Simulation analysis

2025-08-15

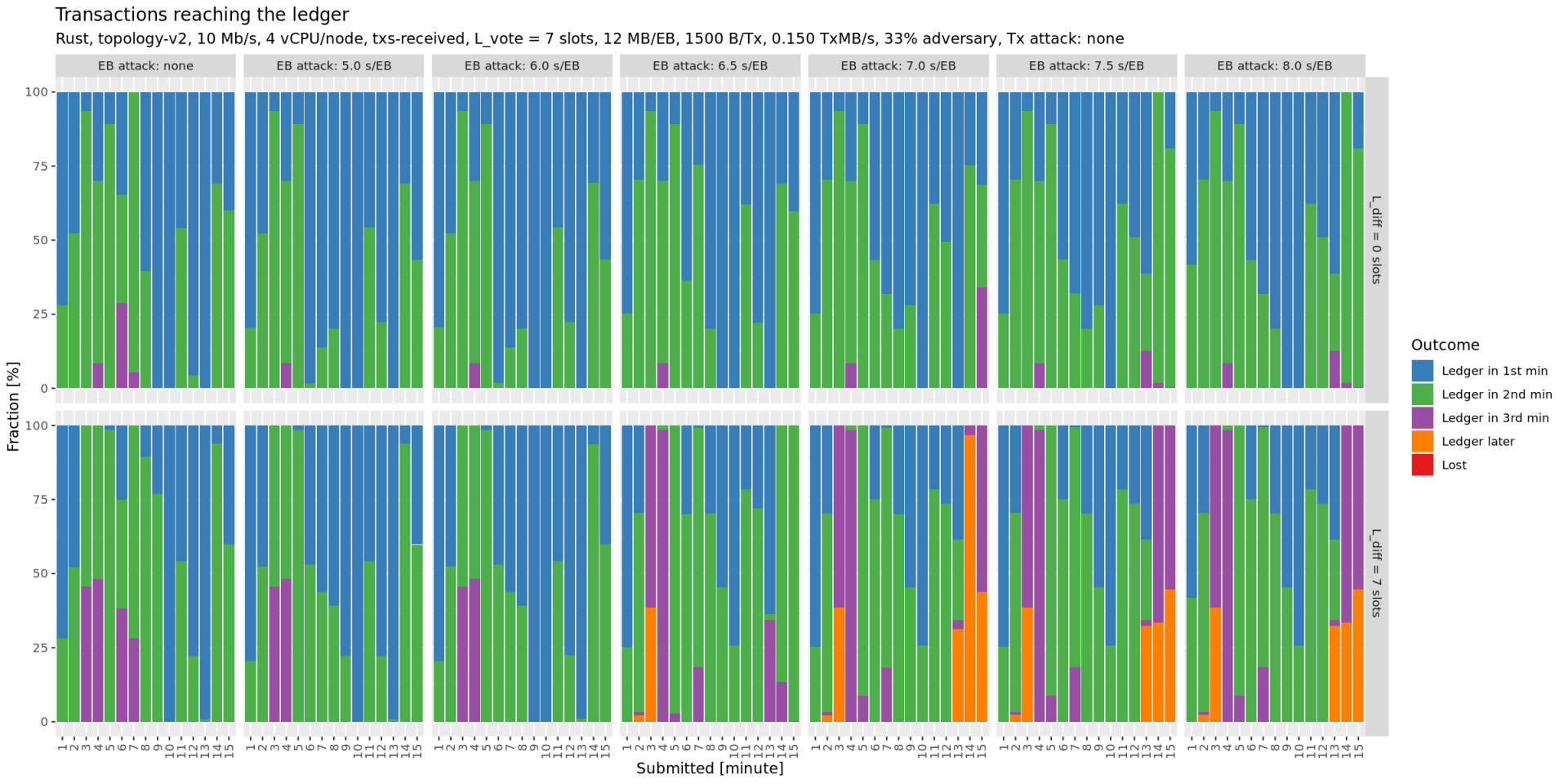
Attacks experiment @ 6eb32386

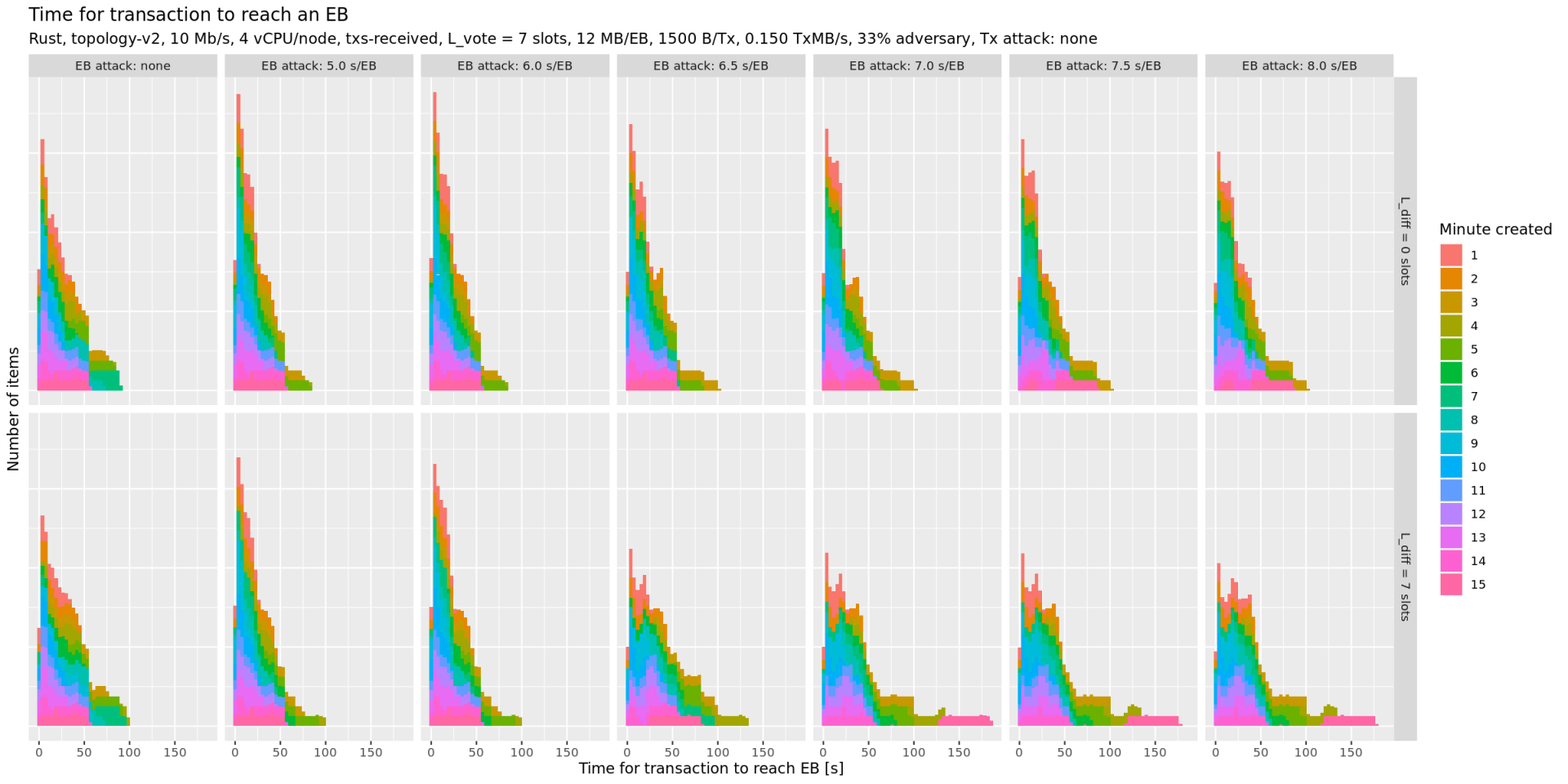
- Rust simulator
- Linear Leios
- Propagation
  - `txs-received`
- Maximum of 12 MB of txs referenced by each EB
- L_{vote} = 7 slots
- L_{diff} = 0 slots
- 33% adversarial stake

- EB attack
  - varied propagation delay
- Tx attack
  - 100% of adversarial EBs
- Throughput: 0.150 TxMb/s
- Tx size: 1500 B/Tx
- TPS: 100 Tx/s
- Mini-mainnet
- 4 vCPU/node
- 10 Mb/s bandwidth

Findings

- Efficiency starts dropping when EBs and transactions are delayed 6.5 seconds.
- Efficiency doesn’t continue dropping much after delays of 7 seconds.
- L_{diff} = 0s performs better than L_{diff} = 7s.
- None of the cases, using `txs-received`, loses transactions or bogs down.


Transactions reaching the ledger
Rust, topology-v2, 10 Mb/s, 4 vCPU/node, txs-received, L_vote = 7 slots, 12 MB/EB, 1500 B/Tx, 0.150 TxMB/s, 33% adversary, Tx attack: none
EB attack: none
EB attack: 5.0 s/EB
EB attack: 6.0 s/EB
EB attack: 6.5 s/EB
EB attack: 7.0 s/EB
EB attack: 7.5 s/EB
EB attack: 8.0 s/EB
L_diff = 0 slots
L_diff = 7 slots
Fraction [%]
0
25
50
75
100
Submitted [minute]
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
Outcome
Ledger in 1st min
Ledger in 2nd min
Ledger in 3rd min
Ledger later
Lost


Time for transaction to reach an EB
Rust, topology-v2, 10 Mb/s, 4 vCPU/node, txs-received, L_vote = 7 slots, 12 MB/EB, 1500 B/Tx, 0.150 TxMB/s, 33% adversary, Tx attack: none
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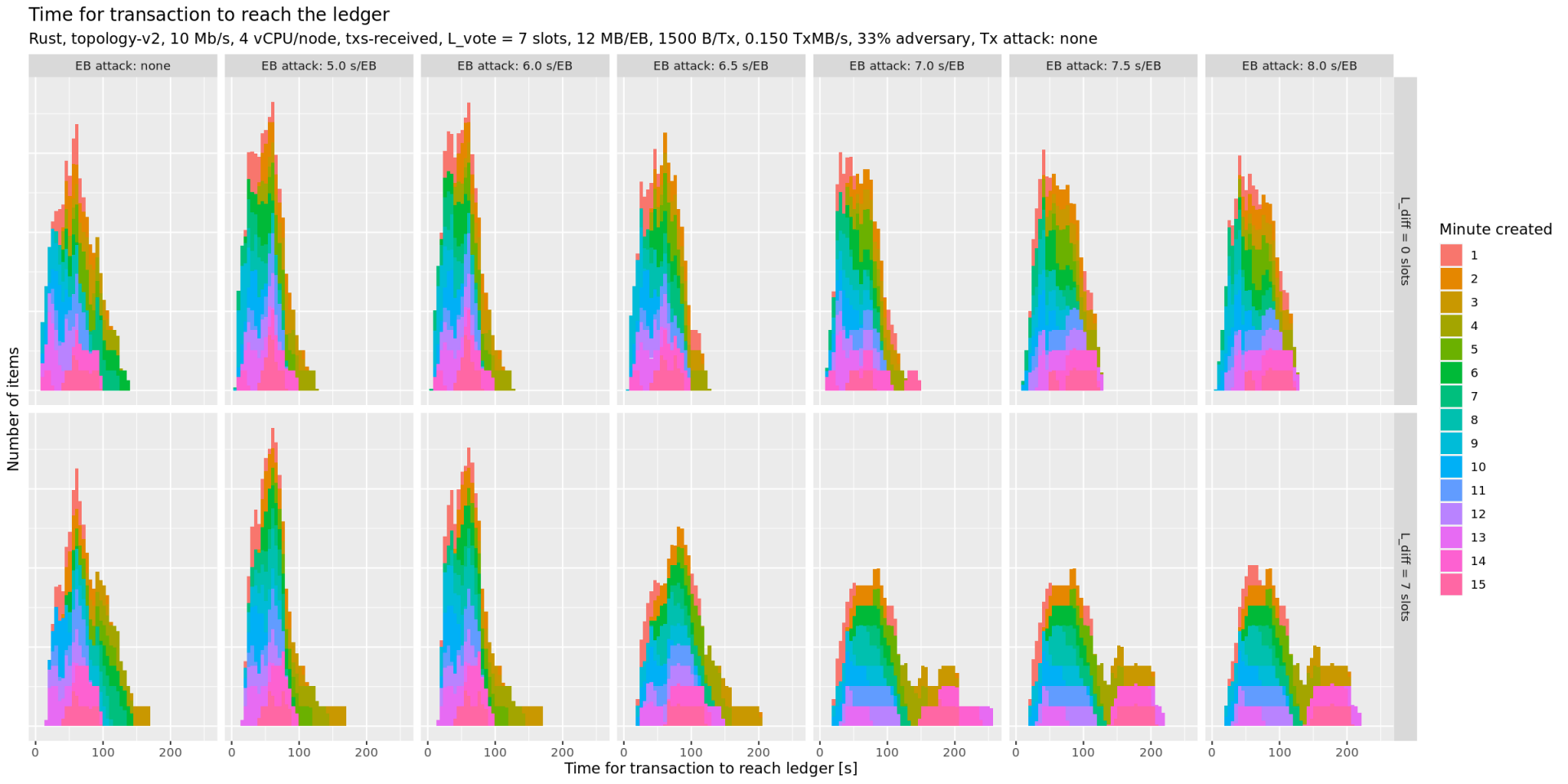
EB attack: 6.5 s/EB
EB attack: 7.0 s/EB
EB attack: 7.5 s/EB
EB attack: 8.0 s/EB
L_diff = 0 slots
L_diff = 7 slots
Number of items
0
50
100
150
Time for transaction to reach EB [s]
Minute created
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15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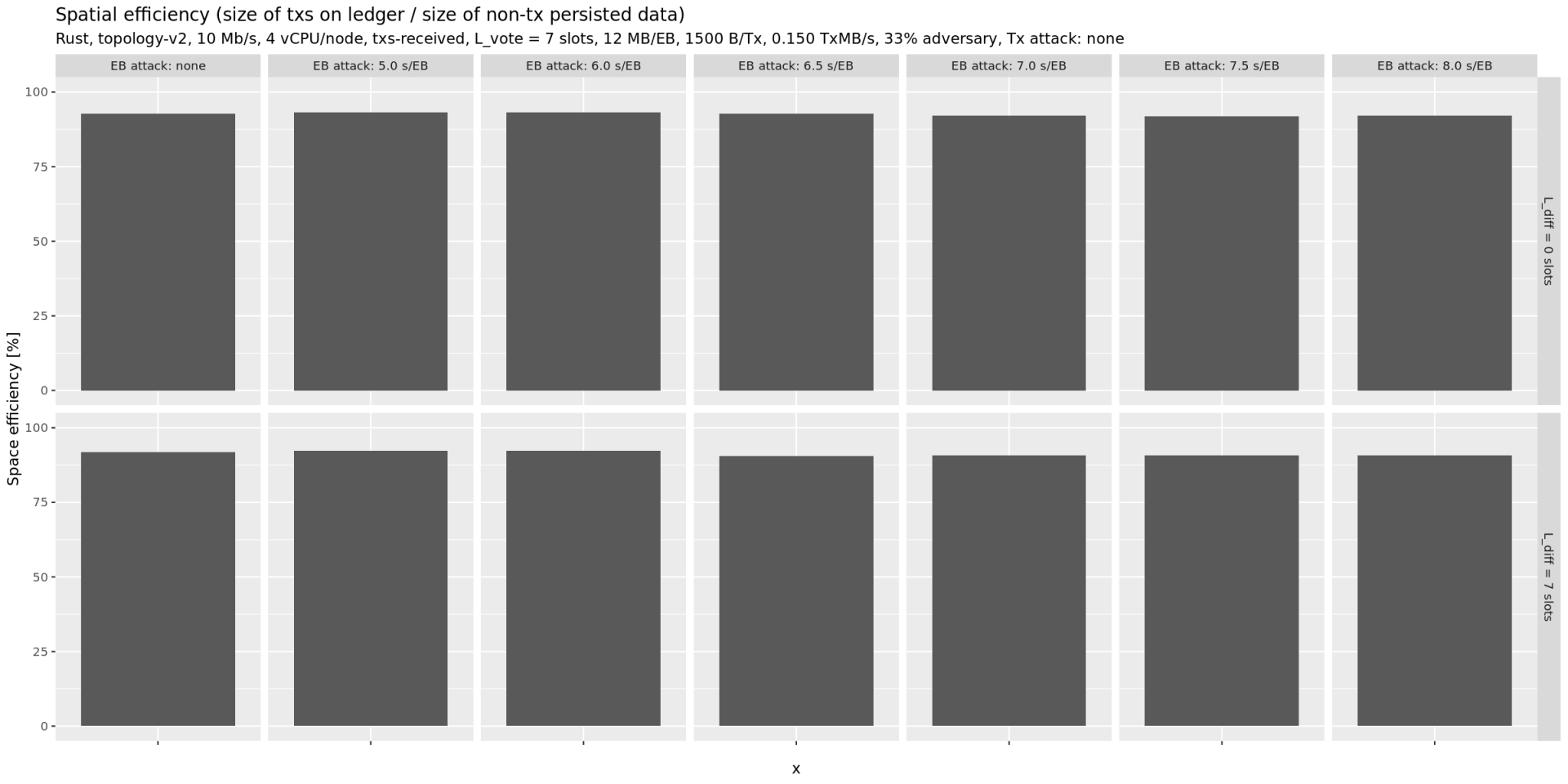
EB attack: 6.0 s/EB
EB attack: 6.5 s/EB
EB attack: 7.0 s/EB
EB attack: 7.5 s/EB
EB attack: 8.0 s/EB
L_diff = 0 slots
L_diff = 7 slots
Number of items
0
100
200
Time for transaction to reach ledger [s]
Minute created
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15


