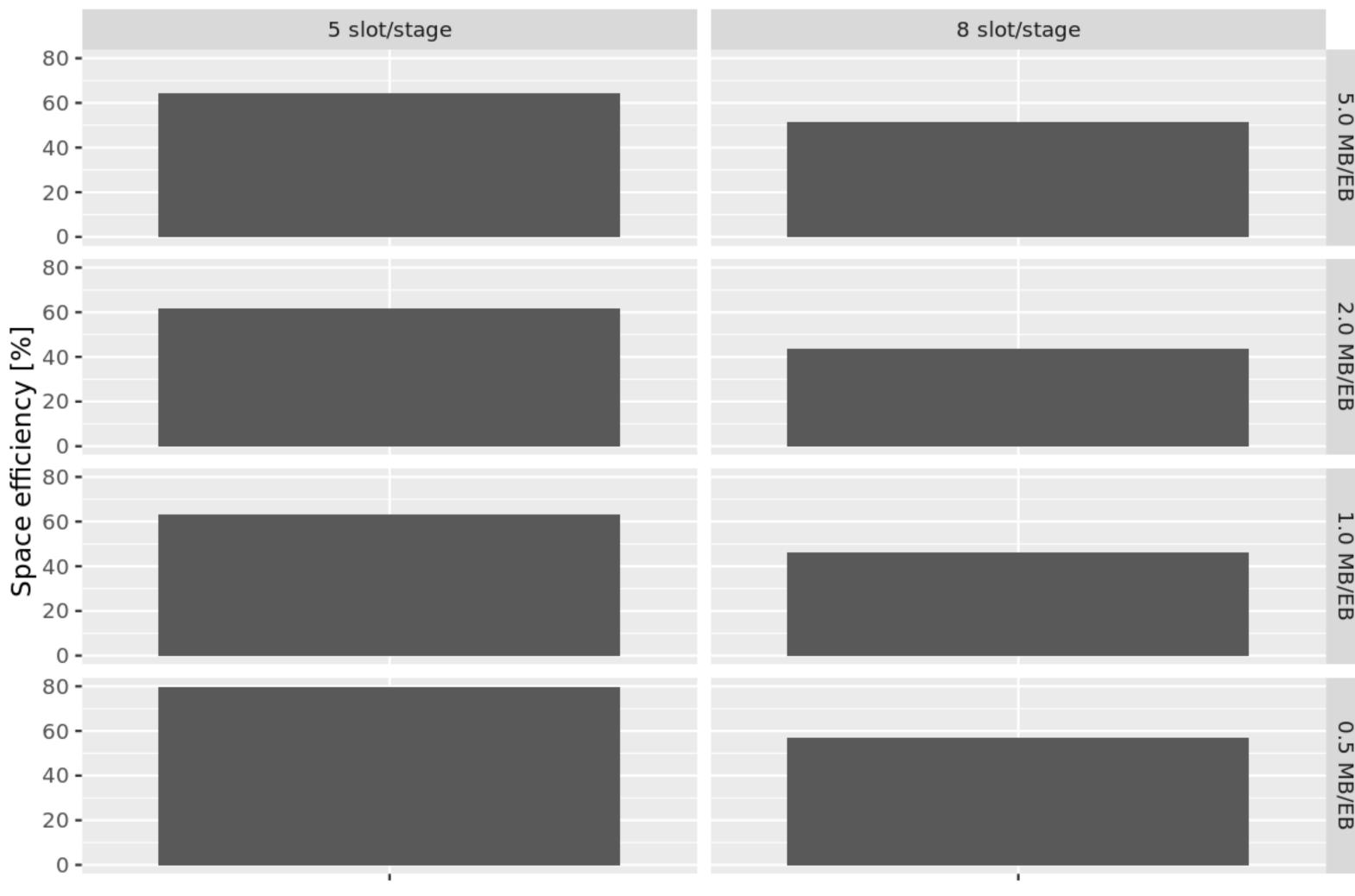
Stage length	Max EB size	Time to reach EB [s]	
<fct></fct>	<fct></fct>	<dbl></dbl>	
5 slot/stage	0.5 MB/EB	5.870323	
5 slot/stage	1.0 MB/EB	5.846619	
5 slot/stage	2.0 MB/EB	5.846295	
5 slot/stage	5.0 MB/EB	5.821703	
8 slot/stage	0.5 MB/EB	9.320229	
8 slot/stage	1.0 MB/EB	9.779036	
8 slot/stage	2.0 MB/EB	10.036648	
8 slot/stage	5.0 MB/EB	9.902443	

Size of diffused data Size of diffused data Rust simulator, mini-mainnet, linear-with-tx-references Rust simulator, mini-mainnet, full-without-ibs 5 slot/stage 5 slot/stage 8 slot/stage 8 slot/stage 60 **-**60 **-**5.0 MB/EB 5.0 MB/EB 40 -40 -20 **-**20 **-**50 **-**50 **-**2.0 MB/EB 40 **-**40 **-**2.0 MB/EB 30 **-**30 **-**20 **-**20 **-**Size [kB/s] [kB/s] Size 15 -1.0 MB/EB 1.0 MB/EB 10-10-12 **-**12 -0.5 MB/EB 0.5 MB/EB 9 -9 -TX RB RB ΤX RB ΤX RB ΤX EΒ EΒ EB EΒ Message Message Size of diffused data Size of diffused data Rust simulator, mini-mainnet, linear Rust simulator, mini-mainnet, linear, no txs 5 slot/stage 5 slot/stage 8 slot/stage 8 slot/stage 5.0 MB/EB 5.0 MB/EB 100 -400 -50 **-**200 -100-150 **-**2.0 MB/EB 2.0 MB/EB 75 **-**100-50 **-**Size [kB/s] 25 - 0 - 40 - 30 -50 **-**Size [kB/s] 120 **-**1.0 MB/EB 1.0 MB/EB 90 -60 **-**20 **-**30 **-**10-60 **-**15 **-**0.5 MB/EB 0.5 MB/EB 40 -10-20 -5 -ΤX TX ΤX EΒ RB ΤX EΒ RB EΒ RB EΒ RB Message Message

