Symmetric, hash-based encryption

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Applied cryptography coursework
MSc Advanced Security & Digital Forensics

Abstract
Established symmetric encryption methods use fixed key lengths.
This practical coursework aims flexibility and security
by supporting anything from any length as key input.

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Introduction

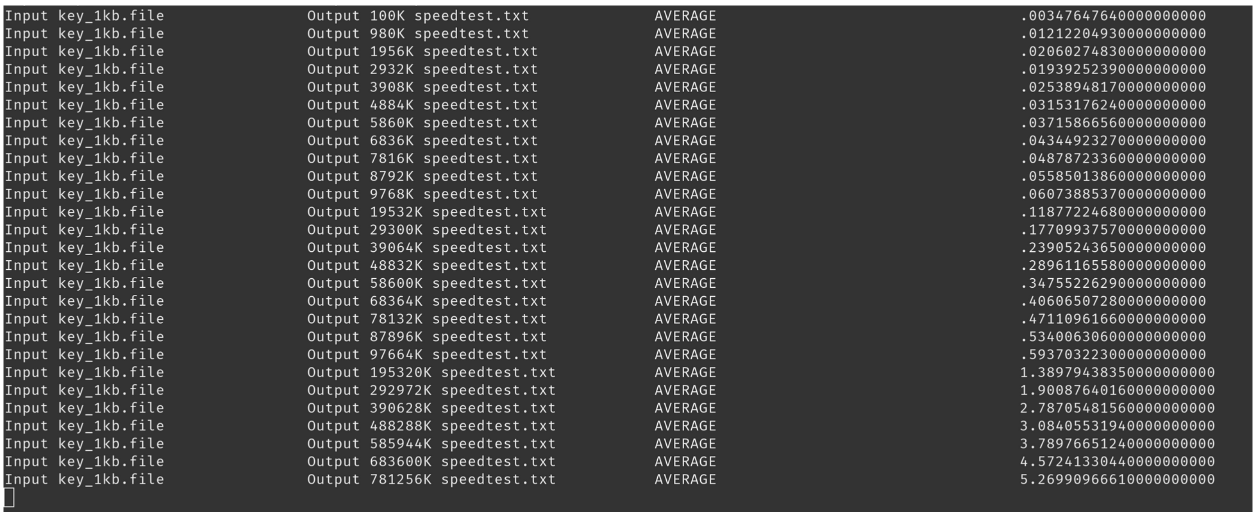
The hash functions Blake3, KangarooTwelve (“K12”) and Shake support outputs of arbitrary length. This coursework will evaluate this hash functions as Key Derivation Function (KDF) and Extendable Output Function (XOF). In regards to the predecessor Blake2, only the fork Blake2X supports outputs of arbitrary length; a rust implementation was not found. Therefore the Blake2 family was not considered in this coursework. To ensure comparability, all tests were performed with the respective rust crates “b3sum”, “k12sum” and “rash” in single-core mode.

Blake3 is well-promising in terms of speed and supports multi-threaded processing on multi-core CPUs. Shake and KangorooTwelve were derived from Keccak. Keccak won the NIST contest for the next generation hash function in 2012 (i.e. now known as SHA-3).

Speed and security of the hash functions are the two main criteria. The best balanced performer in both criteria will be used for a proof of concept. The speed was measured in two dimensions (i.e. input size and output size), while the security was evaluated by a literature review.

Speed of hash functions

The tested input sizes were 1 KB to 10 GB. The tested output sizes were 32 bytes to 1 GB, dumped as HEX. The measurement was done on three different platforms: notebook with Intel i7 x64 and SSD, Android mobile with ARMv8 and eMMC, as well as a dedicated cloud server with Xeon x64 and HDD. The system setup is visible in appendix a. As shown in figure 1, each hash operation was repeated 10 times and the average time was calculated to avoid unwanted breakouts during the measurement. The shell script used for the speed test is attached in appendix e. The raw results are attached in appendix b, c and d.



```
Input key_1kb.file                 Output 100K speedtest.txt             AVERAGE                                   .00347647640000000000
Input key_1kb.file                 Output 980K speedtest.txt             AVERAGE                                   .01212204930000000000
Input key_1kb.file                 Output 1956K speedtest.txt            AVERAGE                                   .02060274830000000000
Input key_1kb.file                 Output 2932K speedtest.txt            AVERAGE                                   .01939252390000000000
Input key_1kb.file                 Output 3908K speedtest.txt            AVERAGE                                   .02538948170000000000
Input key_1kb.file                 Output 4884K speedtest.txt            AVERAGE                                   .03153176240000000000
Input key_1kb.file                 Output 5860K speedtest.txt            AVERAGE                                   .03715866560000000000
Input key_1kb.file                 Output 6836K speedtest.txt            AVERAGE                                   .04344923270000000000
Input key_1kb.file                 Output 7816K speedtest.txt            AVERAGE                                   .04878723360000000000
Input key_1kb.file                 Output 8792K speedtest.txt            AVERAGE                                   .05585013860000000000
Input key_1kb.file                 Output 9768K speedtest.txt            AVERAGE                                   .06073885370000000000
Input key_1kb.file                 Output 19532K speedtest.txt           AVERAGE                                   .11877224680000000000
Input key_1kb.file                 Output 29300K speedtest.txt           AVERAGE                                   .17709937570000000000
Input key_1kb.file                 Output 39064K speedtest.txt           AVERAGE                                   .23905243650000000000
Input key_1kb.file                 Output 48832K speedtest.txt           AVERAGE                                   .28961165580000000000
Input key_1kb.file                 Output 58600K speedtest.txt           AVERAGE                                   .34755226290000000000
Input key_1kb.file                 Output 68364K speedtest.txt           AVERAGE                                   .40606507280000000000
Input key_1kb.file                 Output 78132K speedtest.txt           AVERAGE                                   .47110961660000000000
Input key_1kb.file                 Output 87896K speedtest.txt           AVERAGE                                   .53400630600000000000
Input key_1kb.file                 Output 97664K speedtest.txt           AVERAGE                                   .59370322300000000000
Input key_1kb.file                 Output 195320K speedtest.txt          AVERAGE                                   1.38979438350000000000
Input key_1kb.file                 Output 292972K speedtest.txt          AVERAGE                                   1.90087640160000000000
Input key_1kb.file                 Output 390628K speedtest.txt          AVERAGE                                   2.78705481560000000000
Input key_1kb.file                 Output 488288K speedtest.txt          AVERAGE                                   3.08405531940000000000
Input key_1kb.file                 Output 585944K speedtest.txt          AVERAGE                                   3.78976651240000000000
Input key_1kb.file                 Output 683600K speedtest.txt          AVERAGE                                   4.57241330440000000000
Input key_1kb.file                 Output 781256K speedtest.txt          AVERAGE                                   5.26990966610000000000
```