Spatial efficiency (size of txs on ledger / size of non-tx persisted data)
Rust, topology-v2, 10 Mb/s, 4 vCPU/node, txs-received, L_vote = 7 slots, 12 MB/EB, 1500 B/Tx, 0.150 TxMB/s, 33% adversary, Tx attack: none
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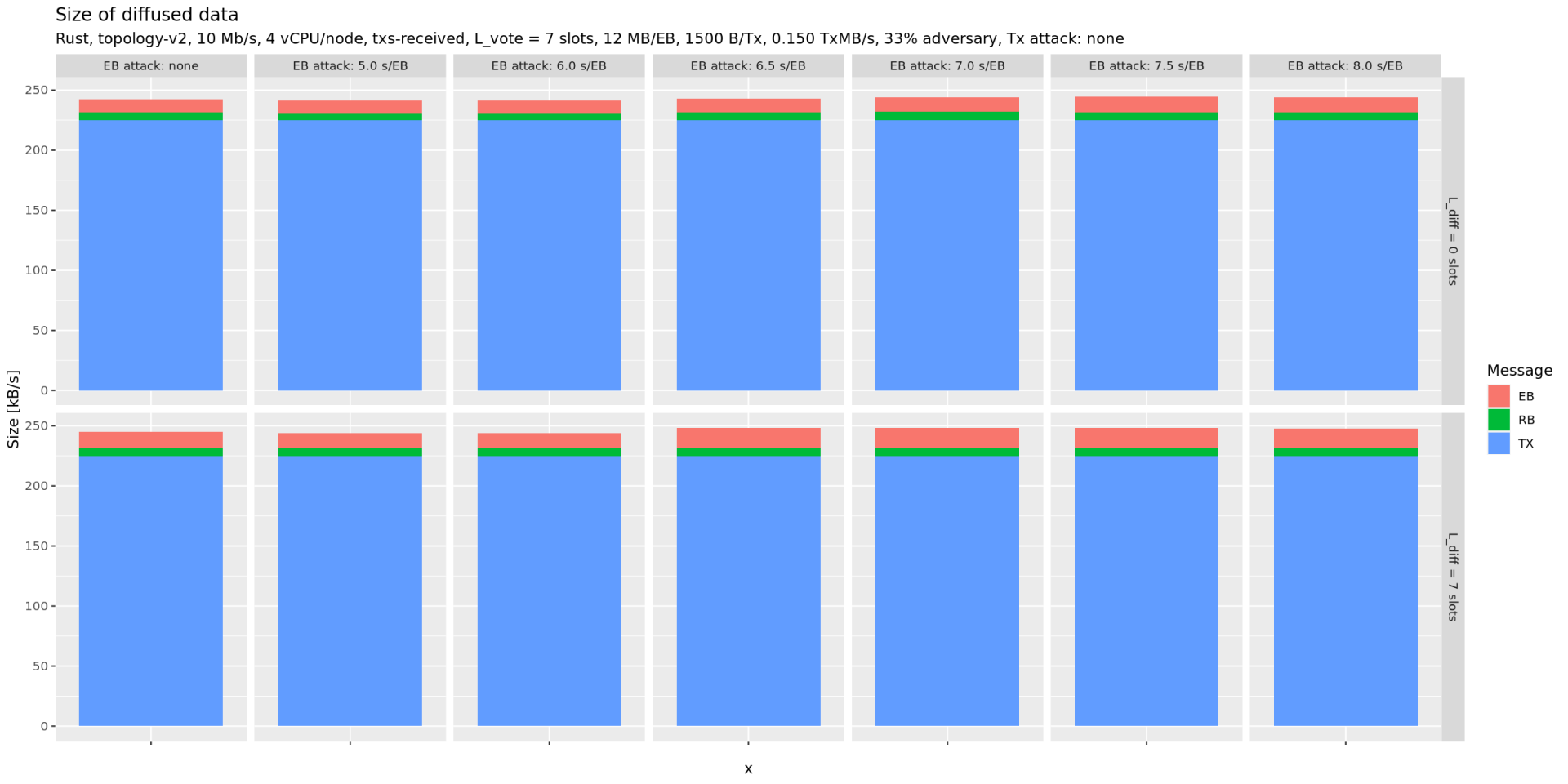
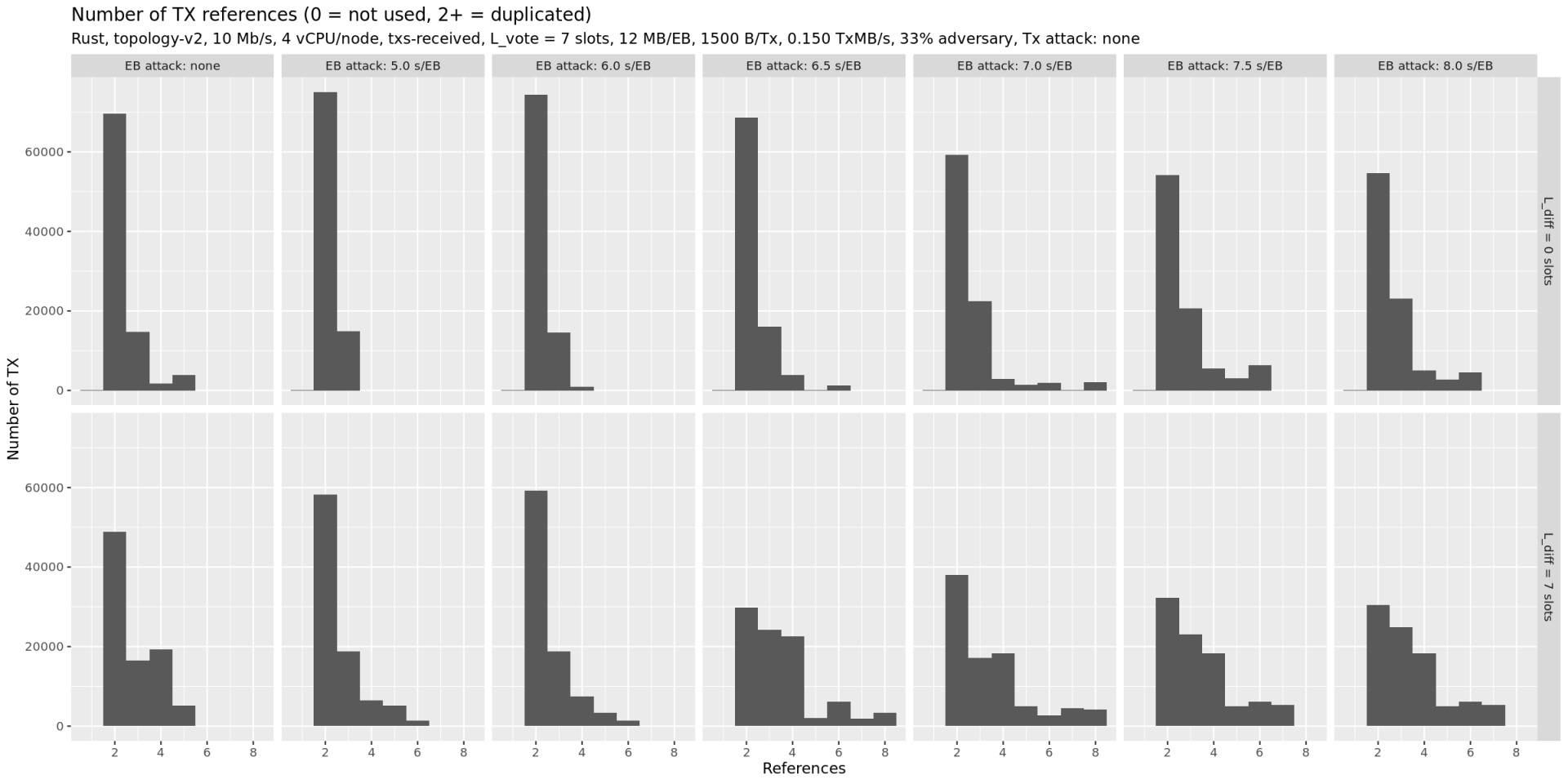
EB attack: 7.5 s/EB
EB attack: 8.0 s/EB
L_diff = 0 slots
L_diff = 7 slots
Space efficiency [%]
100
75
50
25
0
x


Size of diffused data
Rust, topology-v2, 10 Mb/s, 4 vCPU/node, txs-received, L_vote = 7 slots, 12 MB/EB, 1500 B/Tx, 0.150 TxMB/s, 33% adversary, Tx attack: none
EB attack: none
EB attack: 5.0 s/EB
EB attack: 6.0 s/EB
EB attack: 6.5 s/EB
EB attack: 7.0 s/EB
EB attack: 7.5 s/EB
EB attack: 8.0 s/EB
L_diff = 0 slots
L_diff = 7 slots
Size [kB/s]
0
50
100
150
200
250
x
Message
EB
RB
TX


Number of TX references (0 = not used, 2+ = duplicated)
Rust, topology-v2, 10 Mb/s, 4 vCPU/node, txs-received, L_vote = 7 slots, 12 MB/EB, 1500 B/Tx, 0.150 TxMB/s, 33% adversary, Tx attack: none
EB attack: none
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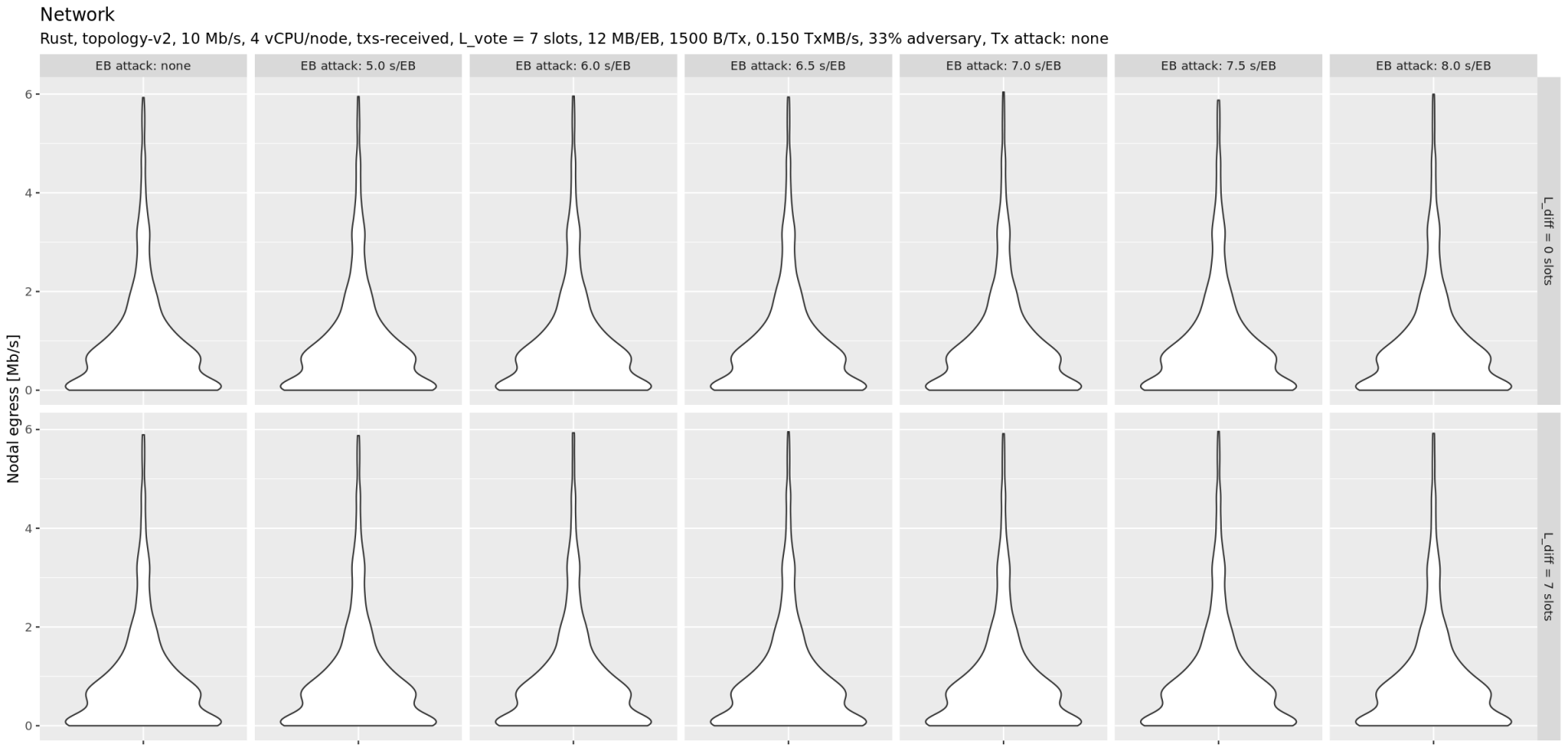
EB attack: 6.0 s/EB
EB attack: 6.5 s/EB
EB attack: 7.0 s/EB
EB attack: 7.5 s/EB
EB attack: 8.0 s/EB
L_diff = 0 slots
L_diff = 7 slots
Number of TX
0
20000
40000
60000
References
2
4
6
8


