

|                                      |   |                  |                     |  |                  |                     |                        |
|--------------------------------------|---|------------------|---------------------|--|------------------|---------------------|------------------------|
| Ask questions to @ollie.j            | For <a href="https://github.com/klaytn/klaytn/issues/1823">https://github.com/klaytn/klaytn/issues/1823</a>   |                  |                     |  |                  |                     |                        |
| Conclusion                           | geth/crypto/bls12381 is faster in point arithmetic, but supranational/blst is also usable.<br>supranational/blst is good enough for consensus which involves only a few op/sec. |                  |                     |  |                  |                     |                        |
| Thesis to verify:                    | The library's performance is coherent to EVM gas pricing  |                  |                     |  |                  |                     |                        |
| Tested by: ollie.j                   | <b>geth/crypto/bls12381 v1.11.5</b>   |                  |                     |  |                  |                     |                        |
| Tested at: 2023.04.07                | <b>darwin/arm64, Apple M1 Max 10-core, MacOS 12.6</b>   |                  |                     | <b>linux/amd64, Xeon E5-2686 16-core, m4.4xlarge</b> |                  |                     |                        |
| <a href="#">EIP-2537 precompiles</a> | <b>bench name</b>   | <b>nsec/op</b>   | <b>Measured gas</b> | <b>EIP gas pricing</b>                               | <b>nsec/op</b>   | <b>Measured gas</b> | <b>EIP gas pricing</b> |
| BLS12_G1ADD                          | BenchmarkG1Add  | 572              | 17                  | 500  | 1,279            | 38                  | 500                    |
| <b>BLS12_G1MUL</b>                   | <b>BenchmarkG1Mul</b>   | <b>152,282</b>   | <b>4,568</b>        | <b>12,000</b>  | <b>503,436</b>   | <b>15,103</b>       | <b>12,000</b>          |
| BLS12_G1MULTIEXP                     | -   | -                | -                   | (variable)   | -                | -                   | (variable)             |
| BLS12_G2ADD                          | BenchmarkG2Add  | 1,720            | 52                  | 800  | 3,878            | 116                 | 800                    |
| <b>BLS12_G2MUL</b>                   | <b>BenchmarkG2Mul</b>   | <b>478,777</b>   | <b>14,363</b>       | <b>45,000</b>  | <b>1,562,219</b> | <b>46,867</b>       | <b>45,000</b>          |
| BLS12_G2MULTIEXP                     | -   | -                | -                   | (variable)   | -                | -                   | (variable)             |
| BLS12_PAIRING                        | BenchmarkPairing (1 pair)   | 899,459          | 26,984              | 108,000  | 1,947,002        | 58,410              | 108,000                |
| BLS12_MAP_FP_TO_G1                   | BenchmarkG1MapToCurve   | 81,953           | 2,459               | 5,500  | 186,214          | 5,586               | 5,500                  |
| BLS12_MAP_FP2_TO_G2                  | BenchmarkG2SWUMap   | 1,337,893        | 40,137              | 75,000   | 2,853,158        | 85,595              | 75,000                 |
| Thesis to verify:                    | (1) The library is efficient enough for consensus purpose (2) the library is also useful for EIP-2537 purpose   |                  |                     |  |                  |                     |                        |
| Tested by: ollie.j                   | <b>supranational/blst/binding/go v0.3.10</b>  |                  |                     |  |                  |                     |                        |
| Tested at: 2023.04.07                | <b>darwin/arm64, Apple M1 Max 10-core, MacOS 12.6</b>   |                  |                     | <b>linux/amd64, Xeon E5-2686 16-core, m4.4xlarge</b> |                  |                     |                        |
| <a href="#">EIP-2537 precompiles</a> | <b>bench name</b>   | <b>ns/op</b>     | <b>Measured gas</b> | <b>EIP gas pricing</b>                               | <b>ns/op</b>     | <b>Measured gas</b> | <b>EIP gas pricing</b> |
| BLS12_G1ADD                          |   |                  |                     |  |                  |                     |                        |
| BLS12_G1MUL                          | BenchmarkMultiScalarP1Once  | 256,352          | 7,691               | 12,000   | 423,817          | 12,715              | 12,000                 |
| BLS12_G1MULTIEXP                     |   |                  |                     |  |                  |                     |                        |
| BLS12_G2ADD                          |   |                  |                     |  |                  |                     |                        |
| BLS12_G2MUL                          | BenchmarkMultiScalarP2Once  | 584,176          | 17,525              | 45,000   | 1,060,165        | 31,805              | 45,000                 |
| BLS12_G2MULTIEXP                     |   |                  |                     |  |                  |                     |                        |