Figure 1: execution of the speed test.

For Blake3, the measurement showed: On system 1 (x64, i7) and system 3 (x64, XEON) the input size did not influence the hash speed so much. For example, on system 1, Blake3 needed 0.00813 seconds to hash a 1KB file to 32 bytes. And for 10GB, Blake3 needed only 1.47779 seconds. Exceptionally outstanding is system 2 (ARMv8). The afore-mentioned speed results are not valid here. The Samsung Galaxy Tab S5e needed 0.03526 seconds to hash a 1 KB file. But for 10 GB, the system needed 35.86665 seconds. Full details can be seen in appendix b.

For K12, the measurement showed: The results were very similar to Blake3. K12 was in many cases faster than Blake3, when input files were small (i.e. < 5 MB) or output was bigger (> 200 MB < 1 GB). But when it came to very large input files, K12 fall slightly behind Blake3. For example, to hash a 10 GB file to 32 bytes, K12 needed 4.59177 seconds. Blake needed for same task 1.47779 seconds. The difference of approx. 3.11398 seconds is also visible when expanding the hash to 1 GB. To hash same file to 1 GB output, K12 needed 9.78375 seconds where Blake3 needed 6.20759 seconds. The reason for that is mainly due to higher number of rounds compared to Blake3, while the sponge functions of K12 and Blake were pretty similarly fast.

For Shake, the speed was the slowest as can be seen in table 1. For example, hashing a 10 GB file to 32 bytes took 33.37358 seconds on system 1, where Blake3 needed 1.47779 seconds as afore-mentioned. In conclusion, the speed was assessed as impractical for hash-based encryption, and therefore it was not considered any-more. In general, Shake is a excellent hash function, which provides very good security and has it’s legitimate use cases (e.g. password hashing).

Hash function on system 1	Speed @ 1 KB input, 32 bytes output	Speed @ 1 GB input, 32 bytes output	Speed @ 10 GB input, 32 bytes output
Blake3	0.00813	0.11541	1.47779
K12	0.00275	0.48192	4.59177
Shake	0.01096	3.5393	33.37358

Table 1: hashing of different input files to 32 bytes on system 1 (in seconds)

Hash function on system 1	Speed @ 10 MB input, 1 KB output	Speed @ 10 MB input, 100 MB output	Speed @ 10 MB input, 1 GB output
Blake3	0.00474	0.54758	5.67466
K12	0.00597	0.57576	6.18107
Shake	0.03583	2.53898	25.63152

Table 2: hashing of a 10 MB file to different output sizes on system 1 (in seconds)

Hash function on system 1	Speed @ 10 GB input, 1 GB output
Blake3	6.20759
K12	9.78375
Shake	58.78856

Table 3: hashing of large input and to large output on system 1 (in seconds)

The winner?
The speed test proofed that hash functions are in general fast enough to be used in a hash-based stream cipher. It is hard to nominate an winner. Blake3 was unbeatable when large files have to be hashed. In case of smaller inputs and larger outputs, in many cases, K12 is a be a better choice. For mobile applications, K12 has significant advantages, as it performed best at smaller inputs. For storage based encryption, Blake3 is be a better choice. This coursework prefers Blake3 for implementation, as it provides a well-balanced speed in all situations.

Critical appraisal for executed speed tests
Please read the chapter “Conclusions”.

Why hash concatenation was not considered?
Why established hash functions (e.g. SHA-512) were not considered?
We will assume following: A file of 100 MB needs to be encrypted. Assuming that the processing is done with the raw bit stream, 156.250 SHA-512 operations are needed. If the key is a 10 MB file, 0.027s are needed for one SHA-512 operation on system 1 (i.e. x64 arch). To expand this to 100 MB size, approx. 70.31 minutes would be needed. Even if the performance can be improved slightly by some tweaks, this range is way beyond the required speed. Therefore the idea of SHA-512 chained outputs was not followed up. For the afore-mentioned task, Blake3 needed 0.54758 seconds instead of 70.31 minutes.

Security Review

KangarooTwelve has 12 rounds, which is seen as a sufficient safety margin [1] . However, some derivates like “MarsupilamiFourteen” use 14 rounds to increase the complexity of the attack. The original Keccak algorithm uses 24 rounds, thus it is more secure, but also slower. For Keccak, a collision attack was possible only up to 6 rounds [2, 3]. Therefore the security margin is still sufficient.