Network
Rust, topology-v2, 10 Mb/s, 4 vCPU/node, txs-received, L_vote = 7 slots, 12 MB/EB, 1500 B/Tx, 0.150 TxMB/s, 33% adversary, Tx attack: none
EB attack: none
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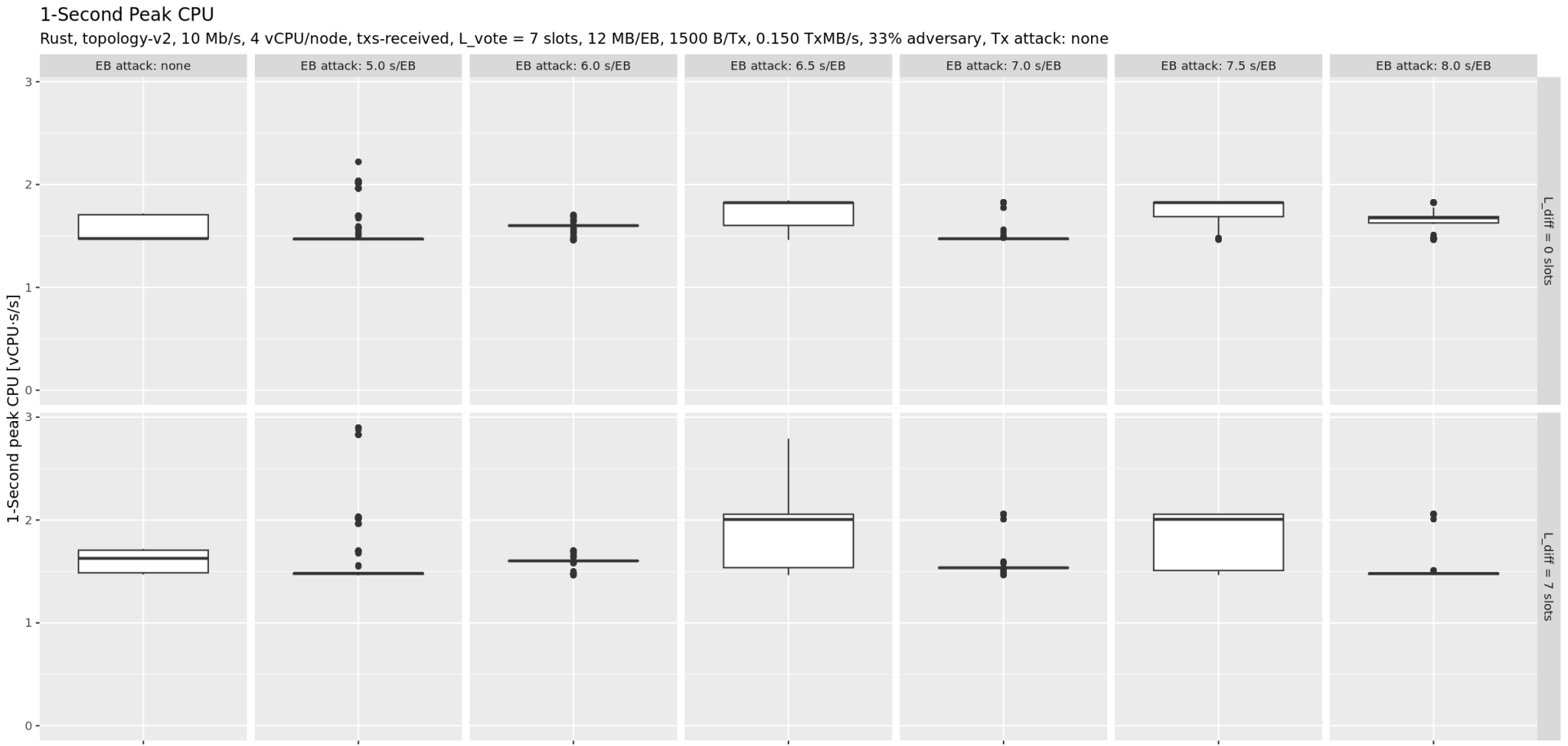
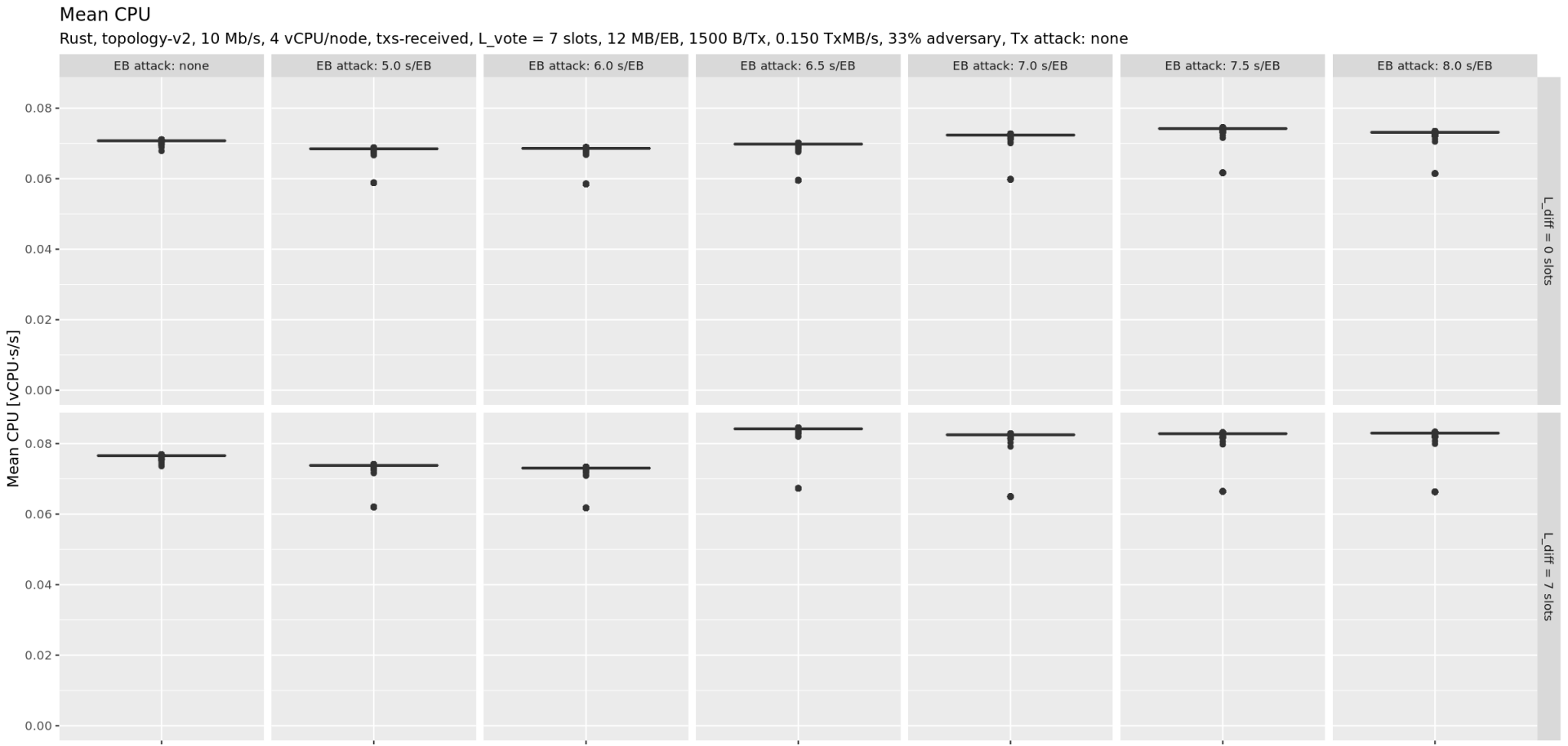
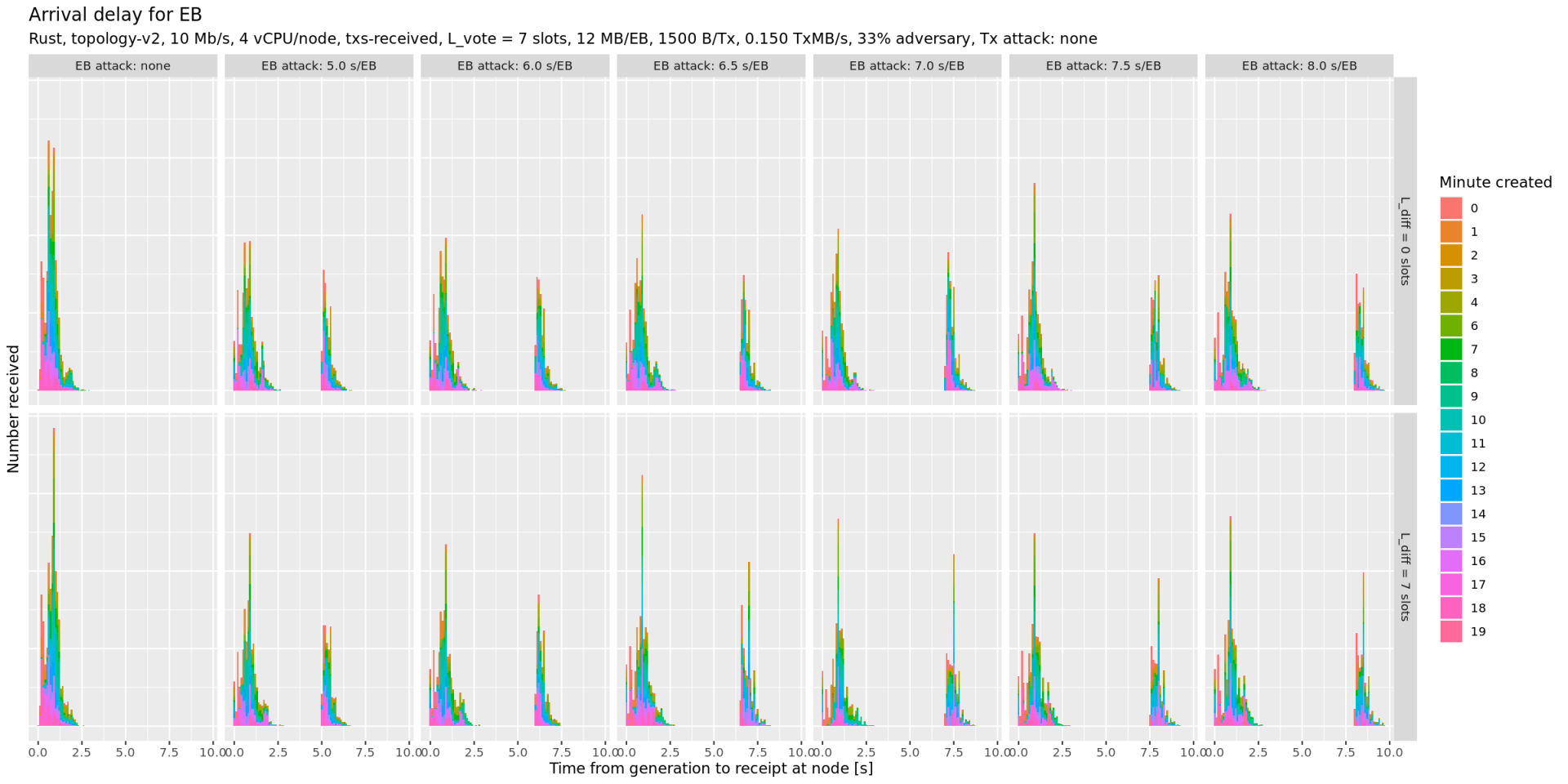
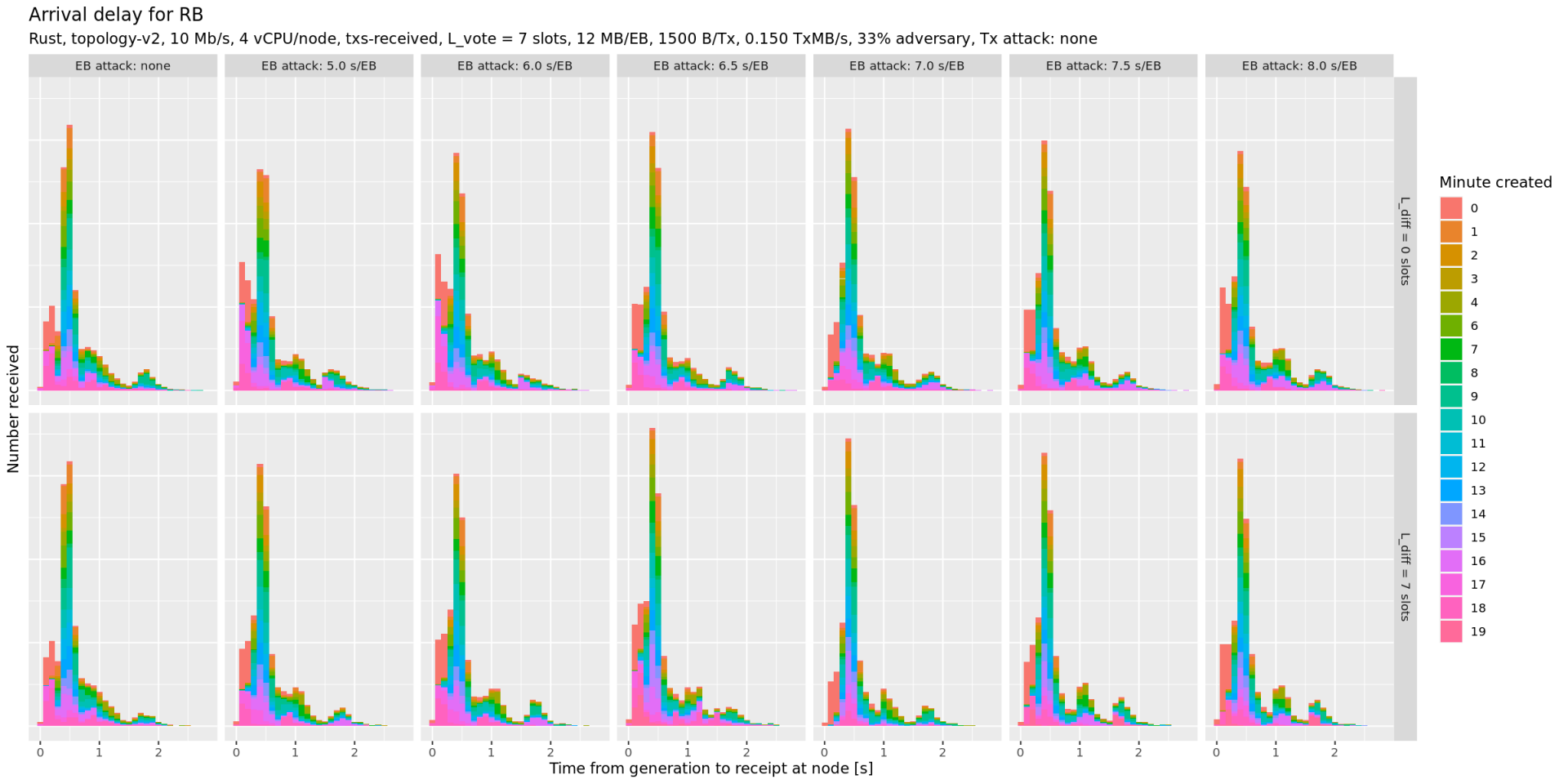
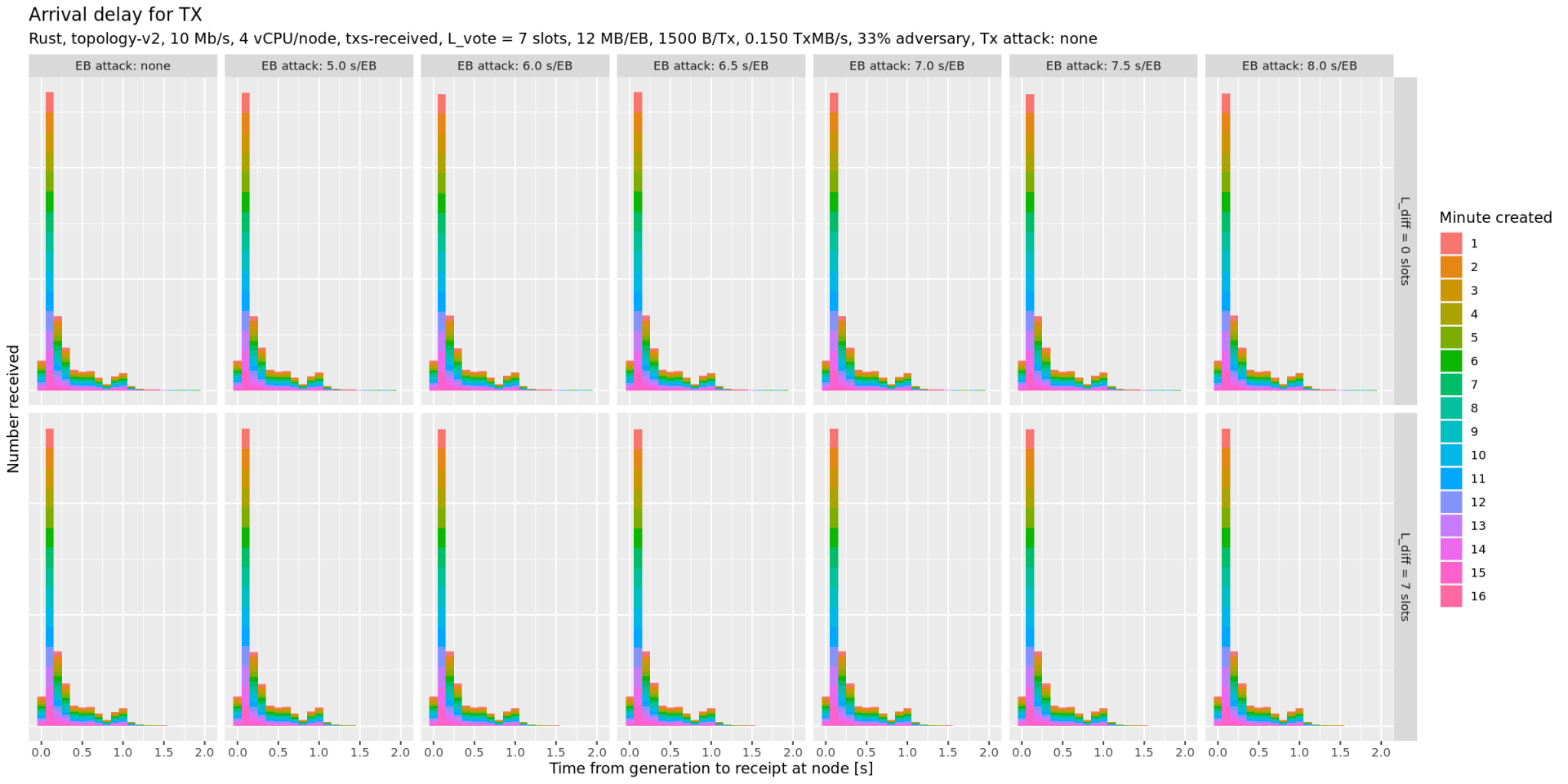
EB attack: 6.0 s/EB
EB attack: 6.5 s/EB
EB attack: 7.0 s/EB
EB attack: 7.5 s/EB
EB attack: 8.0 s/EB
L_diff = 0 slots
L_diff = 7 slots
Nodal egress [Mb/s]
0
2
4
6

