Performance test results

HW Setup

Machine spec

Machine Name	Instance Type	Disk Type	Disk Size	Disk IOPS	Disk Throughput
Sequencer	r5n.2xlarge	gp3	1000 GB	8000	1000 MBps
Executor-1	r5n.4xlarge	gp3	1000 GB	8000	1000 MBps
Executor-2	r5n.4xlarge	gp3	1000 GB	8000	1000 MBps
GCManager	r5n.2xlarge	gp3	1000 GB	8000	1000 MBps
Garbler	r5n.2xlarge	gp3	1000 GB	8000	1000 MBps
Validator	r5n.2xlarge	gp3	1000 GB	8000	1000 MBps

Zone

All machines are located in AWS **us-east-1** region (Northern Virginia).

Bandwidth measurement

Iperf3 results between pair of machines:

Summary:

- Executor -> Executor: ~9.5 Gbps
- Executor -> GCManager: ~5 Gbps
- GCManager -> Garbler: ~5 Gbps

Detailed iperf3 results in Appendix C.

Transaction Distribution and Load Test

Test Purpose

The test was designed to assess the blockchain's ability to handle a high volume of transactions in a short period of time, providing insights into its throughput and stability.

Test Setup

- To simulate real-world usage, we ran 10 accounts in parallel. Each account was programmed to send 10,000 transfers, resulting in a total of 100,000 transactions processed in this test.
- All accounts sent transactions to a pre-deployed cERC20 contract as described in Appendix A.
- The accounts were fully onboarded prior to the start of the test, so the users onboarding process and its associated transactions were excluded from the test scope.
- Relevant parameters:
    - Block Gas Limit: `miner.gaslimit=310000000`
    - Genesis block Interval: 5 seconds
    - Differences in production capacities in `capacitiesConfig.toml` (over machines with > 64GB RAM):

[TRANSFER64] numberOfBatchInDB = 100 circuitsInBatch = 80 numberOfBatchesInMemory = 25 minThreshold = 2000	[ONBOARD64] numberOfBatchInDB = 250 circuitsInBatch = 50 numberOfBatchesInMemory = 120 minThreshold = 6000	[OFFBOARD64] numberOfBatchInDB = 160 circuitsInBatch = 50 numberOfBatchesInMemory = 80 minThreshold = 4000

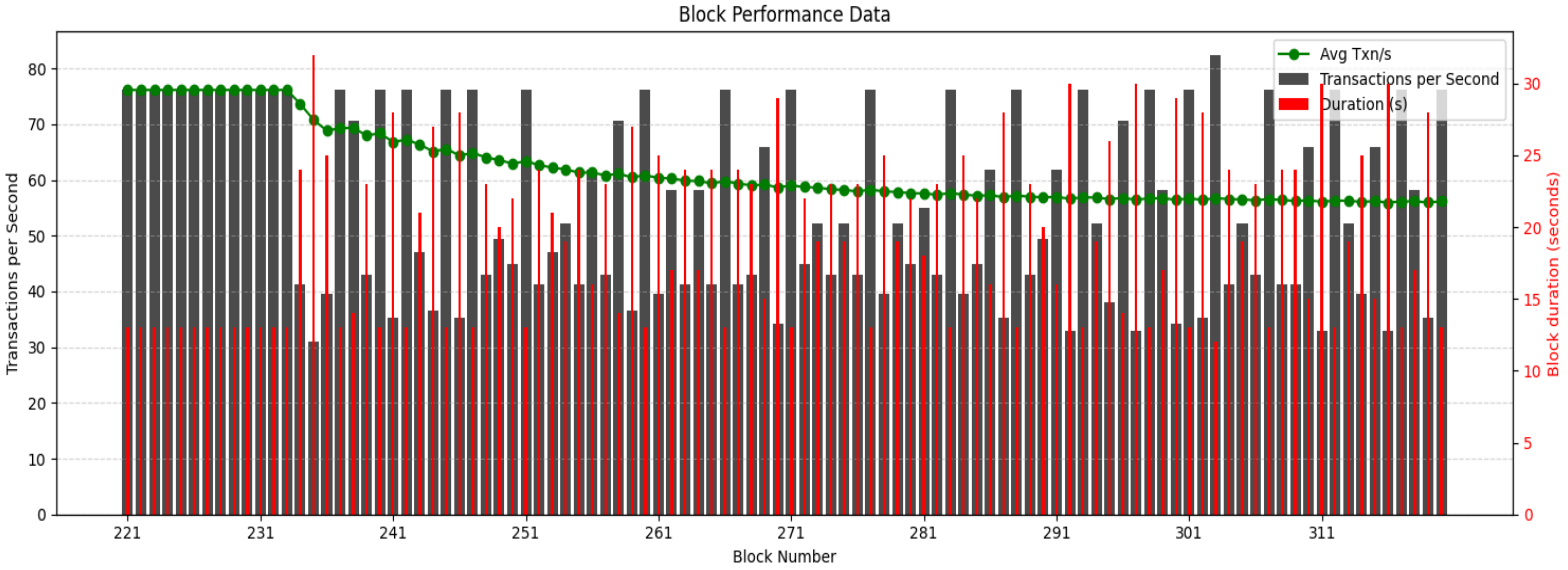
    - Note: We may require further changes in capacities file in order to further improve performance.