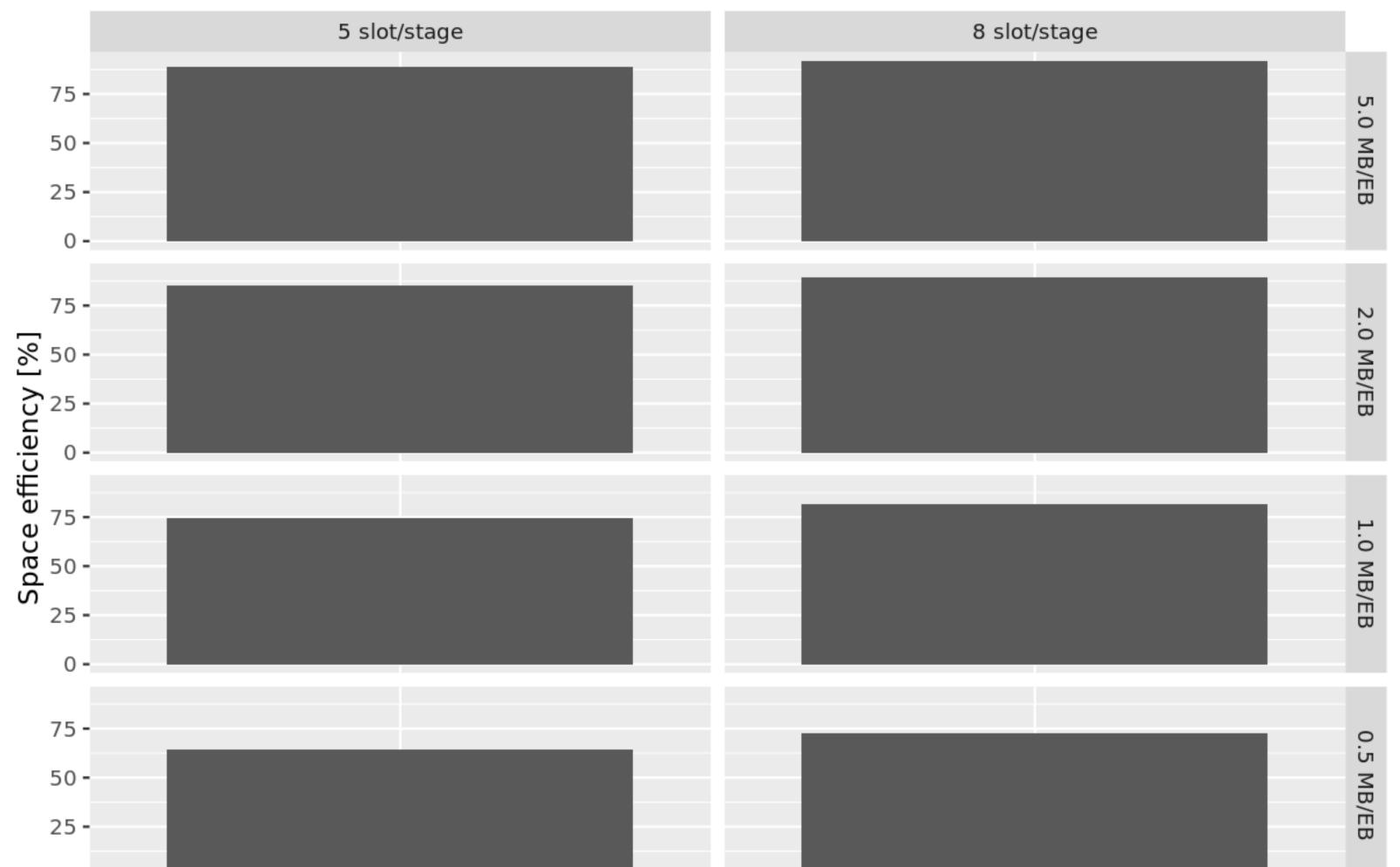
Spatial efficiency (size of txs on ledger / size of non-tx persisted data)
Rust simulator, mini-mainnet, linear-with-tx-references



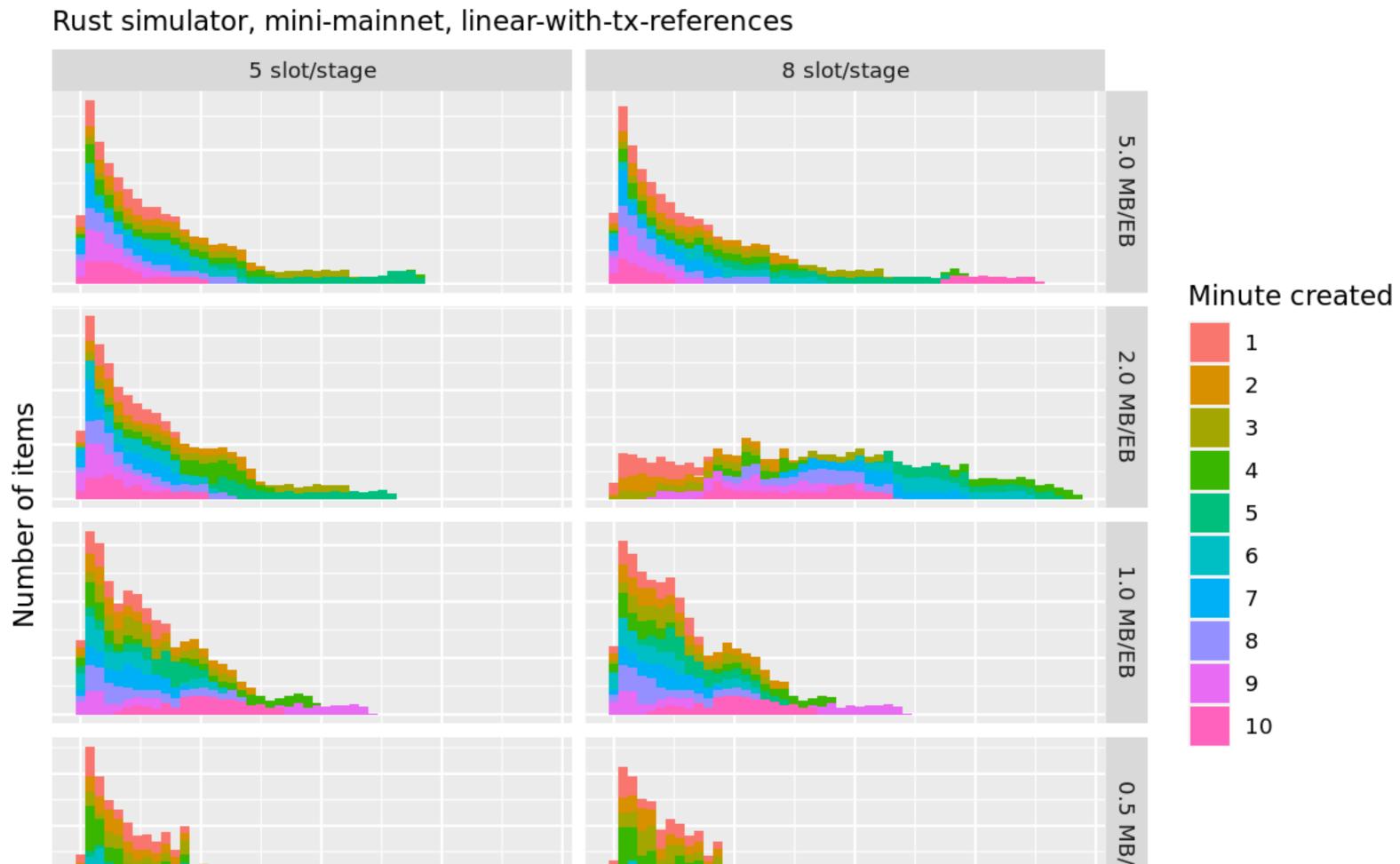
Spatial efficiency (size of txs on ledger / size of non-tx persisted data)
Rust simulator, mini-mainnet, linear



Spatial efficiency (size of txs on ledger / size of non-tx persisted data) Rust simulator, mini-mainnet, full-without-ibs