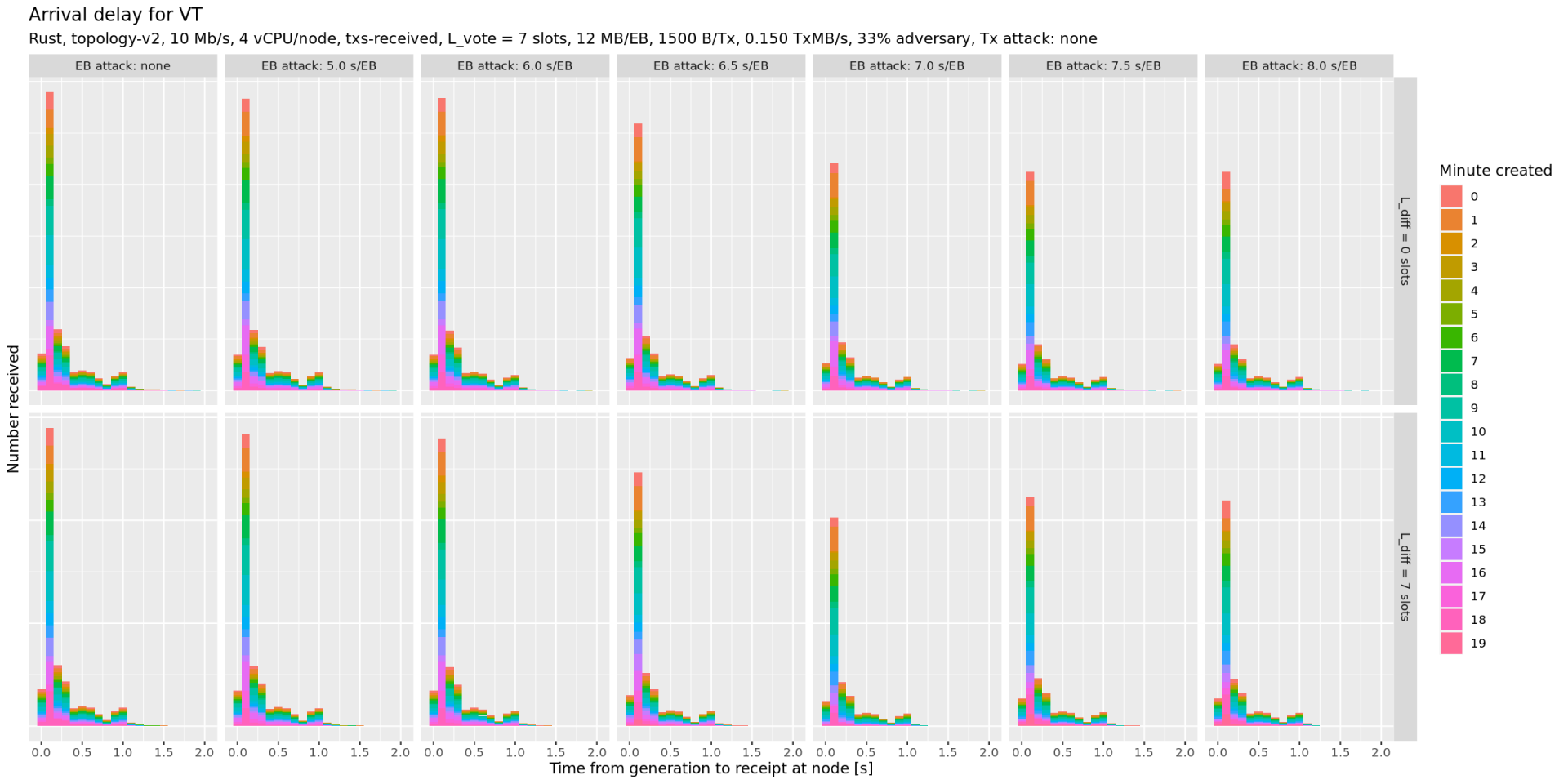

1-Second Peak CPU
Rust, topology-v2, 10 Mb/s, 4 vCPU/node, txs-received, L_vote = 7 slots, 12 MB/EB, 1500 B/Tx, 0.150 TxMB/s, 33% adversary, Tx attack: none
EB attack: none
EB attack: 5.0 s/EB
EB attack: 6.0 s/EB
EB attack: 6.5 s/EB
EB attack: 7.0 s/EB
EB attack: 7.5 s/EB
EB attack: 8.0 s/EB
L_diff = 0 slots
L_diff = 7 slots
1-Second peak CPU [vCPU·s/s]
0
1
2
3

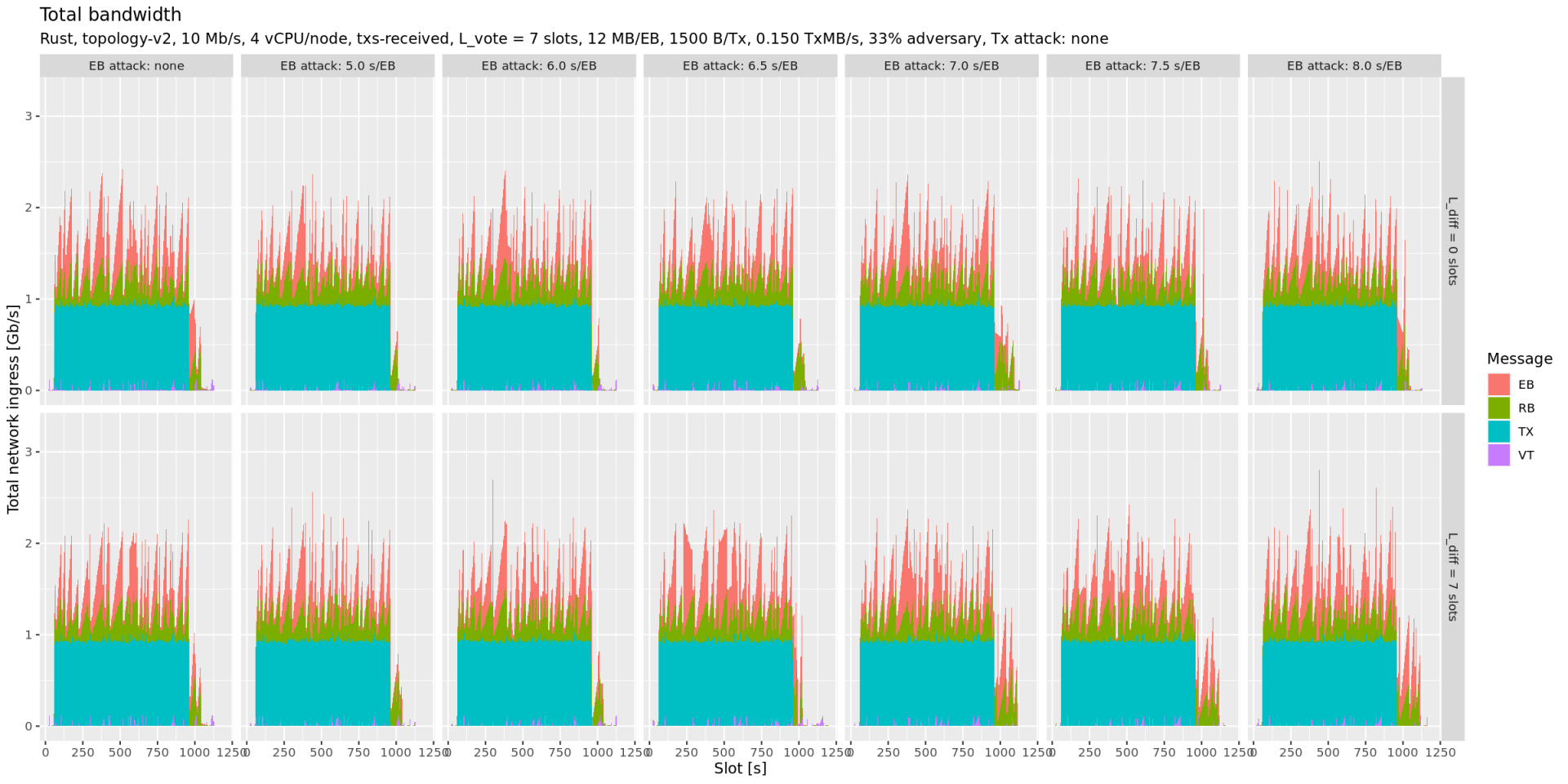

Mean CPU
Rust, topology-v2, 10 Mb/s, 4 vCPU/node, txs-received, L_vote = 7 slots, 12 MB/EB, 1500 B/Tx, 0.150 TxMB/s, 33% adversary, Tx attack: none
EB attack: none
EB attack: 5.0 s/EB
EB attack: 6.0 s/EB
EB attack: 6.5 s/EB
EB attack: 7.0 s/EB
EB attack: 7.5 s/EB
EB attack: 8.0 s/EB
L_diff = 0 slots
L_diff = 7 slots
Mean CPU [vCPU·s/s]
0.08
0.06
0.04
0.02
0.00