- For internal recording purposes, Github repository hashes:
    - Go-ethereum: _____
    - MPC: _____

Test Summary

Raw data in Appendix B. See chart below.

- Bursts of great demand, e.g., ~1000 cERC20 in a very short time:
  - ~75 cTPS
- Steady high demand of about 32 minutes:
  - ~56 cTPS
- The load test revealed periods of high throughput (e.g., the first 13 blocks) as well as standard performance metrics after the initial peak.



Results including first 13 blocks:

The high TPS during the first 13 blocks indicates system optimal conditions, where the inventory is full of circuits. This is the common case

- Average TPS: 56.17 transactions per second.
- Minimum TPS: 30.94 transactions per second.
- Maximum TPS: 82.50 transactions per second.
- Minimum block time: 12.00
- Maximum block time: 32.00
- Average block time: 19.30
- Total time: 1930.00

Results excluding first 13 blocks:

The average TPS is slightly lower, reflecting performance while the inventory got empty.

- Average TPS: 53.19 transactions per second.
- Minimum TPS: 30.94 transactions per second.
- Maximum TPS: 82.50 transactions per second.
- Minimum block time: 12.00
- Maximum block time: 32.00
- Average block time: 20.24
- Total time: 1761.00

Key Insights

This scenario represents the complete performance profile of the blockchain during the test, encompassing both the high-TPS initial blocks and the subsequent standard blocks. The inclusion of all blocks provides the following insights:

1. **High initial performance:**
    - The first 13 blocks exhibit exceptionally high TPS, ranging from 76.15 to 82.58, due to the full inventory of transactions when the system starts. This behavior demonstrates the blockchain's ability to process transactions optimally under ideal conditions. In real-world scenarios, it is unlikely to encounter such a burst of of transactions that lasts so long. Instead, the transaction inventory will fill over time, making the case of a full inventory a widely common occurrence.
2. **Stable long-term performance:**
    - The system sustains an average of 57.50 TPS, which highlights its ability to handle a sustained transaction load efficiently over the duration of the test.
    - The drop in TPS after the initial peak indicates that the system is not overly reliant on optimal starting conditions and can maintain high performance throughout varying workloads.
    - Even when the inventory is depleted, the system maintains sufficient performance, with the average TPS remaining above 50.
3. **Transaction handling capacity:**
    - The maximum TPS of 82.58 transactions per second reflects the system's capability to handle peak transaction loads efficiently.
    - Even during slower blocks, the TPS remains above 28, ensuring consistent throughput and no significant degradation in performance.
4. **Real-world implications:**
    - In a live blockchain, the scenario where the inventory is filled as transactions accumulate over time is common. This makes the inclusion of the initial high-TPS blocks representative of real-world behavior during periods of intensive transaction activity.
5. **System efficiency:**

- The blockchain's ability to process 100,000 confidential ERC20 transactions across 101 blocks in just over 30 minutes demonstrates its robustness and suitability for use cases requiring high throughput.