Time for transaction to reach an EB



60

90

120

Minute created

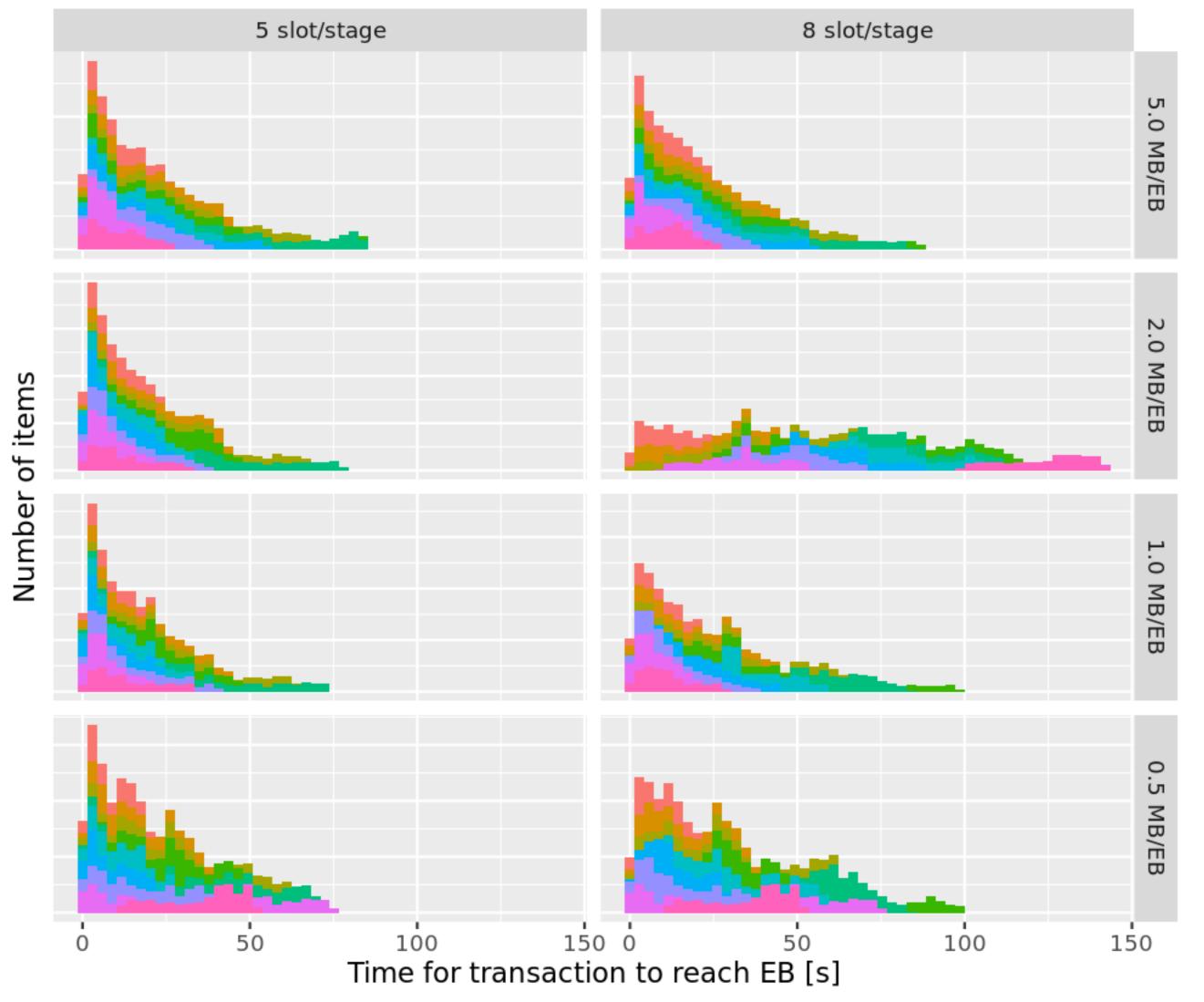
10

Time for transaction to reach an EB

90

Rust simulator, mini-mainnet, linear

30

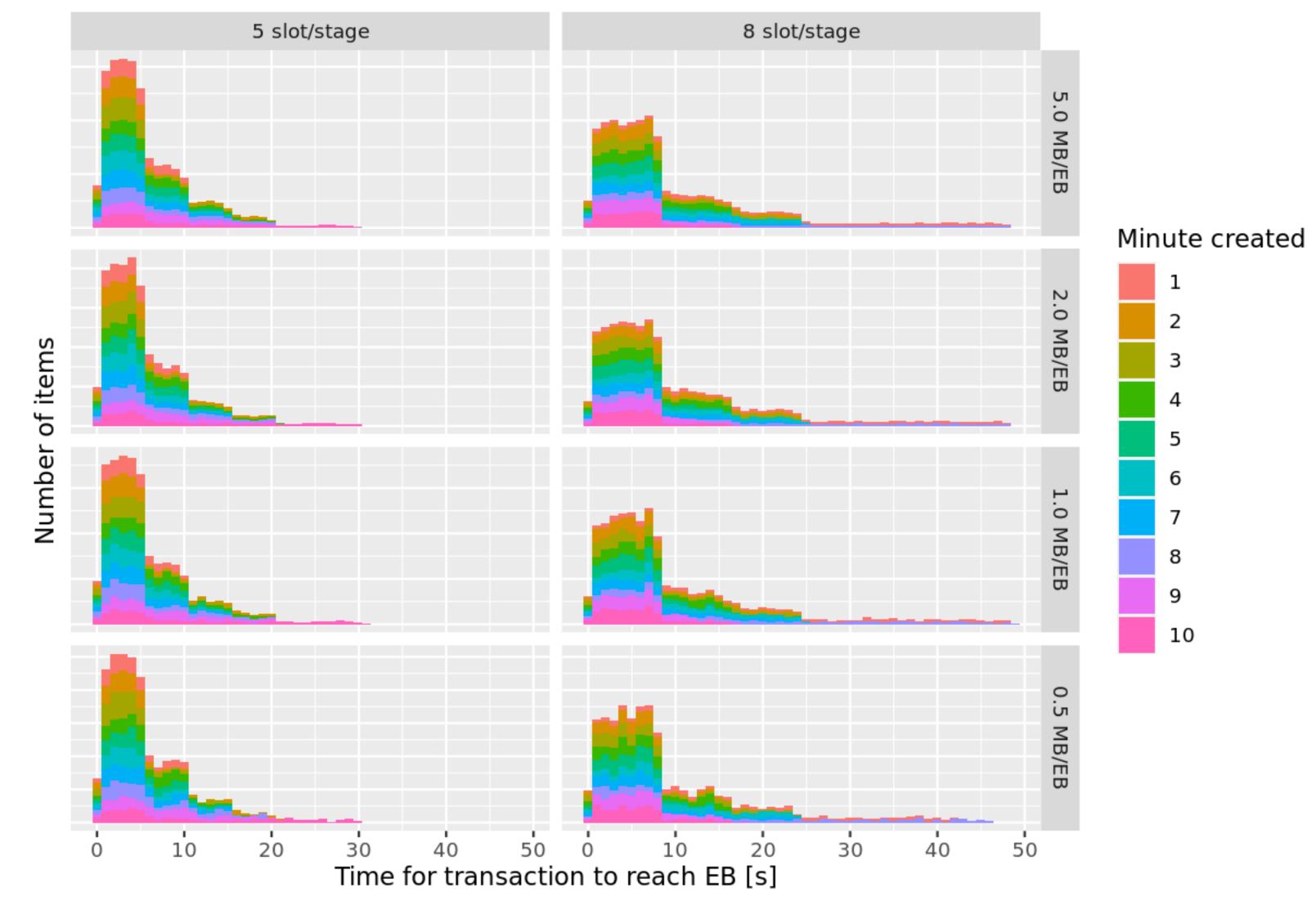


120 0

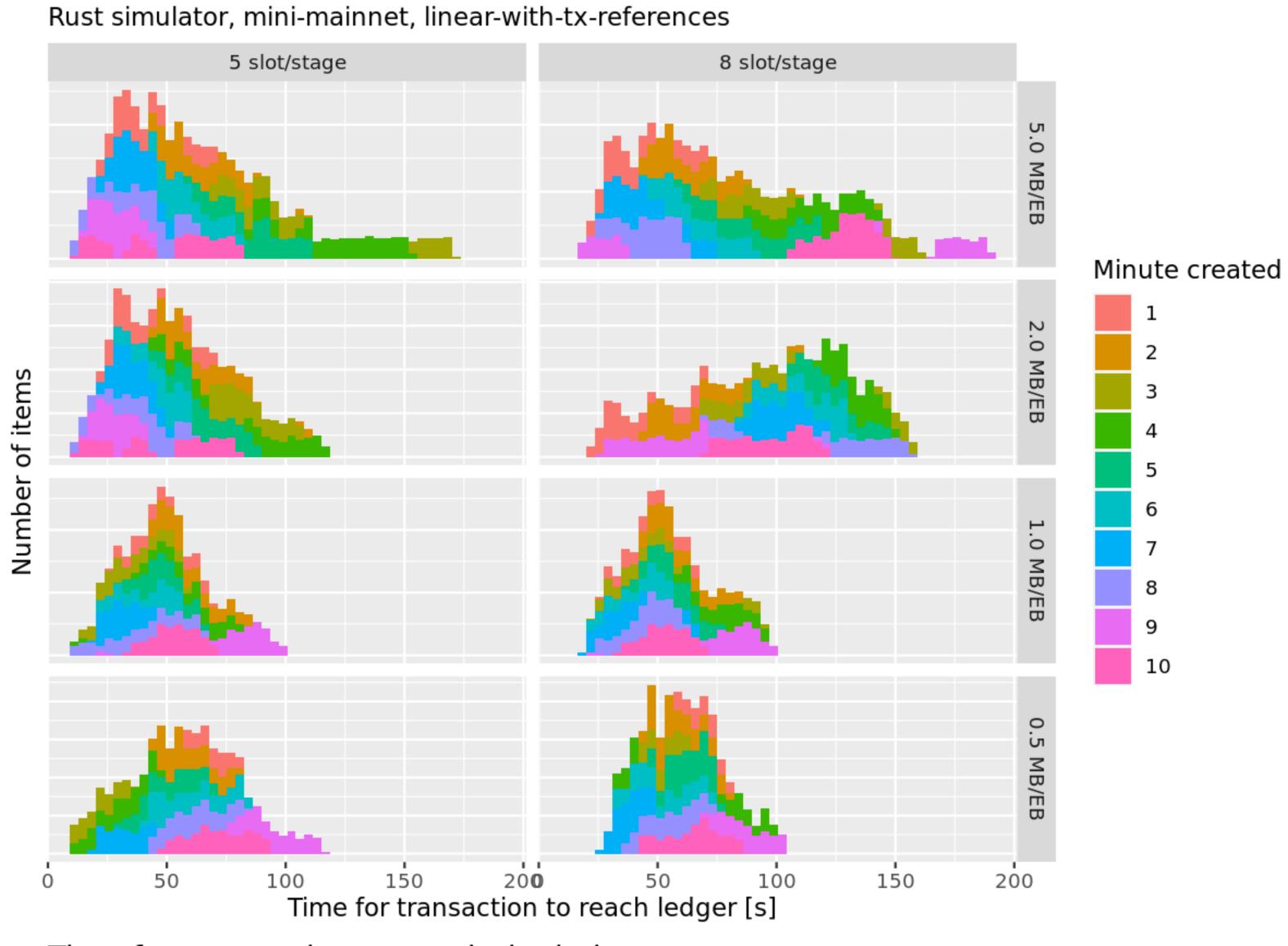