Blake3 has 7 rounds, which is the major reason for the unbeatable speed. The predecessor Blake2b uses 12 rounds and Blake2s 10 rounds [4]. While the Blake hash family is seen as still secure, there are proofs that the complexity of Boomerang attacks was lowered to 2^184 [5]. Blake3 targets 128-bit security against (second-) preimage, differentiability or collision attacks [6]. The reduction to 7 rounds is justified based on long term efforts in cryptanalysis for Blake (version 1) and Blake2 [6]. In conclusion, the authors are of the opinion that a hash function can also be secure with a lower number rounds and benefit from speed. To enhance the security, the Blake3 compression function was improved compared to the predecessor Blake2 (e.g. finalization returns 16 words instead of 8).
Cube attacks on Blake were researched and not followed-up any more due to expected failure [7]. For Blake2, theoretical attacks on the 2.5 rounds on a reduced version were possible [8]. During the competition for SHA-3, NIST assessed that Blake and Keccak “have very large security margins” [9]. However, this applies to the predecessor versions and it is not ensured that this assessment applies to Blake3 and KangarooTwelve as well. Relevant documented attacks for Blake3 were not found.

In conclusion, Blake3 was chosen for implementation. First of all, there were no relevant proofs of security weaknesses found for Blake3 and its predecessors; there was no indicator found that Blake3 is broken or insecure for the goal of this coursework. This coursework continues under the assumption that Blake3 is secure and the speed remains as the major selection criteria. Anyway, if any doubt on the security occur in future, it is easily possible to replace Blake3 by another hash function or to increase the iterations or the rounds. In conclusion, Blake3 is very fast especially for big files. The rust implementation of Blake3 supports multicore CPUs, which can enhance more speed.

For all hash functions it is necessary that the input and output is selected long enough to ensure the security. For KangarooTwelve, it is recommended to choose the output at least at 128-bit to ensure 128-bit (second-) preimage security; for 128-bit collision security output should be at least 256-bits [2].

Concept of symmetric, hash-based encryption

As displayed in figure 2, Alice and Bob use a hash box (“h-Box”) to derive a key for the message. The h-Box takes anything as input, but at least one long-term secret (e.g. a picture or any other digital good), a true random salt to avoid dictionary or rainbow attacks and the time to avoid replay-attacks. More custom inputs are possible (i.e. X*i*).

The hash result will be expanded to the length of the plain text. A XOR operation will take the plaintext P*i* and the expanded hash result H*i* as input. The hash function acts like a trapdoor function, where the creation of a hash H*i* is easy, but the reverse function is impossible and finding an collision is a hard problem.

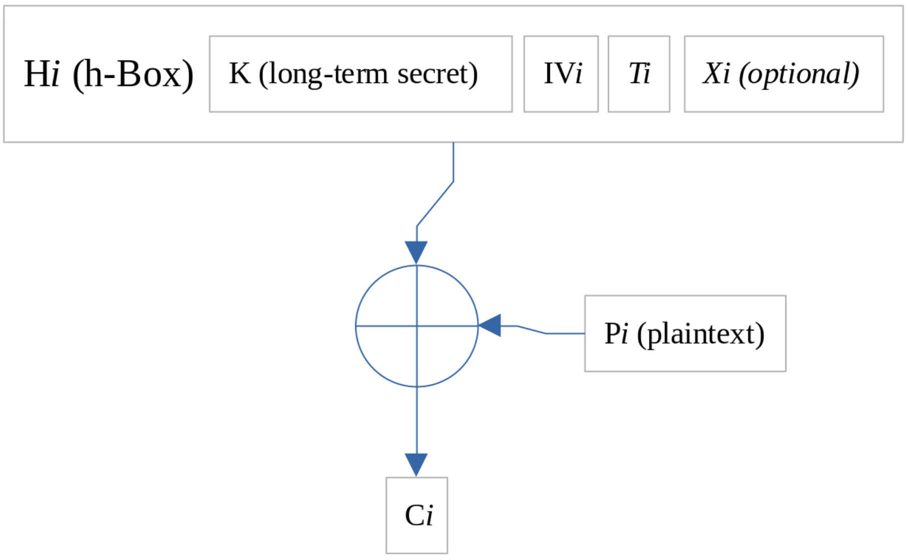


Figure 2: overview of the encryption and decryption process

For decryption, the process is the same as encryption, which is defined as:

$$C_i = P_i \oplus H_i(K, IV_i, T_i, X_i)$$
$$P_i = C_i \oplus H_i(K, IV_i, T_i, X_i)$$
$$\text{where } len(H_i) = len(P_i) = len(C_i)$$

Implementation of SHE proof of concept

This coursework aims a basic implementation in a proof of concept quality. An implementation was evaluated in different languages (e.g. C-, rust- or python-based) but withdrawn at an early stage because of disappointing speed achievements. It turned out that the most effective way is to use the Blake3 rust crate “b3sum”. For the proof of concept, the h-Box function was implemented only for a single long-term secret; the initialisation vector IV*i*, the time T*i* and X*i* were not considered in the proof of concept. The shell script can be found in appendix f.

`SHE.sh` asks for the key file, the plaintext file and the desired output name. In a first step, the script derives a key out of the given key file. This steps includes also to find out the size of the plaintext file to stretch the key respectively. Finally, the script performs a file-based XOR encryption. The `xorfiles` tool was compiled from github.com/sciguy16/xorfiles.

```
./SHE.sh

Enter your key file: new21Scollectionhome.jpg
Enter your input file: plain_10MB.txt
Enter your output file: plain_10MB.txt.enc
========================= STEP 1: derive key

real    0m0.026s
user    0m0.026s
sys     0m0.009s
========================= STEP 2: XOR the two files together

real    0m0.113s
user    0m0.092s
sys     0m0.020s
========================= STEP 3: en-/decryption finished. Cleaned up. See output.
```

If the file `plain_10MB.txt.enc` is decrypted, the decrypted file and the original file are equal according to sha256sum:

```
e5b844cc57f57094ea4585e235f36c78c1cd222262bb89d53c94dcb4d6b3e55d  plain_10MB.txt.dec
e5b844cc57f57094ea4585e235f36c78c1cd222262bb89d53c94dcb4d6b3e55d  plain_10MB.txt
```

In the afore-mentioned example, `new21Scollectionhome.jpg` is a picture of 500kb and the plaintext file `plain_10MB.txt` was created out of */dev/null*.