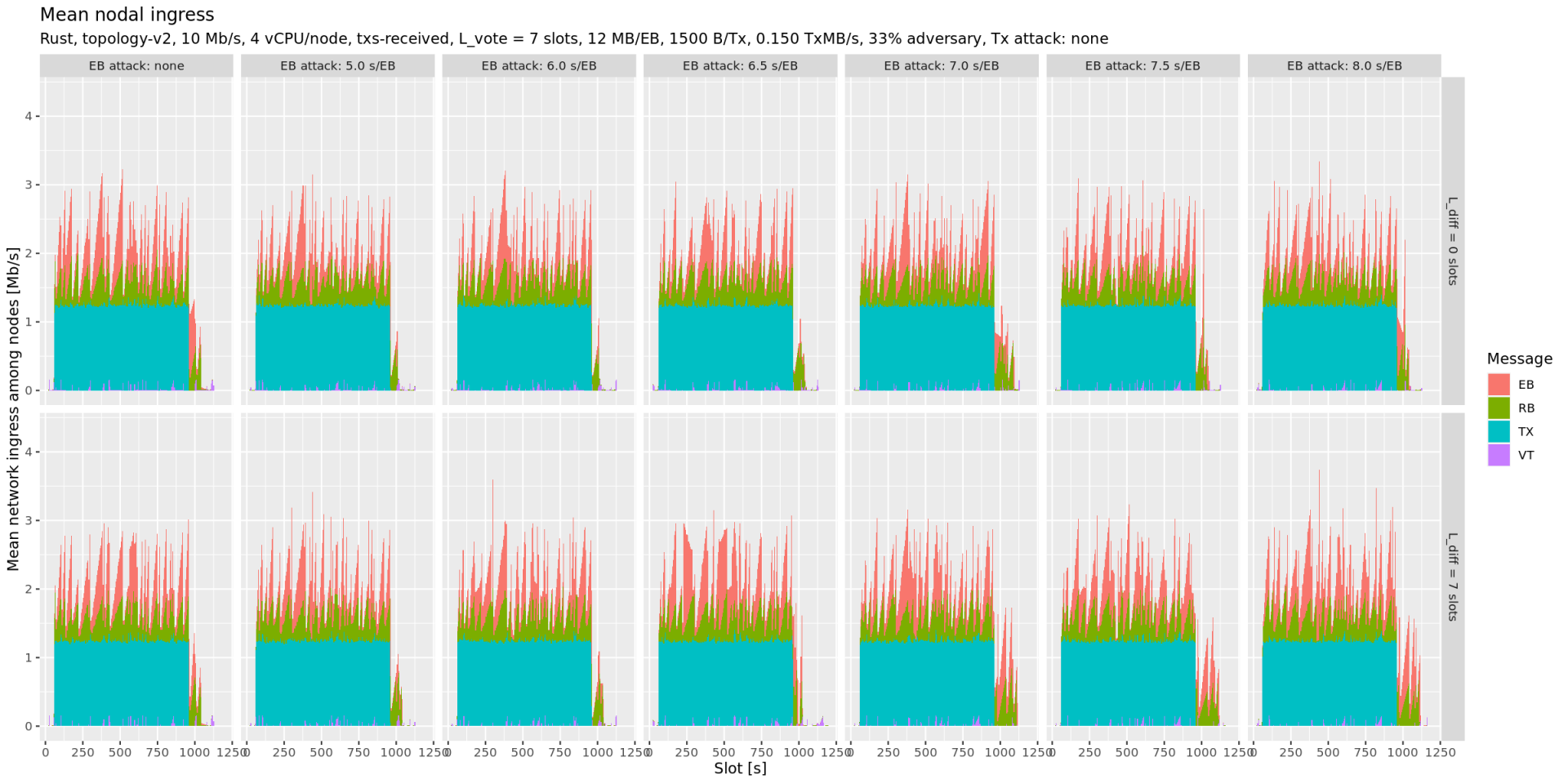

Arrival delay for EB
Rust, topology-v2, 10 Mb/s, 4 vCPU/node, txs-received, L_vote = 7 slots, 12 MB/EB, 1500 B/Tx, 0.150 TxMB/s, 33% adversary, Tx attack: none
EB attack: none
EB attack: 5.0 s/EB
EB attack: 6.0 s/EB
EB attack: 6.5 s/EB
EB attack: 7.0 s/EB
EB attack: 7.5 s/EB
EB attack: 8.0 s/EB
L_diff = 0 slots
L_diff = 7 slots
Number received
0.0
2.5
5.0
7.5
10.0
Time from generation to receipt at node [s]
Minute created
0
1
2
3
4
6
7
8
9
10
11
12
13
14
15
16
17
18
19


Arrival delay for RB
Rust, topology-v2, 10 Mb/s, 4 vCPU/node, txs-received, L_vote = 7 slots, 12 MB/EB, 1500 B/Tx, 0.150 TxMB/s, 33% adversary, Tx attack: none
EB attack: none
EB attack: 5.0 s/EB
EB attack: 6.0 s/EB
EB attack: 6.5 s/EB
EB attack: 7.0 s/EB
EB attack: 7.5 s/EB
EB attack: 8.0 s/EB
L_diff = 0 slots
L_diff = 7 slots
Number received
Time from generation to receipt at node [s]
Minute created
0
1
2
3
4
6
7
8
9
10
11
12
13
14
15
16
17
18
19


Arrival delay for TX
Rust, topology-v2, 10 Mb/s, 4 vCPU/node, txs-received, L_vote = 7 slots, 12 MB/EB, 1500 B/Tx, 0.150 TxMB/s, 33% adversary, Tx attack: none
EB attack: none
EB attack: 5.0 s/EB
EB attack: 6.0 s/EB
EB attack: 6.5 s/EB
EB attack: 7.0 s/EB
EB attack: 7.5 s/EB
EB attack: 8.0 s/EB
L_diff = 0 slots
L_diff = 7 slots
Number received
0.0
0.5
1.0
1.5
2.0
Time from generation to receipt at node [s]
Minute created
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16


Arrival delay for VT
Rust, topology-v2, 10 Mb/s, 4 vCPU/node, txs-received, L_vote = 7 slots, 12 MB/EB, 1500 B/Tx, 0.150 TxMB/s, 33% adversary, Tx attack: none
EB attack: none
EB attack: 5.0 s/EB
EB attack: 6.0 s/EB
EB attack: 6.5 s/EB
EB attack: 7.0 s/EB
EB attack: 7.5 s/EB
EB attack: 8.0 s/EB
L_diff = 0 slots
L_diff = 7 slots
Number received
0.0 0.5 1.0 1.5 2.0
Time from generation to receipt at node [s]
Minute created
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19


Total bandwidth
Rust, topology-v2, 10 Mb/s, 4 vCPU/node, txs-received, L_vote = 7 slots, 12 MB/EB, 1500 B/Tx, 0.150 TxMB/s, 33% adversary, Tx attack: none
EB attack: none
EB attack: 5.0 s/EB
EB attack: 6.0 s/EB
EB attack: 6.5 s/EB
EB attack: 7.0 s/EB
EB attack: 7.5 s/EB
EB attack: 8.0 s/EB
L_diff = 0 slots
L_diff = 7 slots
Total network ingress [Gb/s]
Slot [s]
Message
EB
RB
TX
VT


Mean nodal ingress
Rust, topology-v2, 10 Mb/s, 4 vCPU/node, txs-received, L_vote = 7 slots, 12 MB/EB, 1500 B/Tx, 0.150 TxMB/s, 33% adversary, Tx attack: none
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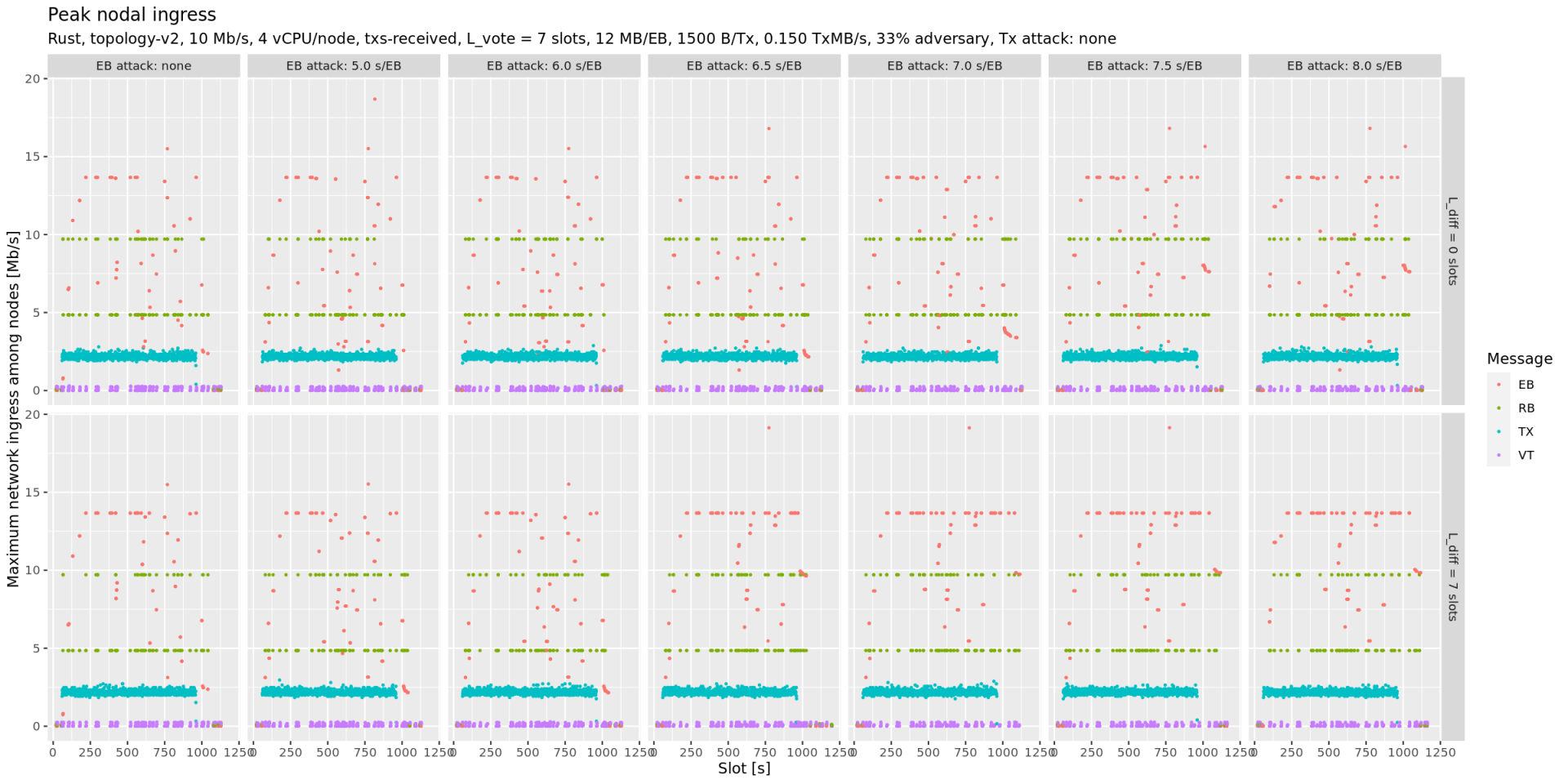
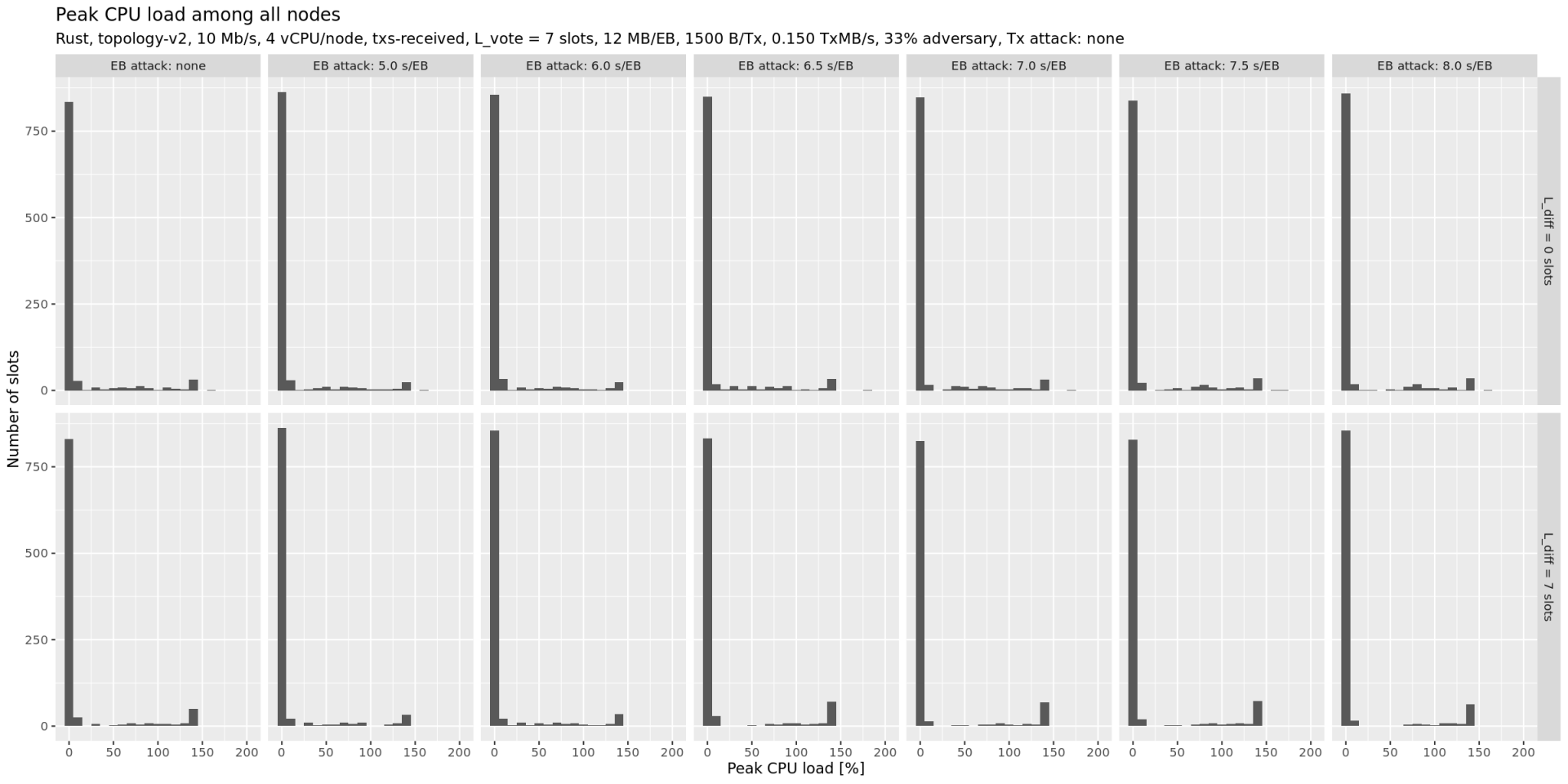
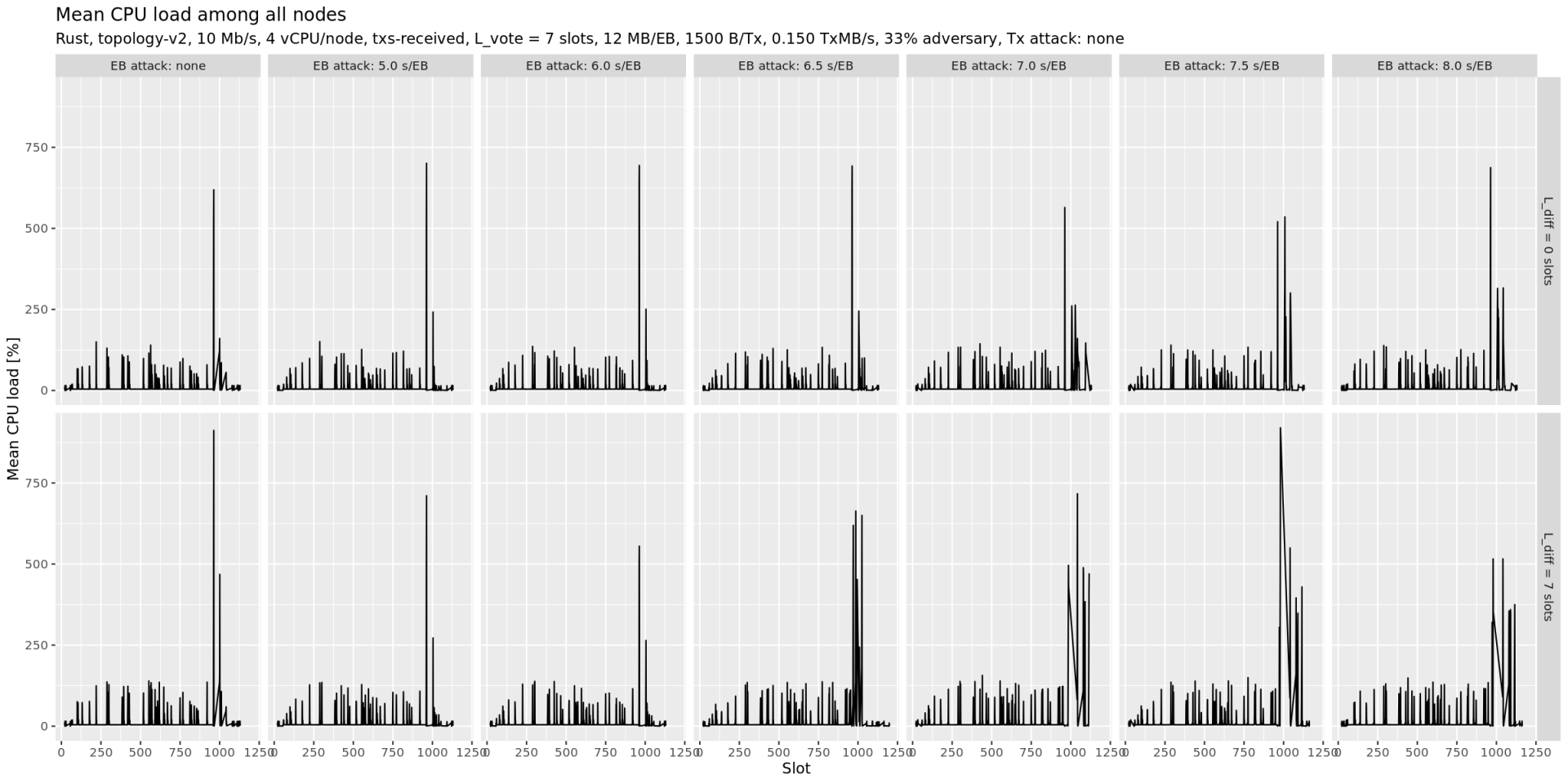
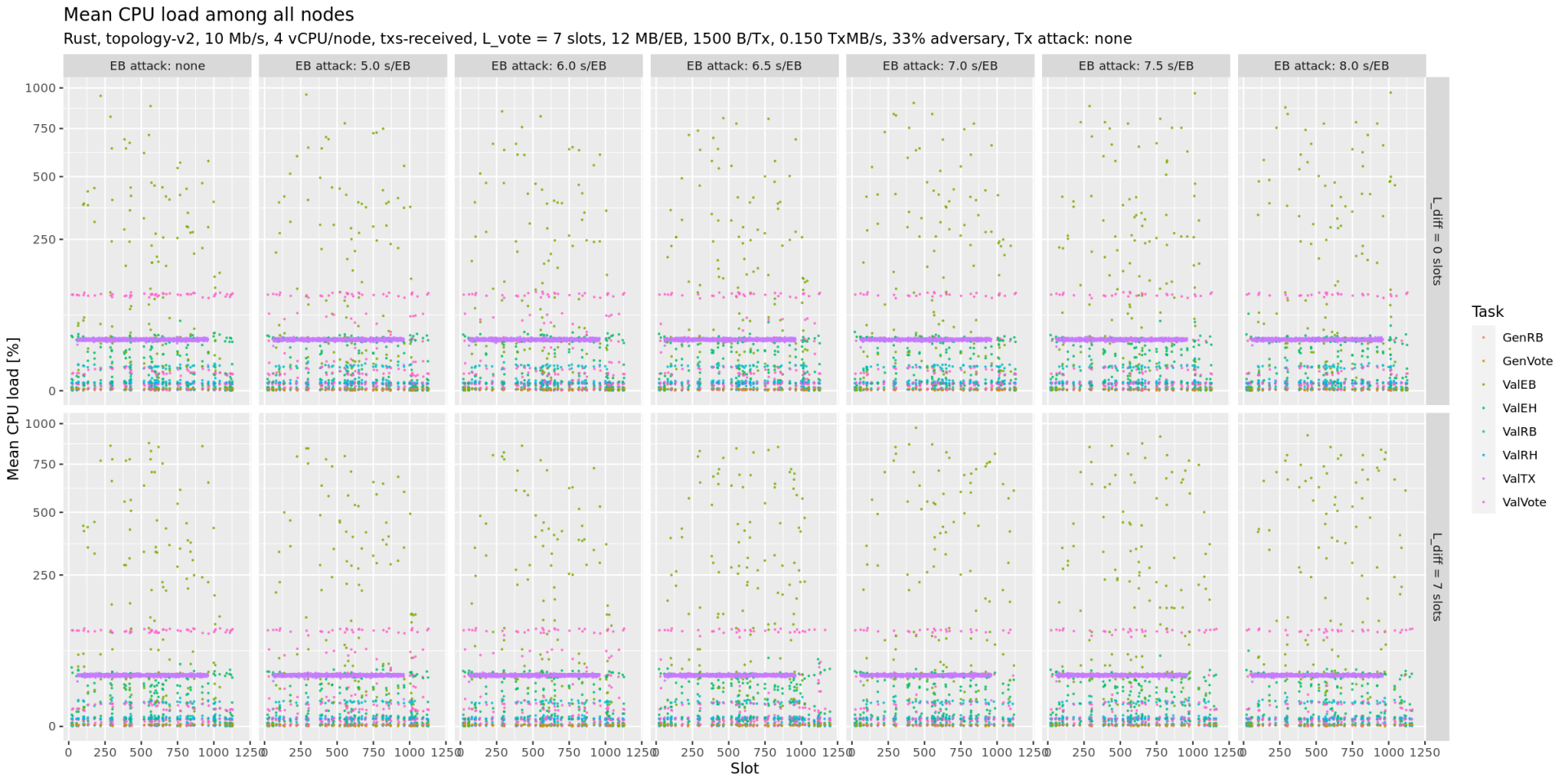
EB attack: 6.0 s/EB
EB attack: 6.5 s/EB
EB attack: 7.0 s/EB
EB attack: 7.5 s/EB
EB attack: 8.0 s/EB
L_diff = 0 slots
L_diff = 7 slots
Mean network ingress among nodes [Mb/s]
Slot [s]
Message
EB
RB
TX
VT