Time for transaction to reach EB [s]

Time for transaction to reach an EB

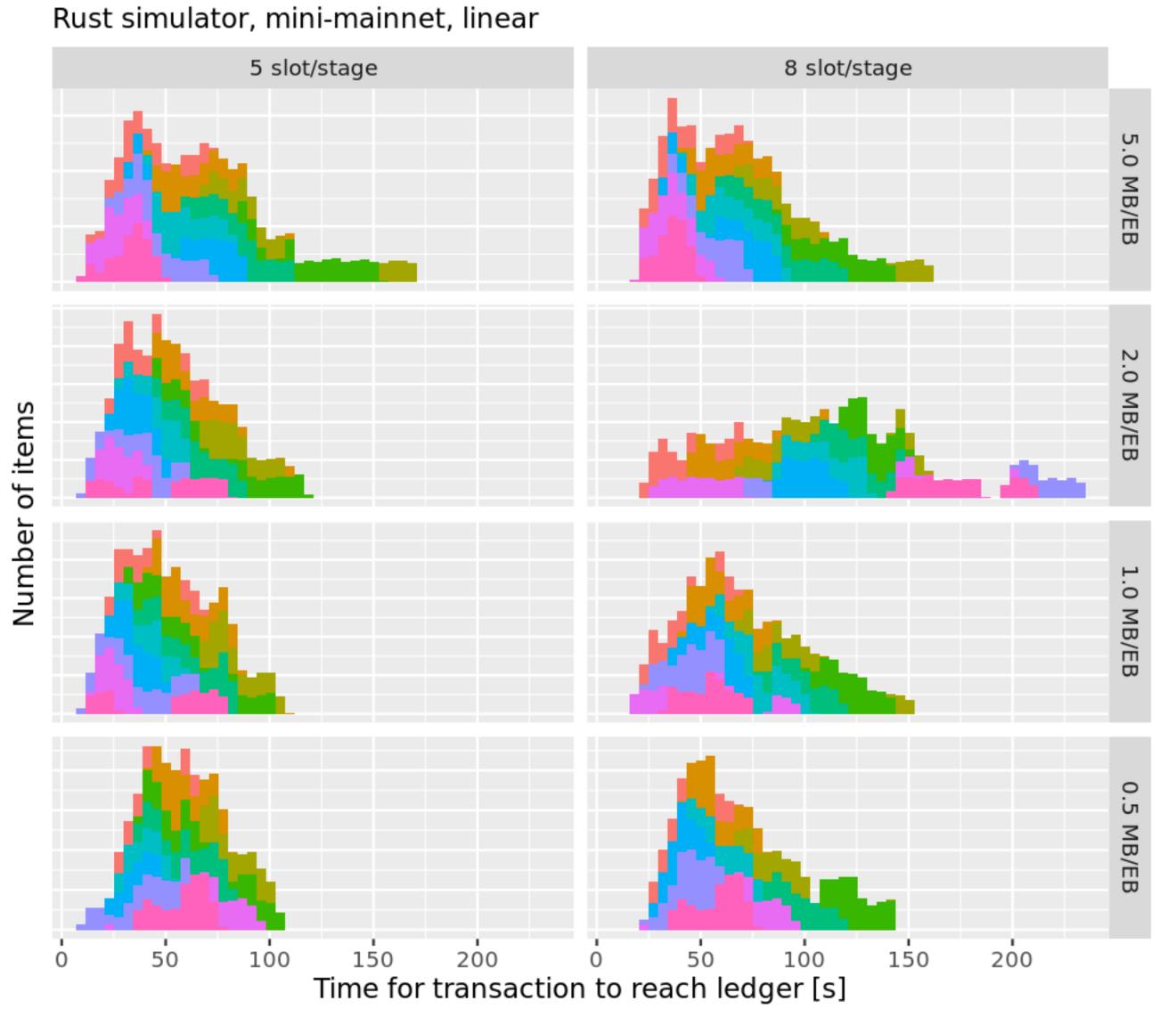
Rust simulator, mini-mainnet, full-without-ibs



Time for transaction to reach the ledger



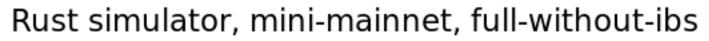
Time for transaction to reach the ledger