Appendix A: Test Code

The transfer function used in the test is `transfer(address _to, uint64 _value, bool revealRes)` from our `PrivateERC20` contract. The contract's implementation can be found at the following link: PrivateERC20Contract.sol. The relevant code is shown below:

```
    // Transfers the amount of tokens given inside the IT (encrypted and signed value) to address _to
    // params: _to: the address to transfer to
    //         _itCT: the encrypted value of the amount to transfer
    //         _itSignature: the signature of the amount to transfer
    //         revealRes: indicates if we should reveal the result of the transfer
    // returns: In case revealRes is true, returns the result of the transfer. In case revealRes is false, always returns
          true
    function transfer(address _to, ctUint64 _itCT, bytes calldata _itSignature, bool revealRes) public returns (bool
          success){
        // Create IT from ciphertext and signature
        itUint64 memory it;
        it.ciphertext = _itCT;
        it.signature = _itSignature;
        // Verify the IT and transfer the value
        gtBool result = contractTransfer(_to, MpcCore.validateCiphertext(it));
        if (revealRes){
            return MpcCore.decrypt(result);
        } else {
            return true;
        }
    }

    // Transfers the amount of tokens given inside the encrypted value to address _to
    // params: _to: the address to transfer to
    //         _value: the encrypted value of the amount to transfer
    // returns: The encrypted result of the transfer.
    function contractTransfer(address _to, gtUint64 _value) public returns (gtBool success){
        (gtUint64 fromBalance, gtUint64 toBalance) = getBalances(msg.sender, _to);
        (gtUint64 newFromBalance, gtUint64 newToBalance, gtBool result) = MpcCore.transfer(fromBalance, toBalance, _value);

        emit Transfer(msg.sender, _to);
        setNewBalances(msg.sender, _to, newFromBalance, newToBalance);
        return result;
    }

    // Returns the encrypted balances of the two addresses
    function getBalances(address _from, address _to) private returns (gtUint64, gtUint64){
        ctUint64 fromBalance = balances[_from];
        ctUint64 toBalance = balances[_to];

        gtUint64 gtFromBalance;
        gtUint64 gtToBalance;
        if (ctUint64.unwrap(fromBalance) == 0){// 0 means that no balance has been set
            gtFromBalance = MpcCore.setPublic64(0);
        } else {
            gtFromBalance = MpcCore.onBoard(fromBalance);
        }
        if (ctUint64.unwrap(toBalance) == 0){// 0 means that no balance has been set
            gtToBalance = MpcCore.setPublic64(0);
        } else {
            gtToBalance = MpcCore.onBoard(toBalance);
        }
        return (gtFromBalance, gtToBalance);
    }

    // Sets the new encrypted balances of the two addresses
    function setNewBalances(address _from, address _to, gtUint64 newFromBalance, gtUint64 newToBalance) private {
        // Convert the gtUInt64 to ctUint64 and store it in the balances mapping
        balances[_from] = MpcCore.offBoard(newFromBalance);
        balances[_to] = MpcCore.offBoard(newToBalance);

    }
```