Excerpt of the derived key, converted from RAW to HEX:

```
43dd24a6aeef6610dd77b09fad04da47333a9c5cde055291b342eac41df
e39c57d8c98688b7f78a362ebb06011ffb36b800071ff5837d4989e27664
3015f049b996838f1975c6ba8aeea63384d8107303061c41b1d060898b09
7e2c93b62669a8f337cacc9e1462525f8789f6d678843f4aa8063af65eec
0a36dca6b59ad5bdeff7361c728f36f39b5820f0c506dea499e2f3067c86
846d475eb59a23afcb793a931d5e307b8a2ef7b06b8234b9214439bda0e2
91969692c55dd69fc09253d73bec2dd0cc1e5a2874a6c3f73f6b30a6f9fb
530b1ec33640f0baea0db781b2d99f7bde4d8a9298048b0b3e8a4cde926c
9575dac135b868ebebc386f3cbe05d1dc56f59985ab510c21e076b5fc6bb
9818e97bebfc9f16c0cae0f773051a1cc19c48b2b65157731f62c3a97801
118ce93494aabb270b27e8b4094f597e3c05d89019d37cf6a2a397786e02
e332a62dd3bc705d95ce120c4dff177b706236bc0bd723458387dfd2f9d2
f759d15038fe27a015f1ee03c30c1aec1f4658e6758d577e3d900a63d2bc
db49f18fe6d1aedf153c75140a36cb1e5fea5b87744b9a767c5a9b0002ee
acd2a7b3062060887074df634d4c01e335e45d939439da877561640f0251
……
```

Evaluation

As shown in table 4, the time was reduced significantly when dumping the hash output in raw format instead of as HEX.

Output of 500.000.000 byte length	Speed in s
In RAW (500 MB)	0.467
As HEX (1 GB)	4.070

Table 4: speed – Dumping in hex vs. dumping in raw format.

In general, the speed results were well-promising. But, the selected XOR file operation took the most time as shown in table 5.

SHE encryption in s with 1 MB key	10 MB file	100 MB file	1 GB file
h-Box operation*	0.027	0.161	1.457
XOR Encryption (i.e. file based)	0.113	1.099	11.113
Total	**0.14**	**1.26**	**12.57**

* including XOF function and writing temporary file to disk

Table 5: sample encryption speed

The ultimate goal is to reach AES encryption speed levels. The AES encryption result for same files is visible in table 6. The `SHE.sh` script took up to 6.6 times longer than AES, which is mainly due to the inefficient XOR operation and writing data temporary to disk. Considering the “quick-and-dirty” proof of concept implementation and a relatively big key size of 1MB, this is a respectful result. It is very interesting what speed can be achieved after implementation of a state-of-the-art XOR-function. This task is a good follow-up work.

AES encryption in s	10 MB file	100 MB file	1 GB file
128-CBC	0.033	0.205	1.889

Table 6: AES encryption speed (i.e. 128-CBC mode)

Conclusions

Definition of follow-up work
The course work represents a practical experiment. Further work is necessary:
- Detailed analysis of the speed results, especially calculation of throughput (i.e. efficiency).
- State-of-the-art code implementation, especially implementation of a fast XOR function.
- After state-of-the-art code implementation, benchmark against AES.
- Research if hash-based encryption can be used in or to enhance public key cryptography.

Advantages of hash-based encryption

1. New Use-Cases: hash-based encryption enables many new use cases; the user can fill h-Box arbitrarily, which increases the attacking complexity as well. But, finally, the security is always restricted by the security of the hash function. Possible uses cases are e.g.:
    1. Encryption depending on where you are: The system environment (e.g. the kernel) can be included in the h-Box. In consequence, once encrypted, decryption requires to be inside the same pre-defined environment / machine.
    2. Encryption with things you own and things you know: The h-Box can be filled with everything you own (e.g. pictures, movies, hash of usb-sticks) as well as your individual secrets.
    3. Additional protection against reading attempts: Audit logs can be used to enforce control of encryption and decryption. For example, the audit log of a HSM can be part of the h-Box. The rotating audit log of YubiHSM 2 supports 62 entries. The first 60 entries could be put into the h-Box. In consequence, the audit log rotates and information needed for decryption gets lost in case of multiple unwanted reading attempts.
2. Easy: Hash based encryption is easy to implement and it is very flexible.
3. Future proof: Because of it's flexibility, hash based encryption can be used on long-term, with no need to adapt the implementation itself.
4. Efficiency: The h-Box input size can be increased without loosing efficiency significantly. For example: On System 1, hashing a 10 MB file to 1MB output took 0.0175 seconds, while hashing a 100 MB file to same length took only 0.01817 seconds.
5. Interchangeable: If the security of the hash function is broken, it can be replaced easily.

Critical appraisal for the coursework and speed tests
The coursework was started at an unexperienced status regarding hash speed and security. Therefore the strategy was to spend most of the time to evaluate the security and perform speed tests at large extent, without restriction of the test scope. Main goal was to learn more about the hash functions and to leave the door open for any result. It was very challenging to measure all constellations and isolate the influencing factors to reduce noise. It was necessary to adapt the test procedure several times, including manual re-tests. Finally a lot of data was collected, which potential was not utilized fully for the coursework because no more time left. Only few findings and statements were possible. The data has to be analyzed in detail afterwards (e.g. throughput).

At the beginning of the coursework, each hash operation was executed only one time. This approach had a high risk of noise. To reduce noise, it was necessary to execute each hash operation 10 times to calculate the average time. In consequence, approx. 2 days of time were lost.