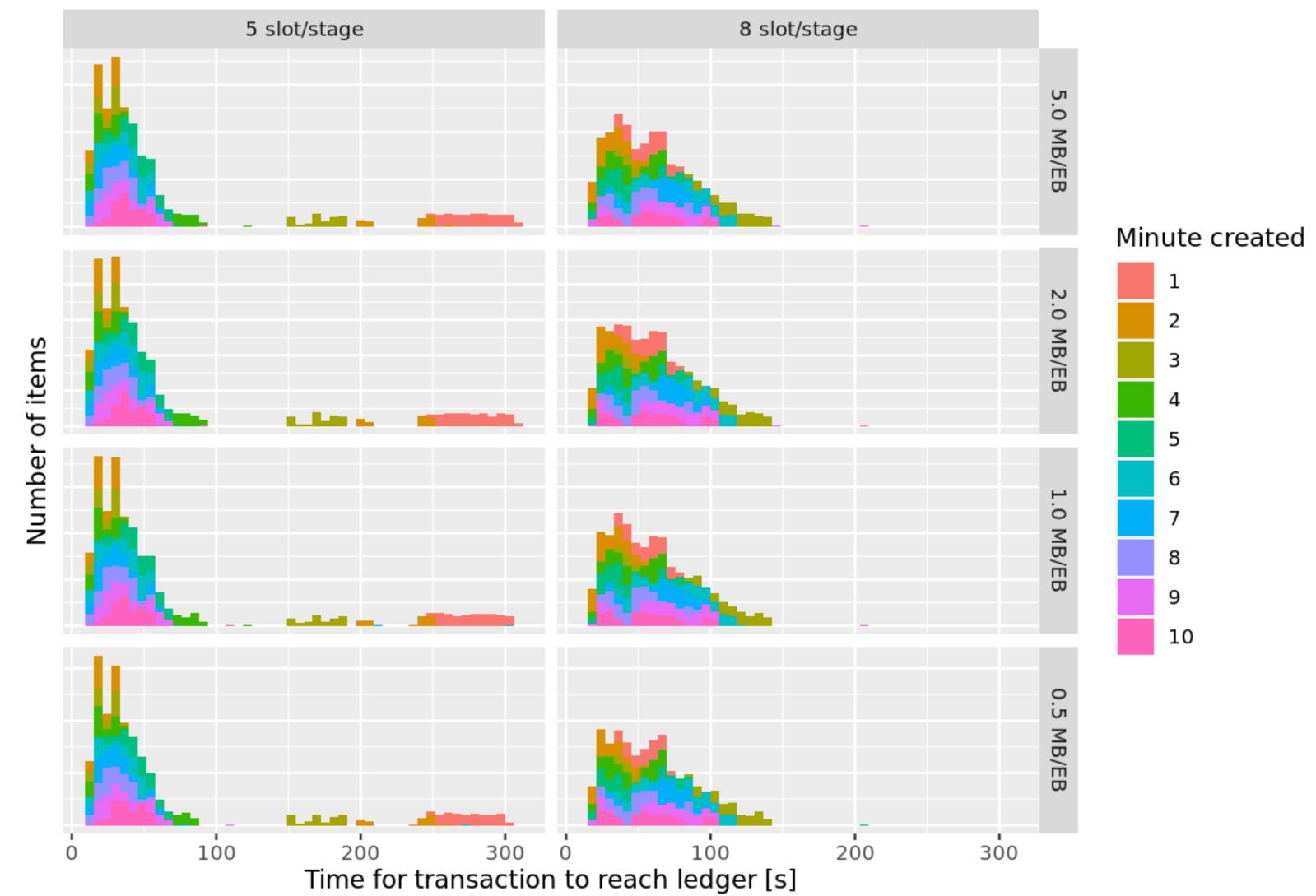


Minute created

10

Time for transaction to reach the ledger





Transactions reaching the ledger Rust simulator, mini-mainnet, linear-with-tx-references 5 slot/stage 8 slot/stage 100 -75 **-**5.0 MB/EB 50 **-**25 **-**75 **-**2.0 MB/EB 50 **-**Fraction [%] Outcome Lost On ledger 1.0 MB/EB 50 **-**25 **-**75 **-**0.5 MB/EB 50 **-**25 **-**1 - 2 - 7 - 7 - 7 2m - 4 5 --6 10- ∞ ∞ Submitted [minute] Transactions reaching the ledger Rust simulator, mini-mainnet, linear 5 slot/stage 8 slot/stage 100 -5.0 MB/EB 75 **-**50 **-**25 **-**75 **-**2.0 MB/EB 50 **-**Fraction [%] Outcome Lost On ledger 1.0 MB/EB 50 **-**25 **-**100-0.5 MB/EB 75 **-**50 **-**25 **-**

2-

10-

Submitted [minute]