Peak nodal ingress
Rust, topology-v2, 10 Mb/s, 4 vCPU/node, txs-received, L_vote = 7 slots, 12 MB/EB, 1500 B/Tx, 0.150 TxMB/s, 33% adversary, Tx attack: none
EB attack: none
EB attack: 5.0 s/EB
EB attack: 6.0 s/EB
EB attack: 6.5 s/EB
EB attack: 7.0 s/EB
EB attack: 7.5 s/EB
EB attack: 8.0 s/EB
L_diff = 0 slots
L_diff = 7 slots
Maximum network ingress among nodes [Mb/s]
Slot [s]
Message
EB
RB
TX
VT


Peak CPU load among all nodes
Rust, topology-v2, 10 Mb/s, 4 vCPU/node, txs-received, L_vote = 7 slots, 12 MB/EB, 1500 B/Tx, 0.150 TxMB/s, 33% adversary, Tx attack: none
EB attack: none
EB attack: 5.0 s/EB
EB attack: 6.0 s/EB
EB attack: 6.5 s/EB
EB attack: 7.0 s/EB
EB attack: 7.5 s/EB
EB attack: 8.0 s/EB
L_diff = 0 slots
L_diff = 7 slots
Number of slots
0
250
500
750
0
50
100
150
200
Peak CPU load [%]


Mean CPU load among all nodes
Rust, topology-v2, 10 Mb/s, 4 vCPU/node, txs-received, L_vote = 7 slots, 12 MB/EB, 1500 B/Tx, 0.150 TxMB/s, 33% adversary, Tx attack: none
EB attack: none
EB attack: 5.0 s/EB
EB attack: 6.0 s/EB
EB attack: 6.5 s/EB
EB attack: 7.0 s/EB
EB attack: 7.5 s/EB
EB attack: 8.0 s/EB
L_diff = 0 slots
L_diff = 7 slots
Mean CPU load [%]
0
250
500
750
0
250
500
750
1000
1250
Slot


Mean CPU load among all nodes
Rust, topology-v2, 10 Mb/s, 4 vCPU/node, txs-received, L_vote = 7 slots, 12 MB/EB, 1500 B/Tx, 0.150 TxMB/s, 33% adversary, Tx attack: none
EB attack: none
EB attack: 5.0 s/EB
EB attack: 6.0 s/EB
EB attack: 6.5 s/EB
EB attack: 7.0 s/EB
EB attack: 7.5 s/EB
EB attack: 8.0 s/EB
L_diff = 0 slots
L_diff = 7 slots
Mean CPU load [%]
10.0
7.5
5.0
2.5
0.0
Task
GenRB
GenVote
ValEB
ValEH
ValRB
ValRH
ValTX
ValVote


Mean CPU load among all nodes
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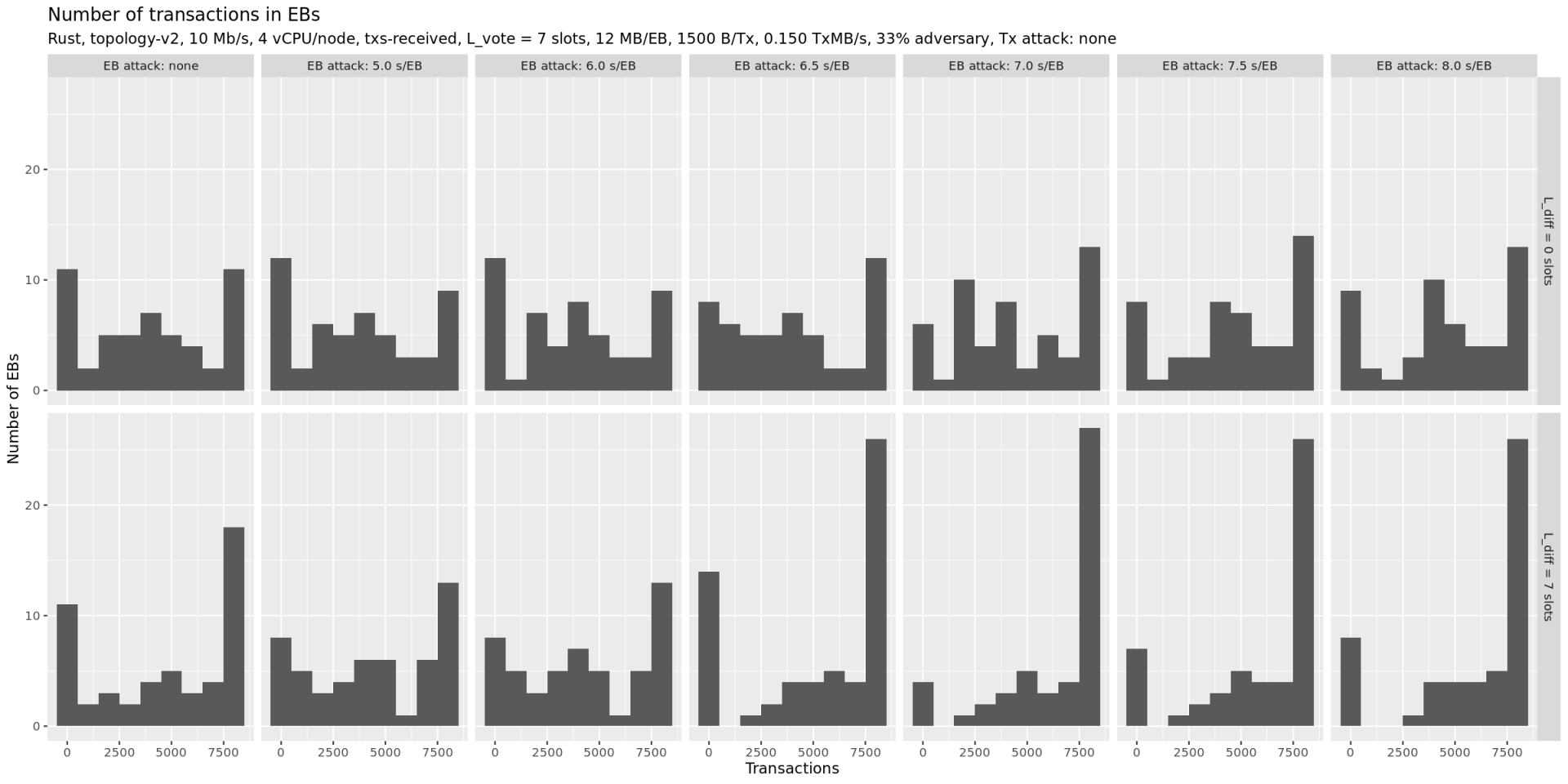
EB attack: 5.0 s/EB
EB attack: 6.0 s/EB
EB attack: 6.5 s/EB
EB attack: 7.0 s/EB
EB attack: 7.5 s/EB
EB attack: 8.0 s/EB
L_diff = 0 slots
L_diff = 7 slots
Mean CPU load [%]
Slot
Task
GenRB
GenVote
ValEB
ValEH
ValRB
ValRH
ValTX
ValVote