Appendix B: Raw Results

Block 219: Timestamp: 1736861446, Gas Used: 28065630, Gas Limit: 310000000, Number of Transactions: 10
Block 220: Timestamp: 1736861451, Gas Used: 198653318, Gas Limit: 310000000, Number of Transactions: 656
Block 221: Timestamp: 1736861461, Gas Used: 300095866, Gas Limit: 310000000, Number of Transactions: 990
Block 222: Timestamp: 1736861474, Gas Used: 300100090, Gas Limit: 310000000, Number of Transactions: 990
Block 223: Timestamp: 1736861487, Gas Used: 300098042, Gas Limit: 310000000, Number of Transactions: 990
Block 224: Timestamp: 1736861500, Gas Used: 300099130, Gas Limit: 310000000, Number of Transactions: 990
Block 225: Timestamp: 1736861513, Gas Used: 300099450, Gas Limit: 310000000, Number of Transactions: 990
Block 226: Timestamp: 1736861526, Gas Used: 300099834, Gas Limit: 310000000, Number of Transactions: 990
Block 227: Timestamp: 1736861539, Gas Used: 300100090, Gas Limit: 310000000, Number of Transactions: 990
Block 228: Timestamp: 1736861552, Gas Used: 300099834, Gas Limit: 310000000, Number of Transactions: 990
Block 229: Timestamp: 1736861565, Gas Used: 300098682, Gas Limit: 310000000, Number of Transactions: 990
Block 230: Timestamp: 1736861578, Gas Used: 300098938, Gas Limit: 310000000, Number of Transactions: 990
Block 231: Timestamp: 1736861591, Gas Used: 300101370, Gas Limit: 310000000, Number of Transactions: 990
Block 232: Timestamp: 1736861604, Gas Used: 300100922, Gas Limit: 310000000, Number of Transactions: 990
Block 233: Timestamp: 1736861617, Gas Used: 300098554, Gas Limit: 310000000, Number of Transactions: 990
Block 234: Timestamp: 1736861630, Gas Used: 300097402, Gas Limit: 310000000, Number of Transactions: 990
Block 235: Timestamp: 1736861654, Gas Used: 300098938, Gas Limit: 310000000, Number of Transactions: 990
Block 236: Timestamp: 1736861686, Gas Used: 300098938, Gas Limit: 310000000, Number of Transactions: 990
Block 237: Timestamp: 1736861711, Gas Used: 300100666, Gas Limit: 310000000, Number of Transactions: 990
Block 238: Timestamp: 1736861724, Gas Used: 300101690, Gas Limit: 310000000, Number of Transactions: 990
Block 239: Timestamp: 1736861738, Gas Used: 300100026, Gas Limit: 310000000, Number of Transactions: 990
Block 240: Timestamp: 1736861761, Gas Used: 300099002, Gas Limit: 310000000, Number of Transactions: 990
Block 241: Timestamp: 1736861774, Gas Used: 300096698, Gas Limit: 310000000, Number of Transactions: 990
Block 242: Timestamp: 1736861802, Gas Used: 300100154, Gas Limit: 310000000, Number of Transactions: 990
Block 243: Timestamp: 1736861815, Gas Used: 300095546, Gas Limit: 310000000, Number of Transactions: 990
Block 244: Timestamp: 1736861836, Gas Used: 300098362, Gas Limit: 310000000, Number of Transactions: 990
Block 245: Timestamp: 1736861863, Gas Used: 300099258, Gas Limit: 310000000, Number of Transactions: 990
Block 246: Timestamp: 1736861876, Gas Used: 300099322, Gas Limit: 310000000, Number of Transactions: 990
Block 247: Timestamp: 1736861904, Gas Used: 300096698, Gas Limit: 310000000, Number of Transactions: 990
Block 248: Timestamp: 1736861917, Gas Used: 300098746, Gas Limit: 310000000, Number of Transactions: 990
Block 249: Timestamp: 1736861940, Gas Used: 300102650, Gas Limit: 310000000, Number of Transactions: 990
Block 250: Timestamp: 1736861960, Gas Used: 300102330, Gas Limit: 310000000, Number of Transactions: 990
Block 251: Timestamp: 1736861982, Gas Used: 300100410, Gas Limit: 310000000, Number of Transactions: 990
Block 252: Timestamp: 1736861995, Gas Used: 300100282, Gas Limit: 310000000, Number of Transactions: 990
Block 253: Timestamp: 1736862019, Gas Used: 300101114, Gas Limit: 310000000, Number of Transactions: 990
Block 254: Timestamp: 1736862040, Gas Used: 300095802, Gas Limit: 310000000, Number of Transactions: 990
Block 255: Timestamp: 1736862059, Gas Used: 300099002, Gas Limit: 310000000, Number of Transactions: 990
Block 256: Timestamp: 1736862083, Gas Used: 300098874, Gas Limit: 310000000, Number of Transactions: 990
Block 257: Timestamp: 1736862099, Gas Used: 300101370, Gas Limit: 310000000, Number of Transactions: 990
Block 258: Timestamp: 1736862122, Gas Used: 300098490, Gas Limit: 310000000, Number of Transactions: 990
Block 259: Timestamp: 1736862136, Gas Used: 300102010, Gas Limit: 310000000, Number of Transactions: 990
Block 260: Timestamp: 1736862163, Gas Used: 300103226, Gas Limit: 310000000, Number of Transactions: 990
Block 261: Timestamp: 1736862176, Gas Used: 300101370, Gas Limit: 310000000, Number of Transactions: 990
Block 262: Timestamp: 1736862201, Gas Used: 300098042, Gas Limit: 310000000, Number of Transactions: 990
Block 263: Timestamp: 1736862218, Gas Used: 300100474, Gas Limit: 310000000, Number of Transactions: 990
Block 264: Timestamp: 1736862242, Gas Used: 300099898, Gas Limit: 310000000, Number of Transactions: 990
Block 265: Timestamp: 1736862259, Gas Used: 300098938, Gas Limit: 310000000, Number of Transactions: 990
Block 266: Timestamp: 1736862283, Gas Used: 300100282, Gas Limit: 310000000, Number of Transactions: 990
Block 267: Timestamp: 1736862296, Gas Used: 300098490, Gas Limit: 310000000, Number of Transactions: 990
Block 268: Timestamp: 1736862320, Gas Used: 300099130, Gas Limit: 310000000, Number of Transactions: 990
Block 269: Timestamp: 1736862343, Gas Used: 300102266, Gas Limit: 310000000, Number of Transactions: 990
Block 270: Timestamp: 1736862358, Gas Used: 300098810, Gas Limit: 310000000, Number of Transactions: 990
Block 271: Timestamp: 1736862387, Gas Used: 300100986, Gas Limit: 310000000, Number of Transactions: 990
Block 272: Timestamp: 1736862400, Gas Used: 300100346, Gas Limit: 310000000, Number of Transactions: 990
Block 273: Timestamp: 1736862422, Gas Used: 300099770, Gas Limit: 310000000, Number of Transactions: 990
Block 274: Timestamp: 1736862441, Gas Used: 300100026, Gas Limit: 310000000, Number of Transactions: 990
Block 275: Timestamp: 1736862464, Gas Used: 300097146, Gas Limit: 310000000, Number of Transactions: 990
Block 276: Timestamp: 1736862483, Gas Used: 300100090, Gas Limit: 310000000, Number of Transactions: 990
Block 277: Timestamp: 1736862506, Gas Used: 300098490, Gas Limit: 310000000, Number of Transactions: 990
Block 278: Timestamp: 1736862519, Gas Used: 300101754, Gas Limit: 310000000, Number of Transactions: 990
Block 279: Timestamp: 1736862544, Gas Used: 300097658, Gas Limit: 310000000, Number of Transactions: 990
Block 280: Timestamp: 1736862563, Gas Used: 300098682, Gas Limit: 310000000, Number of Transactions: 990
Block 281: Timestamp: 1736862585, Gas Used: 300099194, Gas Limit: 310000000, Number of Transactions: 990
Block 282: Timestamp: 1736862603, Gas Used: 300099066, Gas Limit: 310000000, Number of Transactions: 990