ω

- 6

m

4

5 -

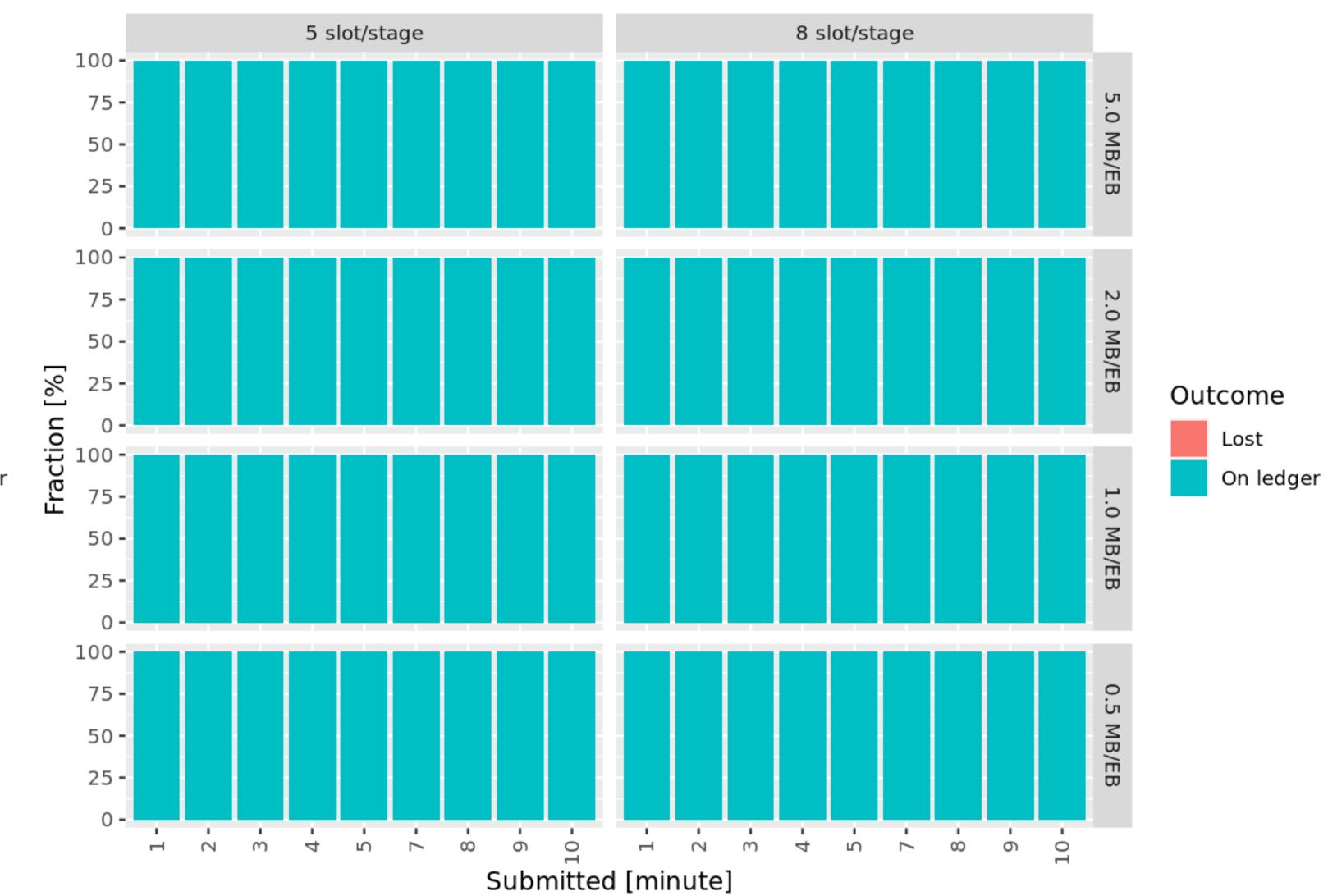
 ∞

10

1 - 2 - 7 - 7 - 7 - 7

Transactions reaching the ledger

Rust simulator, mini-mainnet, full-without-ibs



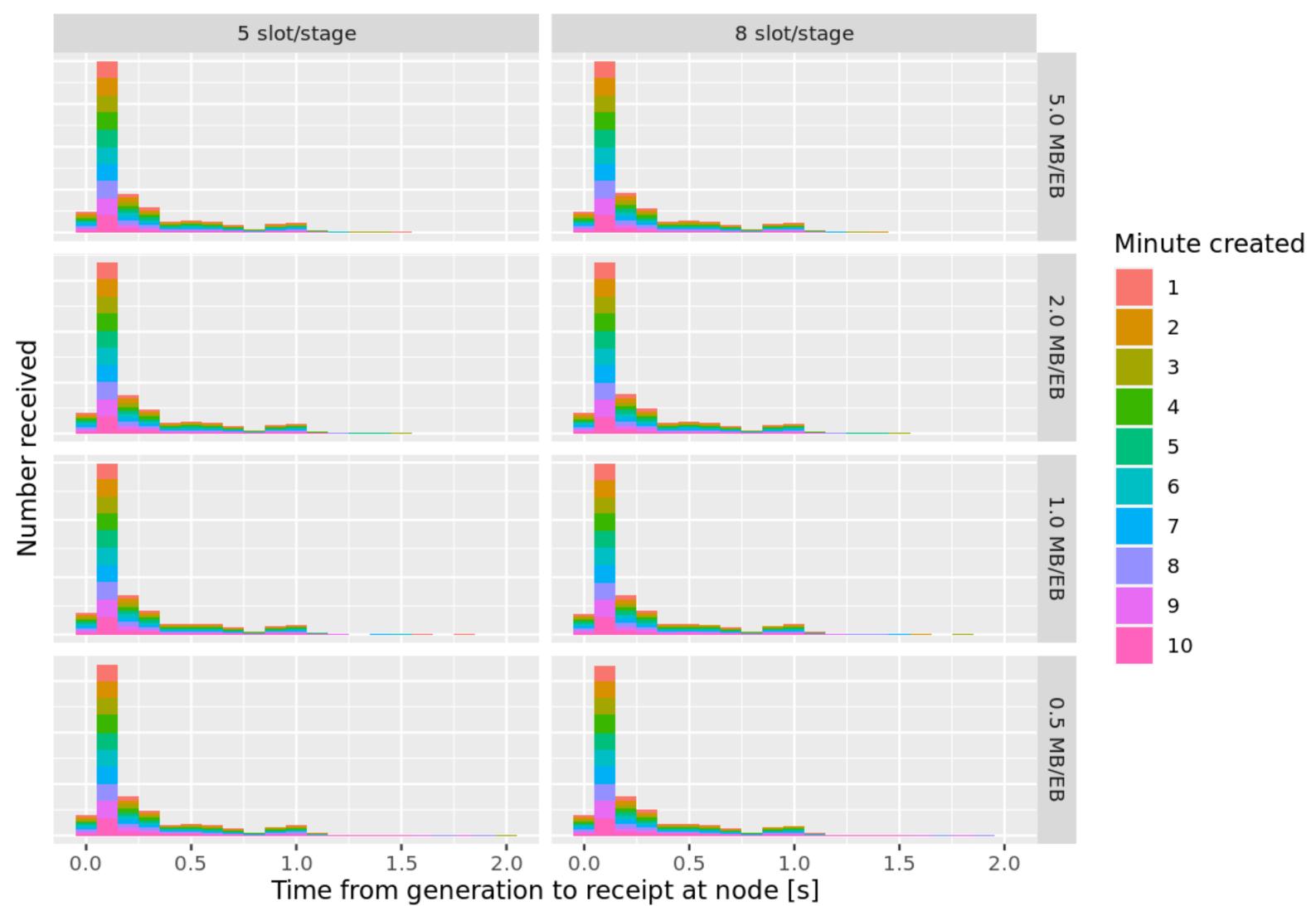
Arrival delay for EB Arrival delay for EB Rust simulator, mini-mainnet, linear-with-tx-references Rust simulator, mini-mainnet, full-without-ibs 5 slot/stage 8 slot/stage 5 slot/stage 8 slot/stage Minute created Minute created received Number Time from generation to receipt at node [s] Time from generation to receipt at node [s] Arrival delay for EB Arrival delay for EB Rust simulator, mini-mainnet, linear Rust simulator, mini-mainnet, linear, no txs 5 slot/stage 8 slot/stage 5 slot/stage 8 slot/stage Minute created Minute created received received Number Time from generation to receipt at node [s] Time from generation to receipt at node [s]

Arrival delay for RB Arrival delay for RB Rust simulator, mini-mainnet, linear-with-tx-references Rust simulator, mini-mainnet, full-without-ibs 5 slot/stage 8 slot/stage 5 slot/stage 8 slot/stage Minute created Minute created Number Time from generation to receipt at node [s] Time from generation to receipt at node [s] Arrival delay for RB Arrival delay for RB Rust simulator, mini-mainnet, linear, no txs Rust simulator, mini-mainnet, linear 5 slot/stage 5 slot/stage 8 slot/stage 8 slot/stage Minute created Minute created received received Number Number Time from generation to receipt at node [s] Time from generation to receipt at node [s]

Arrival delay for TX Rust simulator, mini-mainnet, linear-with-tx-references 5 slot/stage 8 slot/stage Minute created received Number 0.0 1.5 1.5 2.0 2.0 Time from generation to receipt at node [s] Arrival delay for TX Rust simulator, mini-mainnet, linear 5 slot/stage 8 slot/stage Minute created received Number 0.0 1.5 1.5 2.0 2.0

Time from generation to receipt at node [s]

Arrival delay for TX
Rust simulator, mini-mainnet, full-without-ibs



Arrival delay for VT Arrival delay for VT Rust simulator, mini-mainnet, linear-with-tx-references Rust simulator, mini-mainnet, full-without-ibs 5 slot/stage 5 slot/stage 8 slot/stage 8 slot/stage Minute created Minute created received received Number 1.5 2.0 1.5 2.0 2.0 0.0 2.0 1.5 Time from generation to receipt at node [s] Time from generation to receipt at node [s] Arrival delay for VT Arrival delay for VT Rust simulator, mini-mainnet, linear Rust simulator, mini-mainnet, linear, no txs 5 slot/stage 5 slot/stage 8 slot/stage 8 slot/stage Minute created Minute created received received Number 19 1.5 1.5 2.0 2.0 0.0 2.0 2.0 Time from generation to receipt at node [s] Time from generation to receipt at node [s]