Furthermore, after screening the results on system 3 (i.e. XEON with HDD), it was recognized that the first hash operation took always significantly longer time. The first operation hashed a given file to 32 bytes. The second operation hashed the same file again to 500 bytes, but took only a fraction of the previous one. For example, b3sum hashed a 10 GB file to 32 byte in 14.59 seconds. Directly after this, the same file was hashed to 500 bytes in 1.80 seconds; the second operation took 12.79 seconds less. This behavior was very strange at the first look. O'CONNOR from the Blake3-Team was asked to support the root cause analysis; see issue 172 on github.com/BLAKE3-team/BLAKE3. After several manual retests and going through an elimination process, the reason for that behavior is mainly identified in the reading and caching process of Hard Disk Drives (HDDs). All hash operations of a loop pointed to the same input file. The system continued than with cached data if the next operation points to the same file (-name). This large difference (i.e. 12.79 seconds in case of 10 GB input) was only observed when HDDs were in use. If SSDs were in use, the difference was in most of all cases in a range between 10-200 milliseconds. In consequence, all system 3 tests for 32 bytes output were repeated to ensure comparability and overcome the HDD caching and reading issue. Retrospectively, it would had been a better approach, to name all input files differently, although they are equal (e.g. as "key_10GB.file.A", "key_10GB.file.B", etc.). By this, tests would include the reading speed of the disk as well. However, this was not necessary for the coursework. The coursework aimed to compare the hash functions under same conditions. This was reached successfully and noise level was reduced.

Finally, it was evaluated to write the output to */dev/null* instead to disk. After manual retests it was identified that this is not relevant to solve the afore-mentioned problem and was therefore not implemented.

In conclusion, the speed results were useful and adequate for the scope of the coursework. However, in future work, more attention should be put on a clear definition of measurement goals and strategy to avoid unnecessary operations and noise *before* test execution. With a better testing goal definition several re-tests could have been avoided.

But, one is always wiser after the work.

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List of Appendix

Appendix a) Test system and platform configuration

System 1 — x64 architecture - High-end Notebook — HP Zbook x360 G5

CPU	Intel Core i7-8750H; 6 cores @ Max. 4100 MHz
GPU	NVIDIA QUADRO P1000 mobile, GP107GLM
RAM	64 GB (2x32 GB) @ Configured Memory Speed: 2667 MT/s, SODIMM
OS	POP!_OS 20.10 (Ubuntu based)
Storage	1TB SSD

System 2 — ARMv8 architecture - Android Tablet Samsung Tab S5e LTE 64GB

CPU	Kryo 360; 8 cores @ 2x2000 MHz & 6x1700 MHz
GPU	Adreno 615
RAM	4 GB
OS	Android
Storage	64GB eMMC

System 3 — x64 architecture - XEON dedicated server

CPU	Intel Xeon E31230; 4 cores @ Max. 3200 MHz
GPU	none
RAM	4 GB
OS	Ubuntu 20.04
Storage	2TB HDD

Appendix b) Complete speed results for Blake3

General hint: each hash pair was repeated 10 times and the average time was calculated.