Block 283: Timestamp: 1736862626, Gas Used: 300097658, Gas Limit: 310000000, Number of Transactions: 990
Block 284: Timestamp: 1736862639, Gas Used: 300100410, Gas Limit: 310000000, Number of Transactions: 990
Block 285: Timestamp: 1736862664, Gas Used: 300101050, Gas Limit: 310000000, Number of Transactions: 990
Block 286: Timestamp: 1736862686, Gas Used: 300096890, Gas Limit: 310000000, Number of Transactions: 990
Block 287: Timestamp: 1736862702, Gas Used: 300098938, Gas Limit: 310000000, Number of Transactions: 990
Block 288: Timestamp: 1736862730, Gas Used: 300097850, Gas Limit: 310000000, Number of Transactions: 990
Block 289: Timestamp: 1736862743, Gas Used: 300102074, Gas Limit: 310000000, Number of Transactions: 990
Block 290: Timestamp: 1736862766, Gas Used: 300102522, Gas Limit: 310000000, Number of Transactions: 990
Block 291: Timestamp: 1736862786, Gas Used: 300097530, Gas Limit: 310000000, Number of Transactions: 990
Block 292: Timestamp: 1736862802, Gas Used: 300100026, Gas Limit: 310000000, Number of Transactions: 990
Block 293: Timestamp: 1736862832, Gas Used: 300098682, Gas Limit: 310000000, Number of Transactions: 990
Block 294: Timestamp: 1736862845, Gas Used: 300100410, Gas Limit: 310000000, Number of Transactions: 990
Block 295: Timestamp: 1736862864, Gas Used: 300097722, Gas Limit: 310000000, Number of Transactions: 990
Block 296: Timestamp: 1736862890, Gas Used: 300098938, Gas Limit: 310000000, Number of Transactions: 990
Block 297: Timestamp: 1736862904, Gas Used: 300101690, Gas Limit: 310000000, Number of Transactions: 990
Block 298: Timestamp: 1736862934, Gas Used: 300098298, Gas Limit: 310000000, Number of Transactions: 990
Block 299: Timestamp: 1736862947, Gas Used: 300099642, Gas Limit: 310000000, Number of Transactions: 990
Block 300: Timestamp: 1736862964, Gas Used: 300098490, Gas Limit: 310000000, Number of Transactions: 990
Block 301: Timestamp: 1736862993, Gas Used: 300098298, Gas Limit: 310000000, Number of Transactions: 990
Block 302: Timestamp: 1736863006, Gas Used: 300100922, Gas Limit: 310000000, Number of Transactions: 990
Block 303: Timestamp: 1736863034, Gas Used: 300098618, Gas Limit: 310000000, Number of Transactions: 990
Block 304: Timestamp: 1736863046, Gas Used: 300101306, Gas Limit: 310000000, Number of Transactions: 990
Block 305: Timestamp: 1736863070, Gas Used: 300100474, Gas Limit: 310000000, Number of Transactions: 990
Block 306: Timestamp: 1736863089, Gas Used: 300096634, Gas Limit: 310000000, Number of Transactions: 990
Block 307: Timestamp: 1736863112, Gas Used: 300096250, Gas Limit: 310000000, Number of Transactions: 990
Block 308: Timestamp: 1736863125, Gas Used: 300098810, Gas Limit: 310000000, Number of Transactions: 990
Block 309: Timestamp: 1736863149, Gas Used: 300098298, Gas Limit: 310000000, Number of Transactions: 990
Block 310: Timestamp: 1736863173, Gas Used: 300098362, Gas Limit: 310000000, Number of Transactions: 990
Block 311: Timestamp: 1736863188, Gas Used: 300099194, Gas Limit: 310000000, Number of Transactions: 990
Block 312: Timestamp: 1736863218, Gas Used: 300099642, Gas Limit: 310000000, Number of Transactions: 990
Block 313: Timestamp: 1736863231, Gas Used: 300097466, Gas Limit: 310000000, Number of Transactions: 990
Block 314: Timestamp: 1736863250, Gas Used: 300098938, Gas Limit: 310000000, Number of Transactions: 990
Block 315: Timestamp: 1736863275, Gas Used: 300099194, Gas Limit: 310000000, Number of Transactions: 990
Block 316: Timestamp: 1736863290, Gas Used: 300099450, Gas Limit: 310000000, Number of Transactions: 990
Block 317: Timestamp: 1736863320, Gas Used: 300097850, Gas Limit: 310000000, Number of Transactions: 990
Block 318: Timestamp: 1736863333, Gas Used: 300101242, Gas Limit: 310000000, Number of Transactions: 990
Block 319: Timestamp: 1736863350, Gas Used: 300100090, Gas Limit: 310000000, Number of Transactions: 990
Block 320: Timestamp: 1736863378, Gas Used: 300098426, Gas Limit: 310000000, Number of Transactions: 990
Block 321: Timestamp: 1736863391, Gas Used: 104275592, Gas Limit: 310000000, Number of Transactions: 344