Mean nodal ingress Rust simulator, mini-mainnet, linear-with-tx-references 5 slot/stage 8 slot/stage 2.0 -1.5 -Mean network ingress among nodes [Mb/s] Message EB TX VT 0.50 **-**0.25 **-**0.00 -12500 250 250 500 750 1000 500 750 1000 Slot [s] Mean nodal ingress Rust simulator, mini-mainnet, linear 5 slot/stage 8 slot/stage 20 **-**Mean network ingress among nodes [Mb/s] Message EB TX

250

500

750

1000

12500

Slot [s]

500

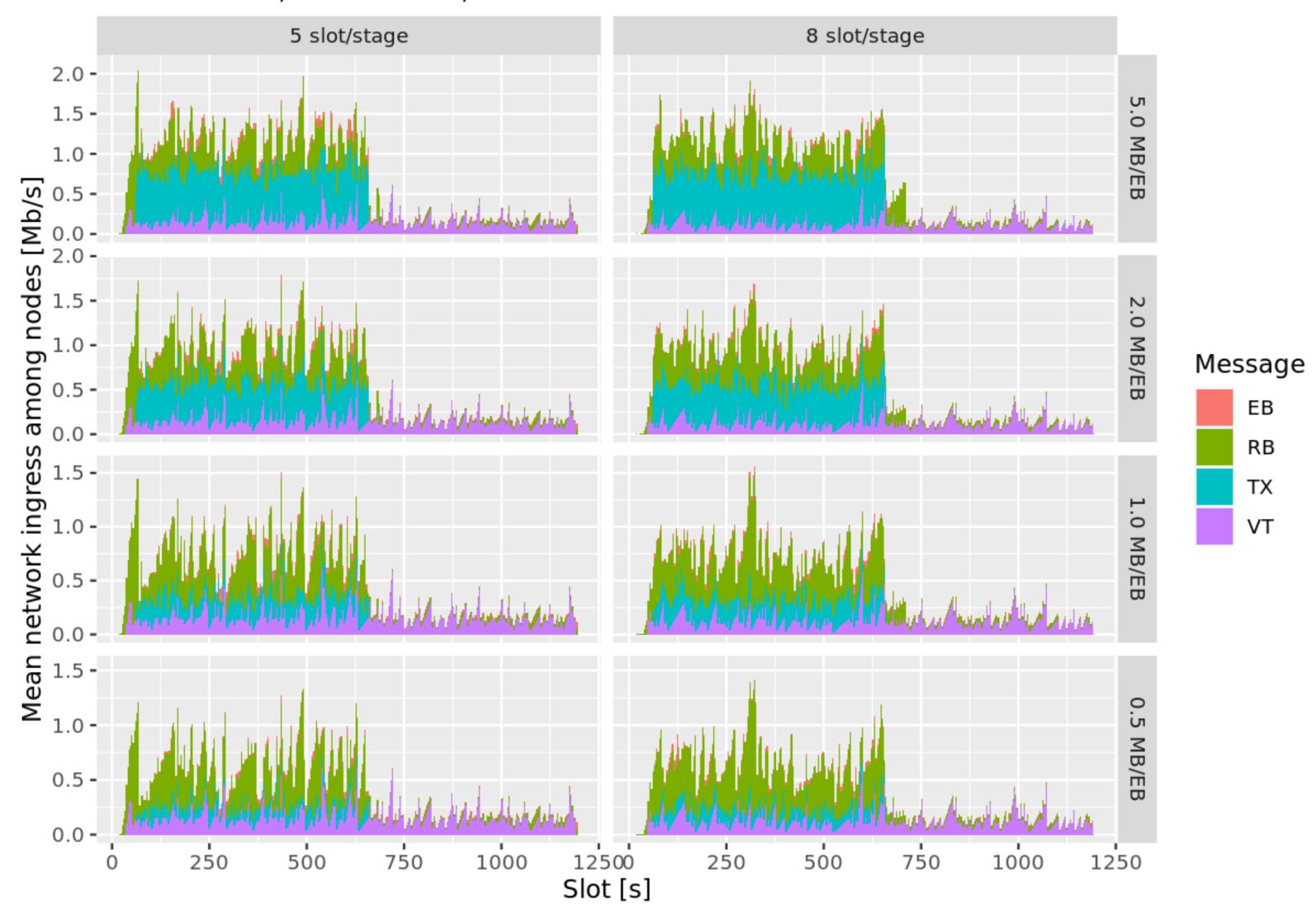
750

1000

250

0

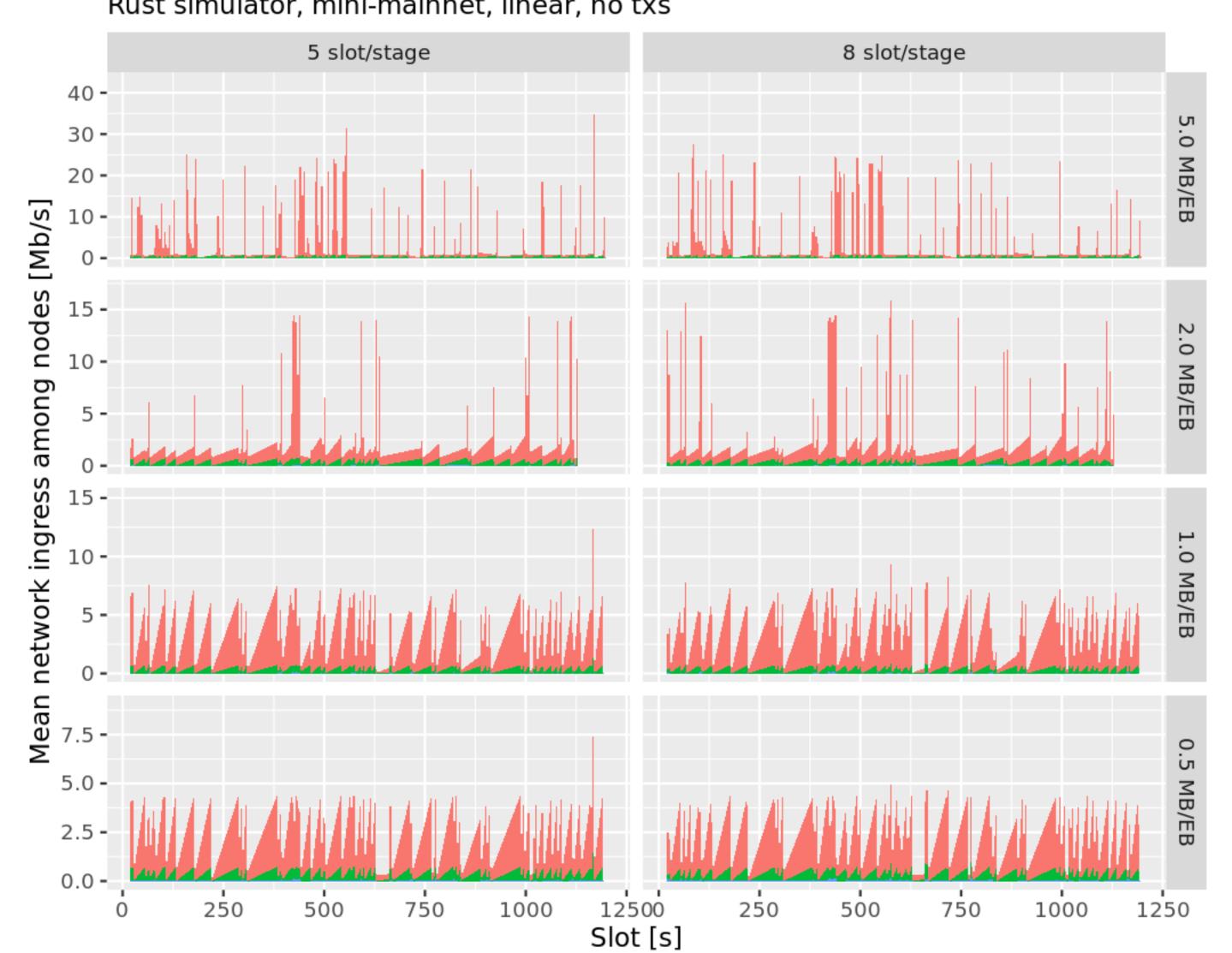
Mean nodal ingress Rust simulator, mini-mainnet, full-without-ibs