On system 1 – x64*

input output	1KB	1MB	2MB	3MB	4MB	5MB	6MB	7MB	8MB	9MB	10MB	20MB	30MB	40MB	50MB	60MB	70MB	80MB	90MB	100MB	200MB	300MB	400MB	500MB	600MB	700MB	800MB	900MB	1GB	2GB	3GB	4GB	5GB	6GB	7GB	8GB	9GB	10GB
std (32b)	0.00813	0.01303	0.01258	0.01141	0.01296	0.01141	0.01139	0.01193	0.01256	0.01168	0.01171	0.01434	0.02079	0.02144	0.01961	0.01944	0.02172	0.02744	0.02406	0.02831	0.03747	0.04621	0.06284	0.07567	0.08106	0.08933	0.10443	0.13688	0.11541	0.253	0.37762	0.55147	0.59982	0.73545	0.84696	0.9698	1.10497	1.47779
1kb	0.00621	0.00205	0.00181	0.00181	0.00184	0.00222	0.00205	0.00242	0.00262	0.00392	0.00474	0.0072	0.00738	0.00613	0.00657	0.00747	0.0099	0.00957	0.01119	0.01227	0.02003	0.031	0.03969	0.04419	0.05588	0.06062	0.06976	0.09603	0.09122	0.16844	0.26415	0.35215	0.41634	0.50284	0.57941	0.66684	0.75491	0.86516
10kb	0.00279	0.00217	0.00277	0.00214	0.00196	0.00226	0.00213	0.00928	0.00918	0.0094	0.00964	0.00512	0.00697	0.00574	0.00639	0.0099	0.01306	0.01083	0.02855	0.01161	0.02005	0.02828	0.03487	0.04683	0.04988	0.05975	0.06673	0.08099	0.08013	0.17246	0.25317	0.36665	0.41832	0.50552	0.56982	0.66204	0.75102	0.85619
100kb	0.00348	0.00292	0.01054	0.01061	0.00258	0.00322	0.00271	0.00875	0.00688	0.0112	0.01161	0.00868	0.00742	0.00591	0.00795	0.01201	0.01191	0.0116	0.03402	0.01211	0.02063	0.0292	0.03312	0.04371	0.05773	0.06408	0.06878	0.07581	0.08976	0.17136	0.25496	0.36443	0.40765	0.50585	0.58611	0.66494	0.74905	0.8488
1MB	0.01212	0.00974	0.01959	0.01189	0.00793	0.02186	0.0078	0.01547	0.01363	0.01494	0.01758	0.01166	0.0123	0.01153	0.01273	0.01407	0.01827	0.01755	0.02689	0.01817	0.02775	0.03605	0.04131	0.04654	0.05621	0.06633	0.08074	0.12375	0.09641	0.18345	0.26383	0.37721	0.42897	0.51093	0.59198	0.67545	0.75416	0.87444
2MB	0.0206	0.01749	0.01724	0.01546	0.0135	0.01795	0.01576	0.01633	0.01793	0.0176	0.01714	0.01858	0.02178	0.02197	0.02118	0.02204	0.02281	0.02321	0.02495	0.02835	0.03531	0.04994	0.04874	0.052	0.06197	0.07897	0.08571	0.0927	0.1051	0.1777	0.27488	0.3793	0.41901	0.50716	0.58862	0.66439	0.74932	0.94975
3MB	0.01939	0.0251	0.02296	0.02141	0.01873	0.01904	0.02052	0.02023	0.02162	0.01921	0.02011	0.0285	0.02577	0.02585	0.0263	0.02578	0.02855	0.02908	0.03115	0.0347	0.04124	0.04785	0.06143	0.06832	0.06768	0.08027	0.09687	0.09898	0.10747	0.19367	0.27097	0.36903	0.42892	0.51347	0.59385	0.69063	0.76213	0.99431
4MB	0.02539	0.03223	0.03417	0.02444	0.02446	0.02438	0.02456	0.02476	0.03155	0.02463	0.02858	0.03227	0.03171	0.03644	0.02915	0.03486	0.03736	0.04343	0.03919	0.04127	0.04485	0.05653	0.06257	0.07092	0.08494	0.09654	0.09596	0.11038	0.11124	0.20754	0.27682	0.38629	0.44612	0.52176	0.59849	0.69006	0.76525	0.9473
5MB	0.03153	0.04006	0.03839	0.03002	0.03083	0.03011	0.03022	0.03336	0.03573	0.03317	0.03118	0.04262	0.03604	0.03697	0.03917	0.04027	0.0423	0.03964	0.04241	0.04633	0.05194	0.06004	0.07056	0.07869	0.09016	0.10414	0.11017	0.13542	0.12474	0.19826	0.28697	0.37114	0.44325	0.52198	0.61483	0.69081	0.76901	0.96773
6MB	0.03716	0.0464	0.04584	0.03544	0.03535	0.03558	0.03564	0.03593	0.03789	0.0359	0.03588	0.04526	0.04113	0.04515	0.04502	0.04504	0.05148	0.04651	0.04704	0.04839	0.05413	0.06507	0.0663	0.08505	0.09403	0.09827	0.11018	0.11388	0.12914	0.20567	0.29477	0.40457	0.44849	0.52505	0.6162	0.69715	0.77594	0.9593
7MB	0.04345	0.05108	0.05604	0.04091	0.04093	0.04387	0.04122	0.04521	0.04672	0.04123	0.0414	0.05259	0.04986	0.04824	0.04517	0.04964	0.049	0.05405	0.05167	0.05578	0.06059	0.06801	0.07633	0.08417	0.0922	0.10417	0.11428	0.11729	0.13156	0.21061	0.29123	0.4016	0.45153	0.53655	0.62627	0.70492	0.77727	1.00196
8MB	0.04879	0.066	0.06209	0.04654	0.04647	0.04649	0.04652	0.05004	0.05209	0.04656	0.04848	0.05578	0.04924	0.05098	0.05654	0.05595	0.05794	0.05368	0.05791	0.06003	0.06825	0.07565	0.08114	0.08927	0.09531	0.10537	0.11762	0.13777	0.13273	0.22747	0.3007	0.41644	0.46441	0.55233	0.62779	0.71252	0.78202	0.99397
9MB	0.05585	0.07901	0.0663	0.05215	0.05239	0.05242	0.05241	0.0539	0.0585	0.05249	0.05252	0.06218	0.05564	0.06091	0.05899	0.06149	0.06639	0.06893	0.06622	0.06595	0.07585	0.083	0.08677	0.09609	0.10414	0.11499	0.12213	0.15485	0.1369	0.223	0.30649	0.421	0.47187	0.60953	0.62783	0.71285	0.79163	1.04185
10MB	0.06074	0.08423	0.07293	0.05773	0.05741	0.05741	0.05742	0.0643	0.06283	0.05916	0.05834	0.07	0.06487	0.06391	0.06784	0.06751	0.06937	0.06745	0.07507	0.06891	0.08054	0.08512	0.09285	0.10099	0.10707	0.12212	0.13133	0.13546	0.14478	0.22822	0.32053	0.40718	0.46835	0.57336	0.63866	0.73358	0.81217	1.00794
20MB	0.11877	0.15277	0.11566	0.11113	0.11034	0.11061	0.11096	0.12052	0.11941	0.11138	0.11116	0.13361	0.1135	0.1162	0.12205	0.11765	0.11875	0.11767	0.12325	0.12506	0.12986	0.13951	0.14731	0.1522	0.16259	0.16891	0.17699	0.1859	0.19425	0.28228	0.36033	0.50559	0.52873	0.65079	0.69608	0.76511	0.84568	1.05828
30MB	0.1771	0.22776	0.17988	0.16481	0.16473	0.16441	0.16375	0.1666	0.17738	0.16447	0.16515	0.17647	0.17482	0.16862	0.16728	0.16967	0.17085	0.17057	0.17413	0.17487	0.18302	0.1915	0.19686	0.20616	0.2116	0.22389	0.28611	0.28	0.24888	0.33041	0.41474	0.49695	0.58941	0.72533	0.74944	0.827	0.9051	1.09798