Calculated TPS:

Block Metrics (Block i -> Block i+1):
Block 221 -> Block 222: 13 seconds, 76.15 transactions per second
Block 222 -> Block 223: 13 seconds, 76.15 transactions per second
Block 223 -> Block 224: 13 seconds, 76.15 transactions per second
Block 224 -> Block 225: 13 seconds, 76.15 transactions per second
Block 225 -> Block 226: 13 seconds, 76.15 transactions per second
Block 226 -> Block 227: 13 seconds, 76.15 transactions per second
Block 227 -> Block 228: 13 seconds, 76.15 transactions per second
Block 228 -> Block 229: 13 seconds, 76.15 transactions per second
Block 229 -> Block 230: 13 seconds, 76.15 transactions per second
Block 230 -> Block 231: 13 seconds, 76.15 transactions per second
Block 231 -> Block 232: 13 seconds, 76.15 transactions per second
Block 232 -> Block 233: 13 seconds, 76.15 transactions per second
Block 233 -> Block 234: 13 seconds, 76.15 transactions per second
Block 234 -> Block 235: 24 seconds, 41.25 transactions per second
Block 235 -> Block 236: 32 seconds, 30.94 transactions per second
Block 236 -> Block 237: 25 seconds, 39.60 transactions per second
Block 237 -> Block 238: 13 seconds, 76.15 transactions per second
Block 238 -> Block 239: 14 seconds, 70.71 transactions per second
Block 239 -> Block 240: 23 seconds, 43.04 transactions per second
Block 240 -> Block 241: 13 seconds, 76.15 transactions per second
Block 241 -> Block 242: 28 seconds, 35.36 transactions per second
Block 242 -> Block 243: 13 seconds, 76.15 transactions per second