Number of transactions in EBs
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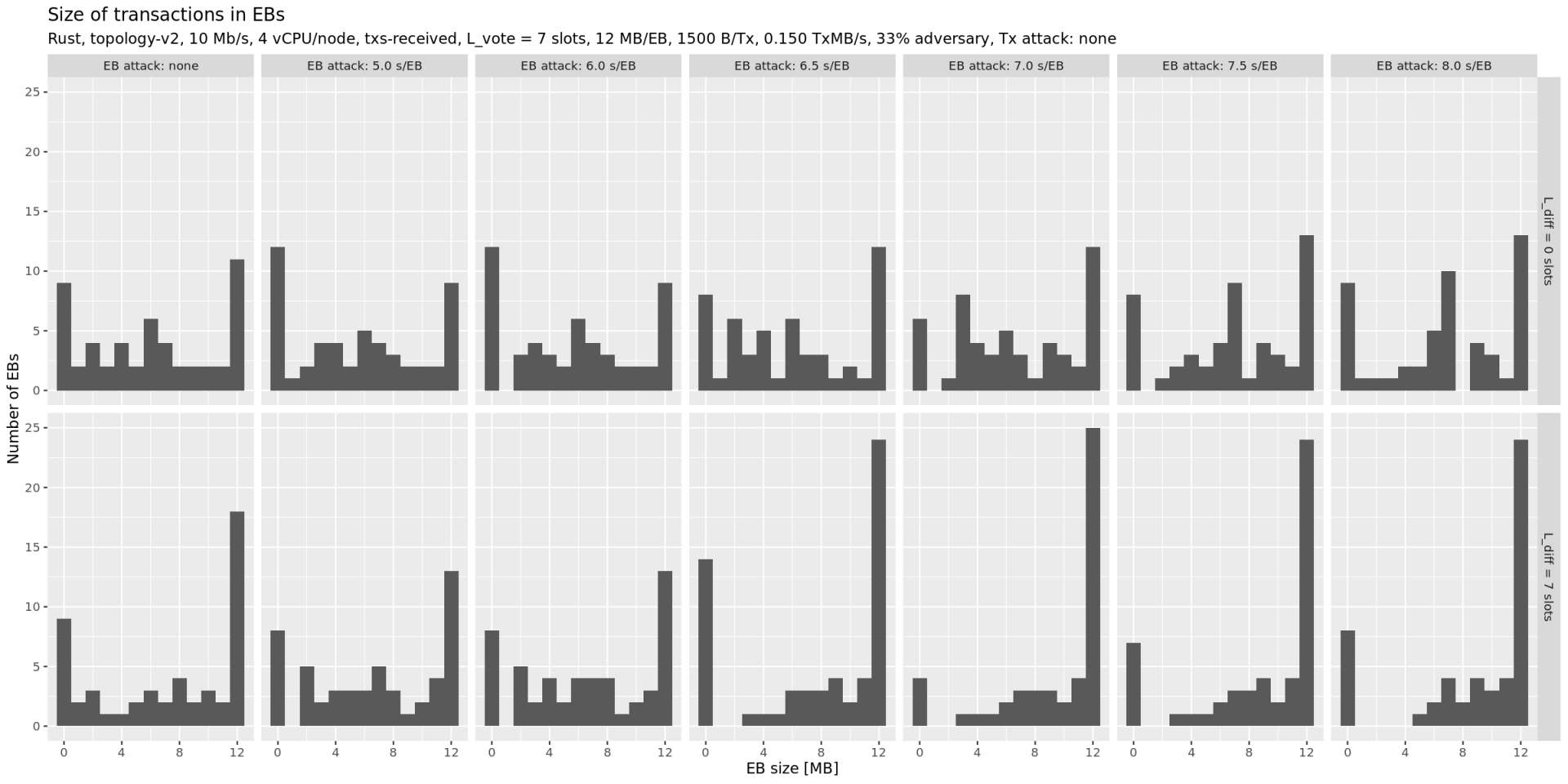
EB attack: 6.0 s/EB
EB attack: 6.5 s/EB
EB attack: 7.0 s/EB
EB attack: 7.5 s/EB
EB attack: 8.0 s/EB
L_diff = 0 slots
L_diff = 7 slots
Number of EBs
0
10
20
0
2500
5000
7500
Transactions


Size of transactions in EBs
Rust, topology-v2, 10 Mb/s, 4 vCPU/node, txs-received, L_vote = 7 slots, 12 MB/EB, 1500 B/Tx, 0.150 TxMB/s, 33% adversary, Tx attack: none
EB attack: none
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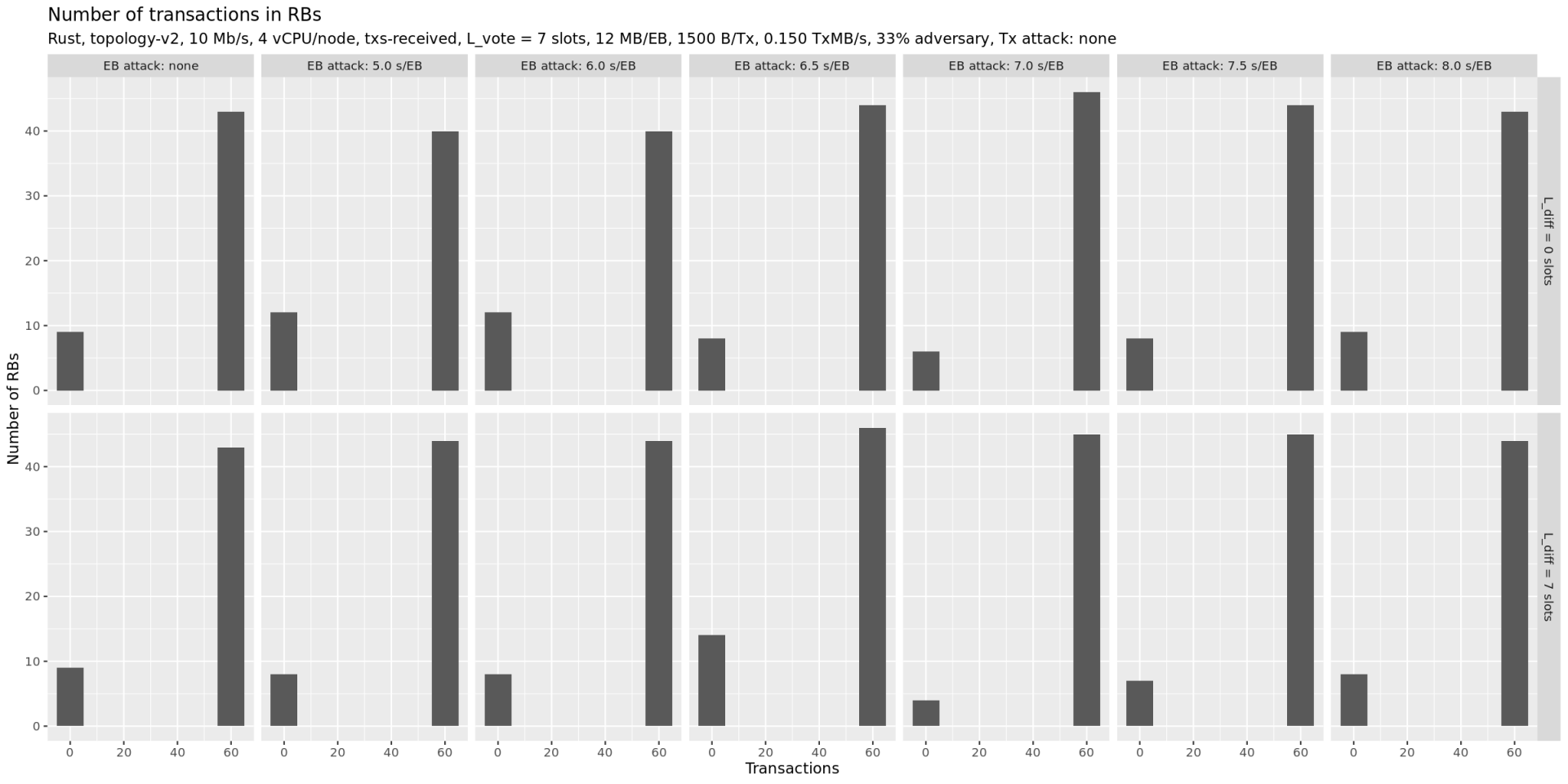
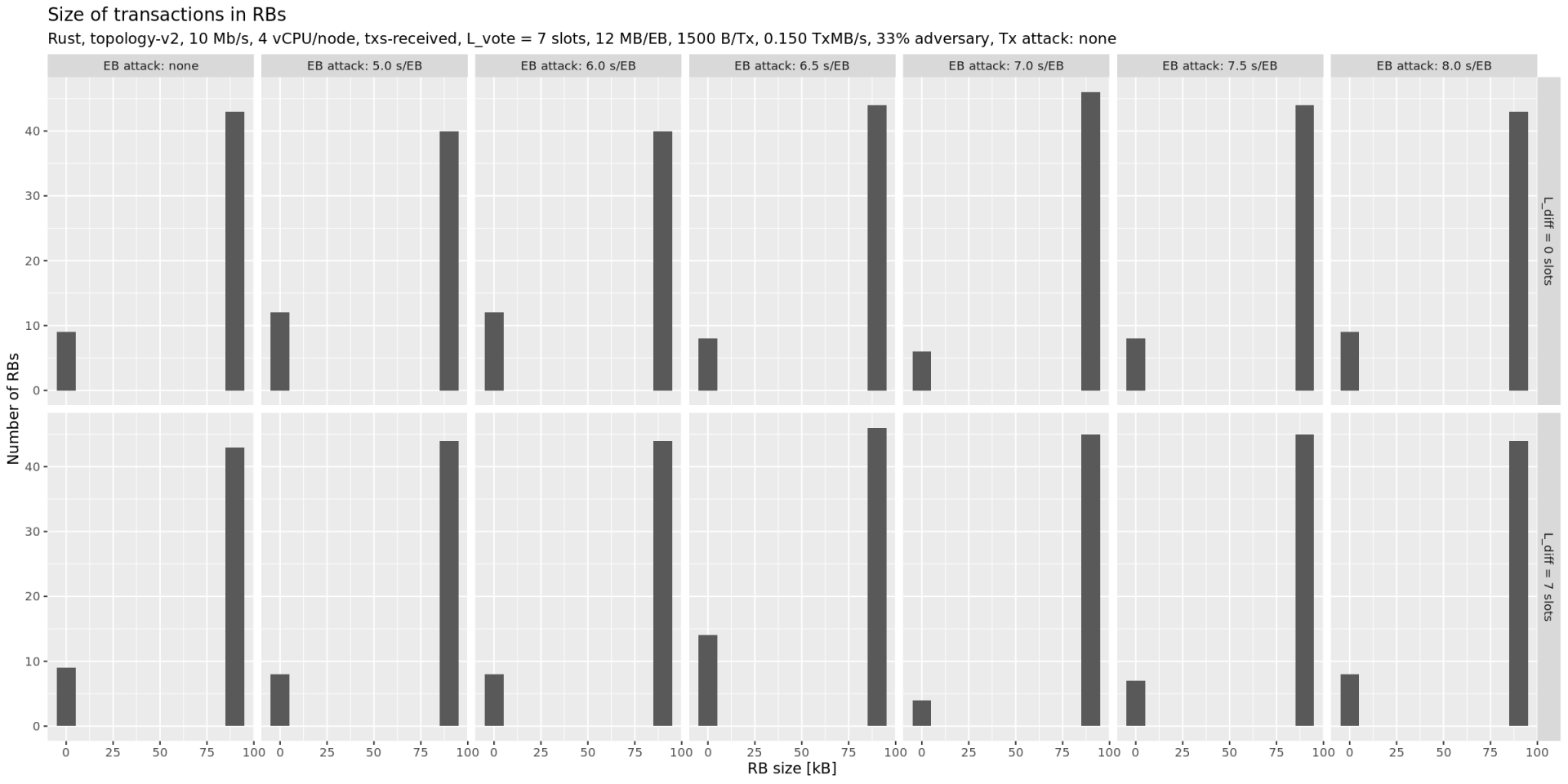
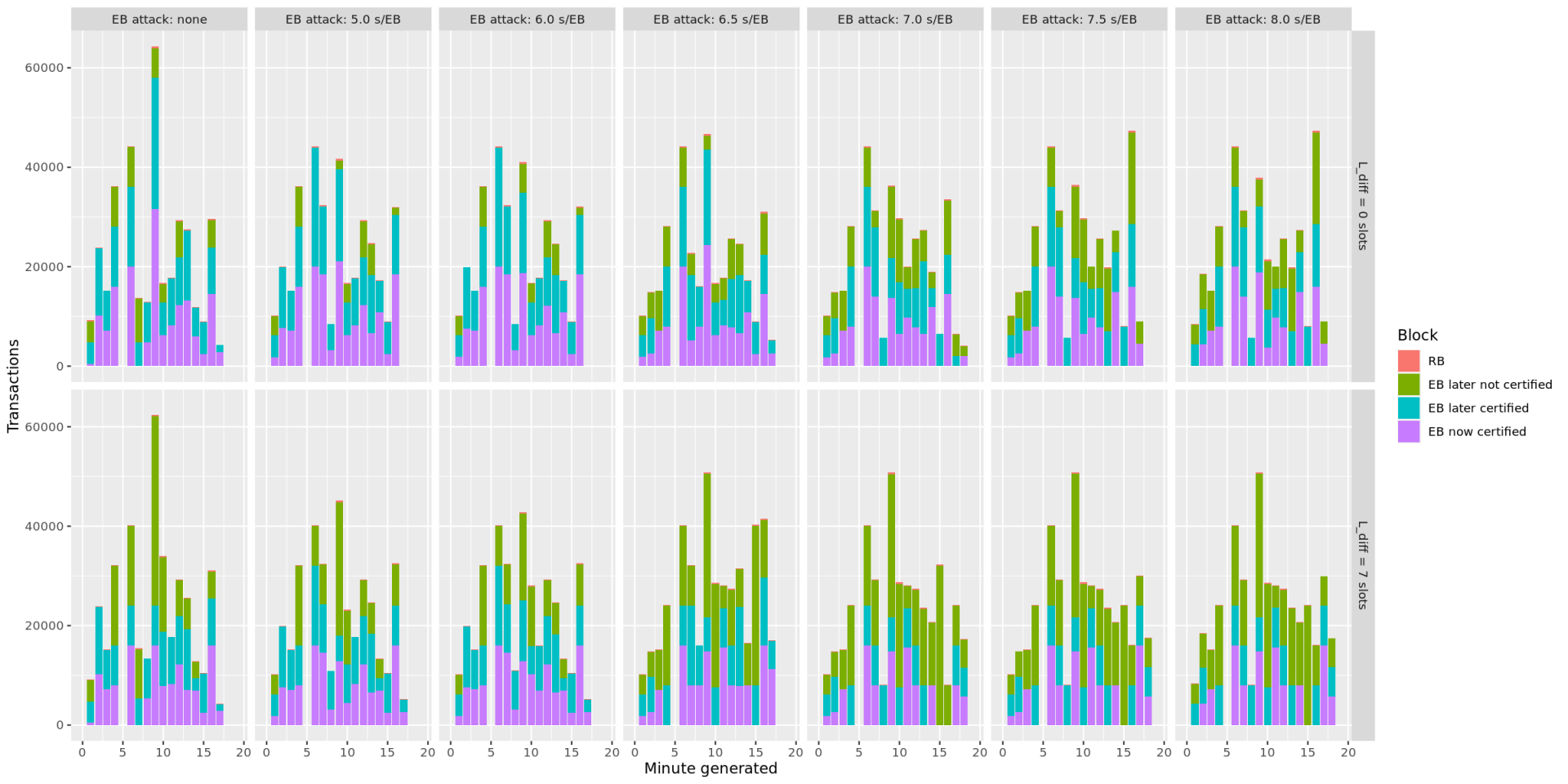
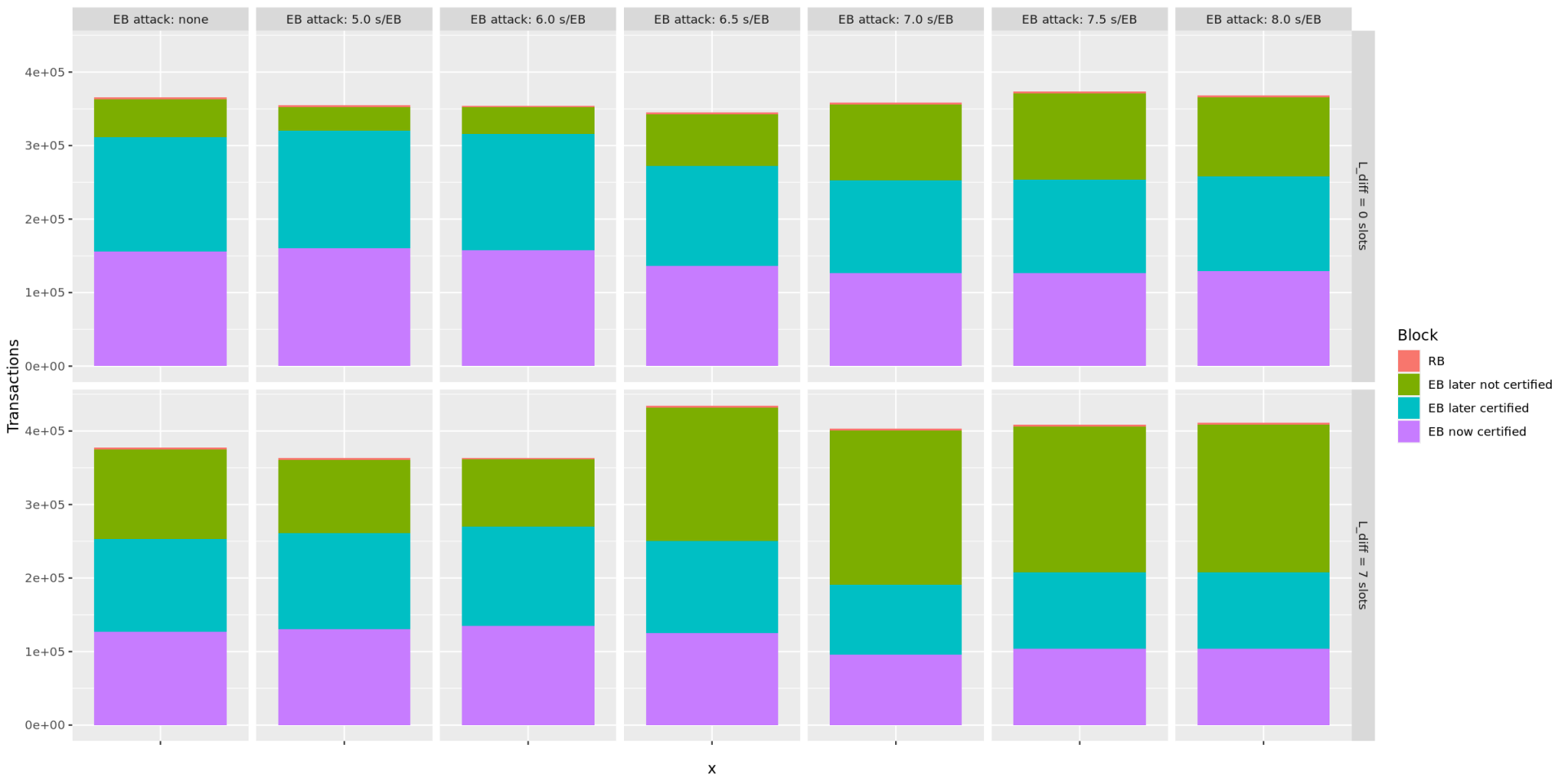
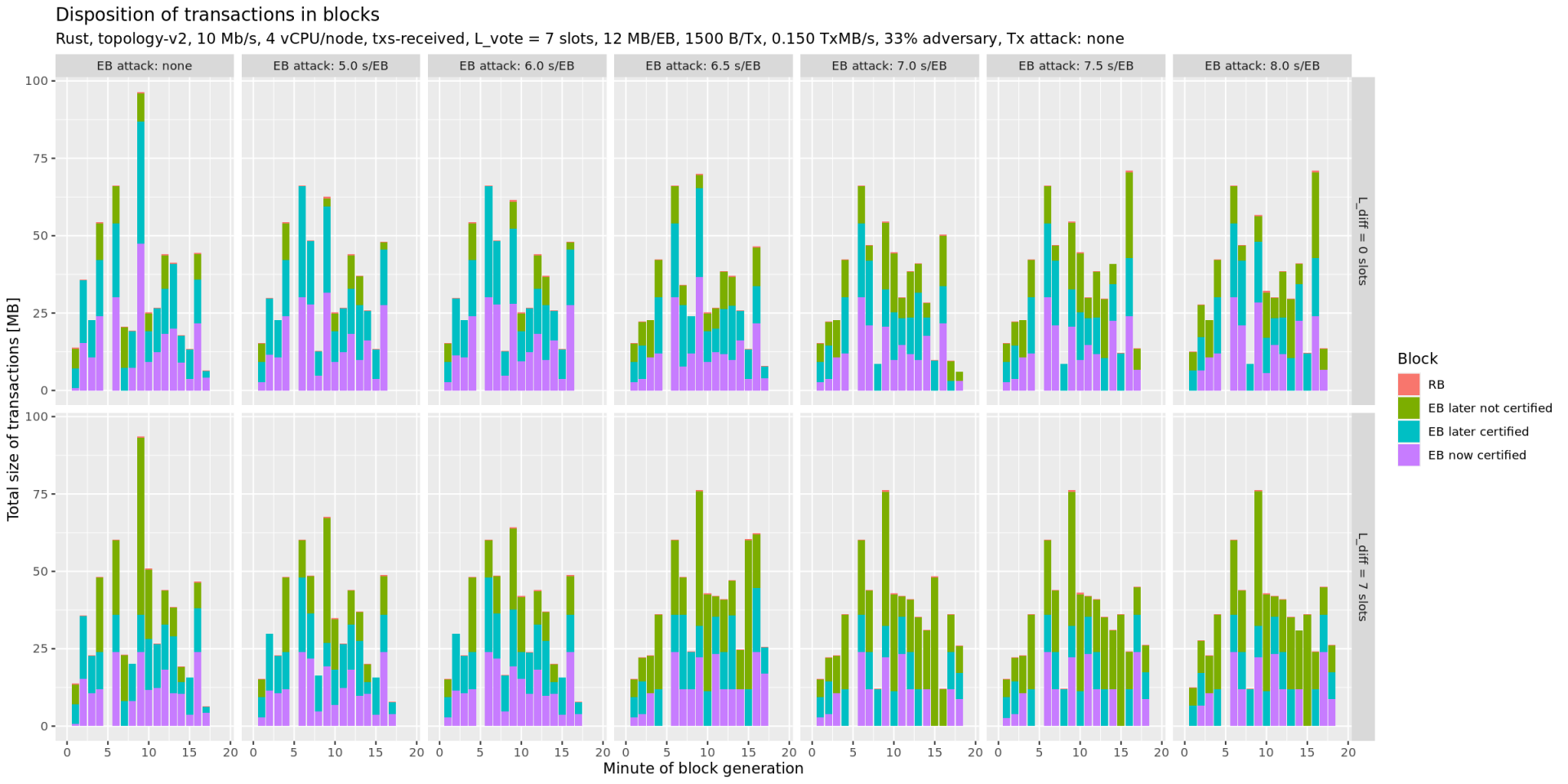
EB attack: 6.0 s/EB
EB attack: 6.5 s/EB
EB attack: 7.0 s/EB
EB attack: 7.5 s/EB
EB attack: 8.0 s/EB
L_diff = 0 slots
L_diff = 7 slots
Number of EBs
EB size [MB]