40MB	0.23905	0.29893	0.26352	0.21933	0.21783	0.21852	0.21719	0.22234	0.2249	0.21721	0.21961	0.25726	0.22131	0.21985	0.21959	0.22089	0.22268	0.22493	0.22733	0.22703	0.23658	0.24149	0.25221	0.2605	0.27124	0.28295	0.29994	0.29613	0.3015	0.39481	0.46953	0.56388	0.63516	0.73974	0.80093	0.88518	0.96694	1.17318
50MB	0.28961	0.3623	0.30738	0.27245	0.27074	0.27152	0.27138	0.2706	0.30965	0.27222	0.27238	0.36502	0.27493	0.27389	0.27591	0.27528	0.27684	0.27547	0.28739	0.28001	0.29318	0.29805	0.30593	0.3137	0.32463	0.33597	0.41656	0.39482	0.37009	0.43775	0.51983	0.65919	0.68862	0.81428	0.86551	0.9554	1.05296	1.21275
60MB	0.34755	0.49954	0.39784	0.32826	0.33064	0.32767	0.33059	0.32621	0.39371	0.32783	0.32704	0.43736	0.33843	0.33715	0.32592	0.33097	0.3306	0.3322	0.33511	0.33386	0.34243	0.34739	0.35896	0.36818	0.38337	0.39517	0.45453	0.40848	0.42692	0.49129	0.59122	0.67534	0.76134	0.84577	0.93186	1.02365	1.13492	1.27289
70MB	0.40607	0.55551	0.45461	0.38127	0.37977	0.37974	0.37758	0.38027	0.47181	0.38643	0.38323	0.44062	0.388	0.38395	0.38232	0.38813	0.38774	0.38434	0.39365	0.39264	0.39986	0.40267	0.41195	0.422	0.43352	0.44197	0.48137	0.52144	0.47659	0.54406	0.6407	0.78909	0.826	0.93369	0.98625	1.08981	1.16015	1.34361
80MB	0.47111	0.62948	0.50742	0.44014	0.44495	0.43105	0.43983	0.43396	0.51922	0.43074	0.43512	0.53305	0.43748	0.43609	0.43302	0.43327	0.43942	0.43677	0.44802	0.44517	0.45271	0.45548	0.47007	0.48208	0.48645	0.50162	0.58125	0.55151	0.52829	0.59761	0.69513	0.81557	0.87932	0.98734	1.04481	1.14173	1.23865	1.36764
90MB	0.53401	0.66983	0.56805	0.49383	0.48628	0.48941	0.49185	0.49869	0.59181	0.49017	0.49342	0.69392	0.49612	0.48999	0.49254	0.49075	0.49382	0.49346	0.4986	0.49454	0.4979	0.51995	0.52256	0.52265	0.54471	0.55665	0.63644	0.58638	0.58842	0.664	0.74885	0.89168	0.92441	1.04125	1.08998	1.19776	1.2825	1.4345
100MB	0.5937	0.68658	0.63403	0.55005	0.55277	0.54907	0.54114	0.55007	0.75711	0.54726	0.54758	0.66286	0.56436	0.54701	0.54347	0.54528	0.55816	0.54195	0.55949	0.5544	0.56206	0.5679	0.57751	0.58241	0.59248	0.61261	0.71114	0.68251	0.64779	0.71135	0.79955	0.92629	0.98996	1.09748	1.14301	1.24791	1.34244	1.51188
200MB	1.38979	1.84632	1.27845	1.09812	1.08287	1.09597	1.07827	1.09253	1.39246	1.08145	1.10125	1.23249	1.10214	1.10478	1.08905	1.07383	1.10409	1.07686	1.12216	1.09154	1.08383	1.09252	1.11688	1.13199	1.13652	1.15614	1.35056	1.25619	1.18249	1.2615	1.35109	1.48663	1.51416	1.67021	1.69243	1.81303	1.92137	2.10943
300MB	1.90088	2.27407	1.90592	1.64252	1.73142	1.61975	1.62427	1.63428	1.83979	1.64529	1.6157	1.92468	1.64715	1.64413	1.61556	1.61071	1.643	1.61571	1.63439	1.62061	1.63512	1.62971	1.6349	1.65254	1.67805	1.67136	2.03397	1.83984	1.72524	1.79854	1.9062	2.10329	2.0929	2.25296	2.19842	2.27946	2.40016	2.63498
400MB	2.78705	2.93376	2.57268	2.20783	2.43264	2.17963	2.16534	2.1726	2.25827	2.18204	2.18884	2.48503	2.18964	2.16054	2.16081	2.17165	2.17048	2.16765	2.20098	2.17263	2.1679	2.18912	2.18874	2.16401	2.16511	2.19336	2.8488	2.30257	2.20504	2.27804	2.37556	2.57482	2.48822	2.66568	2.70218	2.77802	2.90584	3.12502
500MB	3.08406	3.40168	2.94074	2.69041	3.07121	2.63165	2.59374	2.61419	2.67306	2.59995	2.70234	3.13859	2.67785	2.56695	2.64085	2.59512	2.62874	2.56489	2.64568	2.60514	2.57779	2.59678	2.60234	2.65697	2.67676	2.66288	3.05544	2.83459	2.73828	2.77409	2.88293	3.11741	3.04766	3.38084	3.21571	3.31124	3.41618	3.61622
600MB	3.78977	3.98253	3.46367	3.25342	3.60437	3.21428	3.11801	3.17945	3.20842	3.54917	3.24387	3.51173	3.19803	3.13901	3.1233	3.14322	3.11587	3.88127	3.17799	3.13573	3.12755	3.14289	3.1587	3.17115	3.16828	3.21801	3.62826	3.4429	3.26461	3.34051	3.39918	3.64919	3.59417	3.92434	3.77094	3.85235	3.98482	4.32805
700MB	4.57241	4.61024	3.95067	3.71365	3.76329	3.69581	3.65412	3.72703	3.71789	3.83354	3.74934	3.86919	3.77054	3.64181	3.67178	3.68932	3.69037	4.46685	3.68311	3.68157	3.6698	3.68615	3.71391	3.68378	3.6784	3.71525	4.44251	3.85704	3.77906	3.82372	3.93049	4.19225	4.11381	4.25216	4.24964	4.33668	4.4596	4.72731
800MB	5.26991	5.33807	5.21028	4.34836	4.2695	4.22771	4.17963	4.25838	4.24994	4.31855	4.24946	4.31583	4.25436	4.16989	4.14179	4.29449	4.26162	4.39224	4.26227	4.20457	4.17653	4.19866	4.24137	4.25386	4.227	4.23529	4.50825	4.33027	4.29528	4.35144	4.48874	4.57745	4.66533	4.76711	4.78123	4.83218	5.00692	5.31612
900MB	6.25664	5.32585	5.50728	4.79442	4.77985	4.70763	4.65033	4.72503	4.83528	4.90627	4.82764	4.75803	4.74259	4.70293	4.67544	4.68855	4.70096	4.77866	4.74741	4.71005	4.66465	4.69372	4.72835	4.74732	4.68617	4.74103	4.8763	4.85945	4.73772	4.86727	5.1167	4.98617	5.14549	5.24417	5.19971	5.31726	5.38121	5.82932
1000MB	7.80299	5.97015	5.37079	5.21263	5.31949	5.17109	5.23777	5.47787	5.29113	5.27175	5.67466	5.37513	5.18221	5.10329	5.14404	5.1781	5.16505	5.23368	5.19909	5.20607	5.14884	5.18696	5.17141	5.23339	5.20179	5.21591	5.71759	5.29171	5.24578	5.30973	5.64372	5.54098	5.64563	5.72434	5.80858	5.86814	5.96414	6.20759