Block 243 -> Block 244: 21 seconds, 47.14 transactions per second
Block 244 -> Block 245: 27 seconds, 36.67 transactions per second
Block 245 -> Block 246: 13 seconds, 76.15 transactions per second
Block 246 -> Block 247: 28 seconds, 35.36 transactions per second
Block 247 -> Block 248: 13 seconds, 76.15 transactions per second
Block 248 -> Block 249: 23 seconds, 43.04 transactions per second
Block 249 -> Block 250: 20 seconds, 49.50 transactions per second
Block 250 -> Block 251: 22 seconds, 45.00 transactions per second
Block 251 -> Block 252: 13 seconds, 76.15 transactions per second
Block 252 -> Block 253: 24 seconds, 41.25 transactions per second
Block 253 -> Block 254: 21 seconds, 47.14 transactions per second
Block 254 -> Block 255: 19 seconds, 52.11 transactions per second
Block 255 -> Block 256: 24 seconds, 41.25 transactions per second
Block 256 -> Block 257: 16 seconds, 61.88 transactions per second
Block 257 -> Block 258: 23 seconds, 43.04 transactions per second
Block 258 -> Block 259: 14 seconds, 70.71 transactions per second
Block 259 -> Block 260: 27 seconds, 36.67 transactions per second
Block 260 -> Block 261: 13 seconds, 76.15 transactions per second
Block 261 -> Block 262: 25 seconds, 39.60 transactions per second
Block 262 -> Block 263: 17 seconds, 58.24 transactions per second
Block 263 -> Block 264: 24 seconds, 41.25 transactions per second
Block 264 -> Block 265: 17 seconds, 58.24 transactions per second
Block 265 -> Block 266: 24 seconds, 41.25 transactions per second
Block 266 -> Block 267: 13 seconds, 76.15 transactions per second
Block 267 -> Block 268: 24 seconds, 41.25 transactions per second
Block 268 -> Block 269: 23 seconds, 43.04 transactions per second
Block 269 -> Block 270: 15 seconds, 66.00 transactions per second
Block 270 -> Block 271: 29 seconds, 34.14 transactions per second
Block 271 -> Block 272: 13 seconds, 76.15 transactions per second
Block 272 -> Block 273: 22 seconds, 45.00 transactions per second
Block 273 -> Block 274: 19 seconds, 52.11 transactions per second
Block 274 -> Block 275: 23 seconds, 43.04 transactions per second
Block 275 -> Block 276: 19 seconds, 52.11 transactions per second
Block 276 -> Block 277: 23 seconds, 43.04 transactions per second
Block 277 -> Block 278: 13 seconds, 76.15 transactions per second
Block 278 -> Block 279: 25 seconds, 39.60 transactions per second
Block 279 -> Block 280: 19 seconds, 52.11 transactions per second
Block 280 -> Block 281: 22 seconds, 45.00 transactions per second
Block 281 -> Block 282: 18 seconds, 55.00 transactions per second
Block 282 -> Block 283: 23 seconds, 43.04 transactions per second
Block 283 -> Block 284: 13 seconds, 76.15 transactions per second
Block 284 -> Block 285: 25 seconds, 39.60 transactions per second
Block 285 -> Block 286: 22 seconds, 45.00 transactions per second
Block 286 -> Block 287: 16 seconds, 61.88 transactions per second
Block 287 -> Block 288: 28 seconds, 35.36 transactions per second
Block 288 -> Block 289: 13 seconds, 76.15 transactions per second
Block 289 -> Block 290: 23 seconds, 43.04 transactions per second
Block 290 -> Block 291: 20 seconds, 49.50 transactions per second
Block 291 -> Block 292: 16 seconds, 61.88 transactions per second
Block 292 -> Block 293: 30 seconds, 33.00 transactions per second
Block 293 -> Block 294: 13 seconds, 76.15 transactions per second
Block 294 -> Block 295: 19 seconds, 52.11 transactions per second
Block 295 -> Block 296: 26 seconds, 38.08 transactions per second
Block 296 -> Block 297: 14 seconds, 70.71 transactions per second
Block 297 -> Block 298: 30 seconds, 33.00 transactions per second
Block 298 -> Block 299: 13 seconds, 76.15 transactions per second
Block 299 -> Block 300: 17 seconds, 58.24 transactions per second
Block 300 -> Block 301: 29 seconds, 34.14 transactions per second
Block 301 -> Block 302: 13 seconds, 76.15 transactions per second
Block 302 -> Block 303: 28 seconds, 35.36 transactions per second
Block 303 -> Block 304: 12 seconds, 82.50 transactions per second
Block 304 -> Block 305: 24 seconds, 41.25 transactions per second
Block 305 -> Block 306: 19 seconds, 52.11 transactions per second
Block 306 -> Block 307: 23 seconds, 43.04 transactions per second
Block 307 -> Block 308: 13 seconds, 76.15 transactions per second
Block 308 -> Block 309: 24 seconds, 41.25 transactions per second
Block 309 -> Block 310: 24 seconds, 41.25 transactions per second

Block 310 -> Block 311: 15 seconds, 66.00 transactions per second
Block 311 -> Block 312: 30 seconds, 33.00 transactions per second
Block 312 -> Block 313: 13 seconds, 76.15 transactions per second
Block 313 -> Block 314: 19 seconds, 52.11 transactions per second
Block 314 -> Block 315: 25 seconds, 39.60 transactions per second
Block 315 -> Block 316: 15 seconds, 66.00 transactions per second
Block 316 -> Block 317: 30 seconds, 33.00 transactions per second
Block 317 -> Block 318: 13 seconds, 76.15 transactions per second
Block 318 -> Block 319: 17 seconds, 58.24 transactions per second
Block 319 -> Block 320: 28 seconds, 35.36 transactions per second
Block 320 -> Block 321: 13 seconds, 76.15 transactions per second