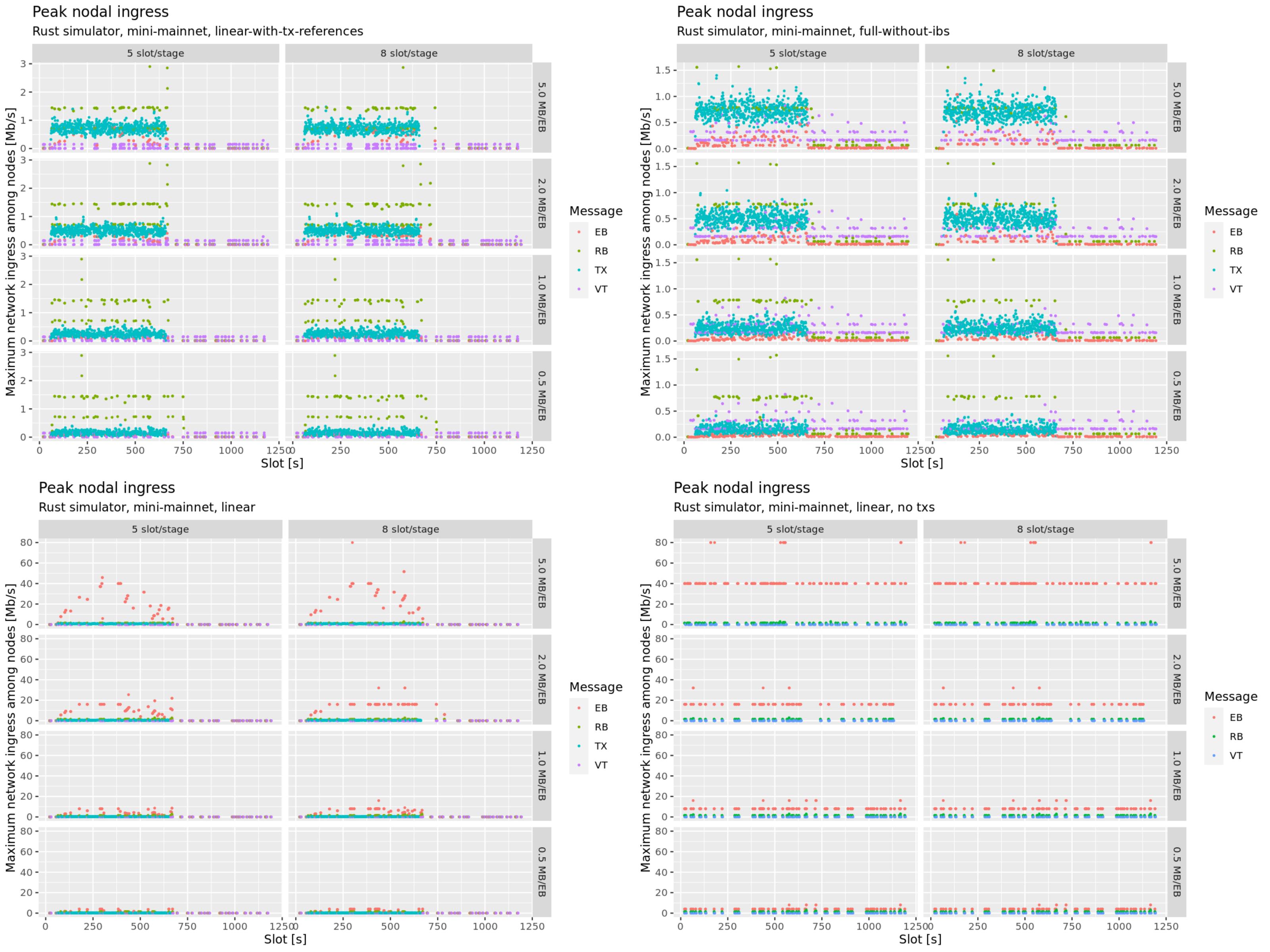


RB

Message

Mean nodal ingress Rust simulator, mini-mainnet, linear, no txs





Peak CPU load among all nodes Peak CPU load among all nodes Rust simulator, mini-mainnet, linear-with-tx-references Rust simulator, mini-mainnet, full-without-ibs 5 slot/stage 5 slot/stage 8 slot/stage 8 slot/stage 400 -5.0 MB/EB 300 -400 **-**200 -200 **-**100-400 -2.0 MB/EB 400 -300 **-**Number of slots slots 100 -Number 300 -1.0 MB/EB 200 **-**200 **-**100-400 -0.5 MB/EB 400 **-**300 -200 -200 -100-0 -100 300 200 200 300 200 300 200 300 100 100 100 Peak CPU load [%] Peak CPU load [%] Peak CPU load among all nodes Peak CPU load among all nodes Rust simulator, mini-mainnet, linear Rust simulator, mini-mainnet, linear, no txs 5 slot/stage 5 slot/stage 8 slot/stage 8 slot/stage 500 **-**150 **-**400 **-**5.0 MB/EB 300 -100-200 **-**50 **-**100-80 -2.0 MB/EB 400 -60 **-**Number of slots 40 slots 20 of Number 150 -1.0 MB/EB 200 **-**50 **-**0.5 MB/EB 90 -400 **-**60 **-**200 **-**30 **-**0 -200 200 200 400 200 400 400 400 Peak CPU load [%] Peak CPU load [%]

Mean CPU load among all nodes Mean CPU load among all nodes Rust simulator, mini-mainnet, linear-with-tx-references Rust simulator, mini-mainnet, full-without-ibs 5 slot/stage 5 slot/stage 8 slot/stage 8 slot/stage 12.5 **-**9 -10.0 -7.5 **-**6 **-**5.0 -3 **-**2.5 -0.0 -10.0 -Task 2.0 MB/EB 7.5 **-**2.0 MB/EB Task GenRB [%] CPU load [%] 5.0 -GenEB GenVote CPU load GenRB 2.5 **-**ValEB GenVote ValEH ValEB ValRB 6 **-**1.0 MB/EB 1.0 MB/EB Mean ValRB Mean ValRH ValTX ValTX ValVote ValVote 0 -2.0 -6 **-**1.5 -4 -1.0 -2 -0.5 -0.0 -0 -Mean CPU load among all nodes Mean CPU load among all nodes Rust simulator, mini-mainnet, linear Rust simulator, mini-mainnet, linear, no txs 5 slot/stage 5 slot/stage 8 slot/stage 8 slot/stage 15 **-**10-5 -Task 2.0 MB/EB Task 2.0 MB/EB GenRB CPU load [%] CPU load [%] GenRB GenVote GenVote ValEB ValEB ValEH ValEH ValRB 1.0 MB/EB Mean **Деал** 2-ValRB 1.0 MB/EB ValRH ValRH ValTX ValVote ValVote 0 -2.0 -1.5 **-**2 -1.0 -0.5 -0.0 -0 -