| BLS12_PAIRING                        |   |                  |                     |  |                  |                     |                        |
| BLS12_MAP_FP_TO_G1                   |   |                  |                     |  |                  |                     |                        |
| BLS12_MAP_FP2_TO_G2                  |   |                  |                     |  |                  |                     |                        |
| <b>Signature (G1=pub,G2=sig)</b>     | <b>bench name</b>   | <b>ns/op</b>     | <b>ms/op</b>        | <b>op/sec</b>  | <b>ns/op</b>     | <b>ms/op</b>        | <b>op/sec</b>          |
| <b>G2.Sign</b>                       | <b>BenchmarkCoreSignMinPk</b>   | <b>312,855</b>   | <b>0.3</b>          | <b>3,196</b>   | <b>537,056</b>   | <b>0.5</b>          | <b>1,862</b>           |
| <b>G2.Verify</b>                     | <b>BenchmarkCoreVerifyMinPk</b>   | <b>696,372</b>   | <b>0.7</b>          | <b>1,436</b>   | <b>1,250,972</b> | <b>1.3</b>          | <b>799</b>             |
| G2.AggSigs; x10                      | BenchmarkCoreAggregateMinPk/10  | 202,108          | 0.2                 | 4,948  | 391,064          | 0.4                 | 2,557                  |
| <b>G2.AggSigs; x100</b>              | <b>BenchmarkCoreAggregateMinPk/100</b>  | <b>1,011,215</b> | <b>1.0</b>          | <b>989</b>   | <b>1,734,007</b> | <b>1.7</b>          | <b>577</b>             |
| G2.AggSigs; x1000                    | BenchmarkCoreAggregateMinPk/1000  | 9,015,656        | 9.0                 | 111  | 15,185,507       | 15.2                | 66                     |
| G2.AggVerify; same msg; x10          | BenchmarkCoreFastVerifyAggregateMinPk/10  | 694,654          | 0.7                 | 1,440  | 1,289,785        | 1.3                 | 775                    |
| <b>G2.AggVerify; same msg; x100</b>  | <b>BenchmarkCoreFastVerifyAggregateMinPk/100</b>  | <b>743,987</b>   | <b>0.7</b>          | <b>1,344</b>   | <b>1,378,276</b> | <b>1.4</b>          | <b>726</b>             |
| G2.AggVerify; same msg; x1000        | BenchmarkCoreFastVerifyAggregateMinPk/1000  | 1,265,313        | 1.3                 | 790  | 1,865,692        | 1.9                 | 536                    |
| G2.AggVerify; many msgs; x10         | BenchmarkCoreVerifyAggregateMinPk/10  | 1,104,490        | 1.1                 | 905  | 2,063,752        | 2.1                 | 485                    |
| G2.AggVerify; many msgs; x100        | BenchmarkCoreVerifyAggregateMinPk/100   | 5,067,965        | 5.1                 | 197  | 8,197,031        | 8.2                 | 122                    |
| G2.AggVerify; many msgs; x1000       | BenchmarkCoreVerifyAggregateMinPk/1000  | 41,577,262       | 41.6                | 24   | 71,776,914       | 71.8                | 14                     |
| <b>Signature (G1=sig,G2=pub)</b>     | <b>bench name</b>   | <b>ns/op</b>     | <b>ms/op</b>        | <b>op/sec</b>  | <b>ns/op</b>     | <b>ms/op</b>        | <b>op/sec</b>          |
| <b>G1.Sign</b>                       | <b>BenchmarkCoreSignMinSig</b>  | <b>143,730</b>   | <b>0.1</b>          | <b>6,957</b>   | <b>215,327</b>   | <b>0.2</b>          | <b>4,644</b>           |
| <b>G1.Verify</b>                     | <b>BenchmarkCoreVerifyMinSig</b>  | <b>578,030</b>   | <b>0.6</b>          | <b>1,730</b>   | <b>1,106,987</b> | <b>1.1</b>          | <b>903</b>             |
| G1.AggSigs; x10                      | BenchmarkCoreAggregateMinSig/10   | 164,248          | 0.2                 | 6,088  | 323,610          | 0.3                 | 3,090                  |
| <b>G1.AggSigs; x100</b>              | <b>BenchmarkCoreAggregateMinSig/100</b>   | <b>782,225</b>   | <b>0.8</b>          | <b>1,278</b>   | <b>1,273,525</b> | <b>1.3</b>          | <b>785</b>             |
| G1.AggSigs; x1000                    | BenchmarkCoreAggregateMinSig/1000   | 6,867,378        | 6.9                 | 146  | 10,851,514       | 10.9                | 92                     |
| G1.AggVerify; same msg; x10          | BenchmarkCoreFastVerifyAggregateMinSig/10   | 592,340          | 0.6                 | 1,688  | 1,289,785        | 1.3                 | 775                    |
| <b>G1.AggVerify; same msg; x100</b>  | <b>BenchmarkCoreFastVerifyAggregateMinSig/100</b>   | <b>680,527</b>   | <b>0.7</b>          | <b>1,469</b>   | <b>1,378,276</b> | <b>1.4</b>          | <b>726</b>             |
| G1.AggVerify; same msg; x1000        | BenchmarkCoreFastVerifyAggregateMinSig/1000   | 1,396,783        | 1.4                 | 716  | 1,865,692        | 1.9                 | 536                    |
| G1.AggVerify; many msgs; x10         | BenchmarkCoreVerifyAggregateMinSig/10   | 906,087          | 0.9                 | 1,104  | 1,820,643        | 1.8                 | 549                    |
| G1.AggVerify; many msgs; x100        | BenchmarkCoreVerifyAggregateMinSig/100  | 3,939,685        | 3.9                 | 254  | 6,333,793        | 6.3                 | 158                    |
| G1.AggVerify; many msgs; x1000       | BenchmarkCoreVerifyAggregateMinSig/1000   | 29,809,165       | 29.8                | 34   | 51,260,395       | 51.3                | 20                     |