Appendix C : Detailed bandwidth results

- R5n.4xlarge -> r5n.4xlarge (Executor -> Executor):

```
[  4] local 172.31.45.249 port 53554 connected to 172.31.41.34 port 5201
[ ID] Interval           Transfer     Bandwidth       Retr  Cwnd
[  4]   0.00-1.00   sec  1.11 GBytes  9.56 Gbits/sec    0    979 KBytes
[  4]   1.00-2.00   sec  1.11 GBytes  9.53 Gbits/sec    0    979 KBytes
[  4]   2.00-3.00   sec  1.11 GBytes  9.53 Gbits/sec    0    979 KBytes
[  4]   3.00-4.00   sec  1.11 GBytes  9.53 Gbits/sec    0    979 KBytes
[  4]   4.00-5.00   sec  1.11 GBytes  9.53 Gbits/sec    0    979 KBytes
[  4]   5.00-6.00   sec  1.11 GBytes  9.53 Gbits/sec    0    979 KBytes
[  4]   6.00-7.00   sec  1.11 GBytes  9.53 Gbits/sec    0    979 KBytes
[  4]   7.00-8.00   sec  1.11 GBytes  9.53 Gbits/sec    0    979 KBytes
[  4]   8.00-9.00   sec  1.11 GBytes  9.53 Gbits/sec    0    979 KBytes
[  4]   9.00-10.00  sec  1.11 GBytes  9.54 Gbits/sec    0    979 KBytes
- - - - - - - - - - - - - - - - - - - - - - - - -
[ ID] Interval           Transfer     Bandwidth       Retr
[  4]   0.00-10.00  sec  11.1 GBytes  9.53 Gbits/sec    0             sender
[  4]   0.00-10.00  sec  11.1 GBytes  9.53 Gbits/sec                  receiver
```

- R5n.4xlarge -> r5n.2xlarge (Executor -> GCManager):

```
[  4] local 172.31.45.249 port 49814 connected to 172.31.32.193 port 5201
[ ID] Interval           Transfer     Bandwidth       Retr  Cwnd
[  4]   0.00-1.00   sec   594 MBytes  4.98 Gbits/sec    0    813 KBytes
[  4]   1.00-2.00   sec   593 MBytes  4.98 Gbits/sec    0    944 KBytes
[  4]   2.00-3.00   sec   592 MBytes  4.96 Gbits/sec    0    996 KBytes
[  4]   3.00-4.00   sec   591 MBytes  4.96 Gbits/sec    0    996 KBytes
[  4]   4.00-5.00   sec   592 MBytes  4.97 Gbits/sec    6    769 KBytes
[  4]   5.00-6.00   sec   592 MBytes  4.96 Gbits/sec    0    996 KBytes
[  4]   6.00-7.00   sec   592 MBytes  4.96 Gbits/sec    8    725 KBytes
[  4]   7.00-8.00   sec   592 MBytes  4.96 Gbits/sec    0    725 KBytes
[  4]   8.00-9.00   sec   591 MBytes  4.96 Gbits/sec    0    725 KBytes
[  4]   9.00-10.00  sec   592 MBytes  4.96 Gbits/sec    0    961 KBytes
- - - - - - - - - - - - - - - - - - - - - - - - -
[ ID] Interval           Transfer     Bandwidth       Retr
[  4]   0.00-10.00  sec  5.78 GBytes  4.97 Gbits/sec   14             sender
[  4]   0.00-10.00  sec  5.78 GBytes  4.96 Gbits/sec                  receiver
```

- R5n.2xlarge -> r5n.large (GCManager -> Garbler):

```
[  4] local 172.31.32.193 port 53064 connected to 172.31.32.241 port 5201
[ ID] Interval           Transfer     Bandwidth       Retr  Cwnd
[  4]   0.00-1.00   sec   593 MBytes  4.98 Gbits/sec    0   1.11 MBytes
[  4]   1.00-2.00   sec   592 MBytes  4.97 Gbits/sec    0   1.19 MBytes
[  4]   2.00-3.00   sec   591 MBytes  4.96 Gbits/sec    0   1.19 MBytes
[  4]   3.00-4.00   sec   592 MBytes  4.97 Gbits/sec    0   1.19 MBytes
[  4]   4.00-5.00   sec   591 MBytes  4.96 Gbits/sec    0   1.19 MBytes
[  4]   5.00-6.00   sec   591 MBytes  4.96 Gbits/sec    0   1.19 MBytes
[  4]   6.00-7.00   sec   592 MBytes  4.97 Gbits/sec    0   1.19 MBytes
[  4]   7.00-8.00   sec   590 MBytes  4.95 Gbits/sec   24    804 KBytes
[  4]   8.00-9.00   sec   591 MBytes  4.96 Gbits/sec    0    874 KBytes
[  4]   9.00-10.00  sec   591 MBytes  4.96 Gbits/sec    8    856 KBytes
- - - - - - - - - - - - - - - - - - - - - - - - -
[ ID] Interval           Transfer     Bandwidth       Retr
[  4]   0.00-10.00  sec  5.78 GBytes  4.96 Gbits/sec   32             sender
[  4]   0.00-10.00  sec  5.78 GBytes  4.96 Gbits/sec                  receiver
```