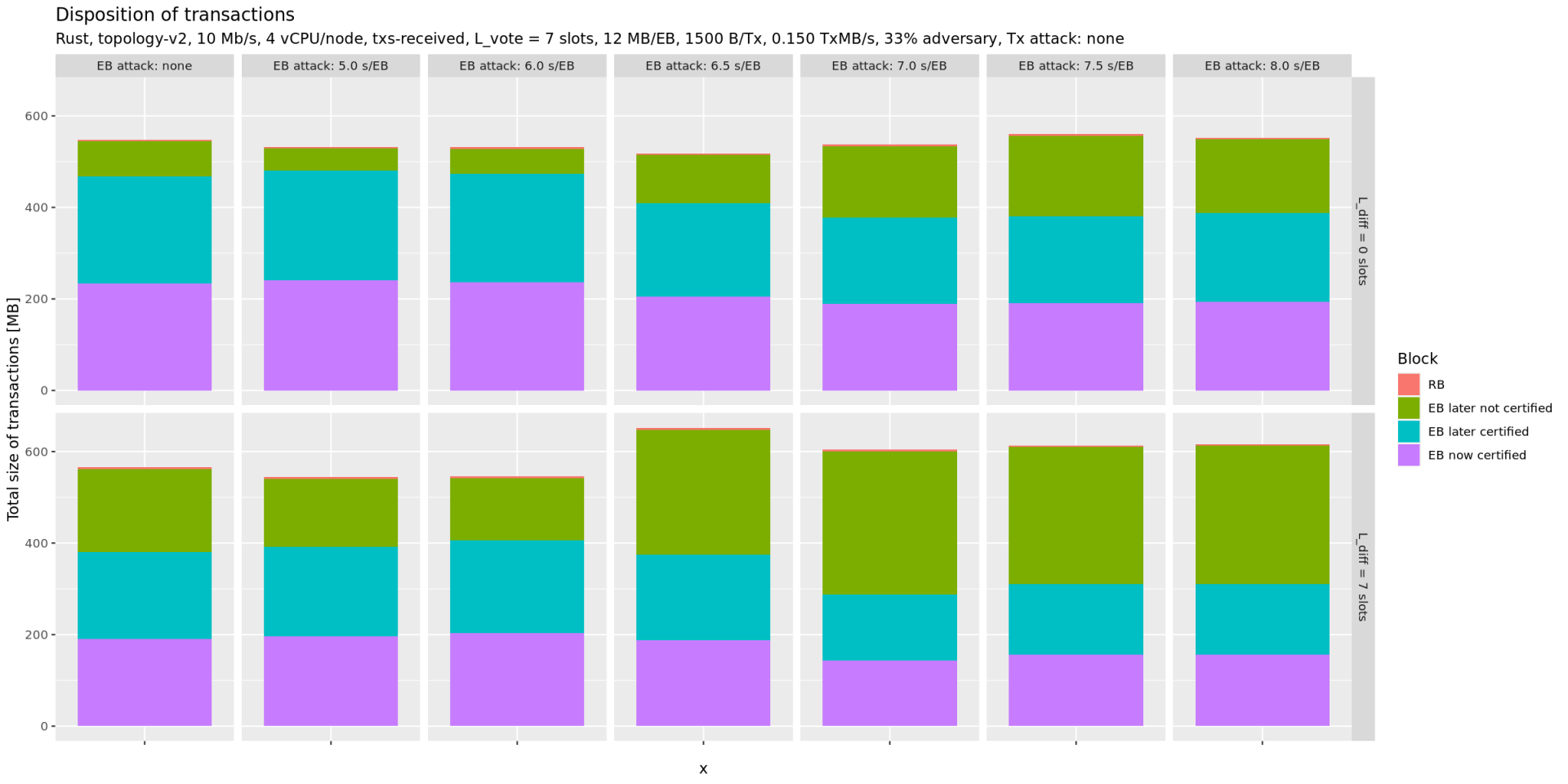

Number of transactions in RBs
Rust, topology-v2, 10 Mb/s, 4 vCPU/node, txs-received, L_vote = 7 slots, 12 MB/EB, 1500 B/Tx, 0.150 TxMB/s, 33% adversary, Tx attack: none
EB attack: none
EB attack: 5.0 s/EB
EB attack: 6.0 s/EB
EB attack: 6.5 s/EB
EB attack: 7.0 s/EB
EB attack: 7.5 s/EB
EB attack: 8.0 s/EB
L_diff = 0 slots
L_diff = 7 slots
Number of RBs
0
10
20
30
40
Transactions
0
20
40
60


Size of transactions in RBs
Rust, topology-v2, 10 Mb/s, 4 vCPU/node, txs-received, L_vote = 7 slots, 12 MB/EB, 1500 B/Tx, 0.150 TxMB/s, 33% adversary, Tx attack: none
EB attack: none
EB attack: 5.0 s/EB
EB attack: 6.0 s/EB
EB attack: 6.5 s/EB
EB attack: 7.0 s/EB
EB attack: 7.5 s/EB
EB attack: 8.0 s/EB
L_diff = 0 slots
L_diff = 7 slots
Number of RBs
RB size [kB]
0
10
20
30
40
0
25
50
75
100


EB attack: none
EB attack: 5.0 s/EB
EB attack: 6.0 s/EB
EB attack: 6.5 s/EB
EB attack: 7.0 s/EB
EB attack: 7.5 s/EB
EB attack: 8.0 s/EB
L_diff = 0 slots
L_diff = 7 slots
Transactions
0
20000
40000
60000
0
5
10
15
20
Minute generated
Block
RB
EB later not certified
EB later certified
EB now certified


EB attack: none
EB attack: 5.0 s/EB
EB attack: 6.0 s/EB
EB attack: 6.5 s/EB
EB attack: 7.0 s/EB
EB attack: 7.5 s/EB
EB attack: 8.0 s/EB
L_diff = 0 slots
L_diff = 7 slots
Transactions
0e+00
1e+05
2e+05
3e+05
4e+05
x
Block
RB
EB later not certified
EB later certified
EB now certified


Disposition of transactions in blocks
Rust, topology-v2, 10 Mb/s, 4 vCPU/node, txs-received, L_vote = 7 slots, 12 MB/EB, 1500 B/Tx, 0.150 TxMB/s, 33% adversary, Tx attack: none
EB attack: none
EB attack: 5.0 s/EB
EB attack: 6.0 s/EB
EB attack: 6.5 s/EB
EB attack: 7.0 s/EB
EB attack: 7.5 s/EB
EB attack: 8.0 s/EB
L_diff = 0 slots
L_diff = 7 slots
Total size of transactions [MB]
Minute of block generation
Block
RB
EB later not certified
EB later certified
EB now certified


Disposition of transactions
Rust, topology-v2, 10 Mb/s, 4 vCPU/node, txs-received, L_vote = 7 slots, 12 MB/EB, 1500 B/Tx, 0.150 TxMB/s, 33% adversary, Tx attack: none
EB attack: none
EB attack: 5.0 s/EB
EB attack: 6.0 s/EB
EB attack: 6.5 s/EB
EB attack: 7.0 s/EB
EB attack: 7.5 s/EB
EB attack: 8.0 s/EB
L_diff = 0 slots
L_diff = 7 slots
Total size of transactions [MB]
0
200
400
600
x
Block
RB
EB later not certified
EB later certified
EB now certified