*** 32bytes output length was calculated only one time, the gap between std (32b) and 1kb was accepted.**

On system 2 – ARM*

input output	1KB	1MB	2MB	3MB	4MB	5MB	6MB	7MB	8MB	9MB	10MB	20MB	30MB	40MB	50MB	60MB	70MB	80MB	90MB	100MB	200MB	300MB	400MB	500MB	600MB	700MB	800MB	900MB	1GB	2GB	3GB	4GB	5GB	6GB	7GB	8GB	9GB	10GB
std (32b)	0.03526	0.07487	0.07808	0.079	0.08163	0.04232	0.04523	0.08466	0.07741	0.38091	0.08467	0.08392	0.10536	0.11531	0.12596	0.1378	0.14637	0.16071	0.17223	0.18624	0.29181	0.39748	0.50015	0.61666	1.30255	1.55083	1.5298	1.70206	1.82312	3.52474	10.31034	14.51737	15.28375	21.89104	26.44905	28.60768	32.65976	35.86665
1kb	0.03647	0.04385	0.03876	0.04311	0.04374	0.04681	0.04361	0.05472	0.04901	0.04813	0.05194	0.06043	0.07444	0.08616	0.08456	0.10424	0.10301	0.10898	0.11725	0.12807	0.2018	0.2826	0.3581	0.44173	0.52283	0.60758	0.67716	0.75991	0.83445	1.63435	7.20097	13.87527	12.43796	21.94667	25.9481	28.26066	32.4718	35.87424
10kb	0.03738	0.03422	0.03695	0.04071	0.04456	0.03842	0.04497	0.04696	0.04349	0.04753	0.05114	0.05951	0.07525	0.07771	0.08398	0.09375	0.10517	0.10967	0.11782	0.12951	0.20277	0.28778	0.37048	0.45113	0.52834	0.60981	0.68545	0.77563	0.83447	1.62098	6.26987	13.54195	12.82443	21.84772	25.84754	28.2929	32.36089	35.68754
100kb	0.04006	0.03573	0.04018	0.04383	0.05304	0.04614	0.04686	0.05113	0.0476	0.05499	0.0539	0.06243	0.0723	0.08103	0.08678	0.09426	0.10466	0.11719	0.12175	0.13105	0.21236	0.29873	0.36648	0.44878	0.52457	0.60843	0.68712	0.7692	0.83959	1.6311	6.53329	13.31627	12.68675	21.74866	25.85451	28.47586	32.55823	35.72719
1MB	0.08069	0.0647	0.06256	0.08528	0.08378	0.06448	0.0751	0.06888	0.06946	0.0824	0.09327	0.07739	0.08439	0.09182	0.10965	0.11322	0.11592	0.14463	0.15152	0.16143	0.2357	0.31175	0.39166	0.47118	0.54384	0.6205	0.69433	0.7783	0.85523	1.63032	6.26178	13.04373	12.26383	21.63239	25.93044	28.31708	33.46913	35.68442
2MB	0.10574	0.08185	0.10178	0.08481	0.09712	0.08319	0.08428	0.0851	0.08387	0.10426	0.08761	0.11367	0.10014	0.10924	0.14416	0.14559	0.13194	0.17001	0.17016	0.18267	0.25721	0.33233	0.40487	0.4821	0.55849	0.63766	0.70993	0.78748	0.86709	1.65272	6.26317	12.97831	12.67347	21.71272	26.22625	28.3054	32.40736	36.22814
3MB	0.12113	0.12134	0.1224	0.10053	0.1157	0.10802	0.09181	0.10529	0.11496	0.1312	0.10496	0.13273	0.12355	0.15128	0.15801	0.16749	0.17311	0.18203	0.19582	0.19913	0.26956	0.34427	0.42382	0.50182	0.5767	0.65607	0.72714	0.81141	0.88249	1.66319	6.15985	12.78062	12.46848	21.74361	26.13578	28.3821	32.30296	35.66594
4MB	0.13404	0.13962	0.14124	0.12727	0.12336	0.09911	0.13912	0.12382	0.1138	0.14402	0.12253	0.15071	0.16182	0.16016	0.17604	0.18574	0.1866	0.20156	0.20591	0.21431	0.28595	0.36768	0.43675	0.53123	0.58601	0.67497	0.74876	0.83985	0.90192	1.684	6.29564	12.36091	12.92409	22.14574	26.07481	28.39448	31.19974	35.82523
5MB	0.15123	0.15113	0.15325	0.15508	0.1533	0.12814	0.15278	0.14577	0.14483	0.16086	0.16069	0.18024	0.17474	0.1883	0.18931	0.20154	0.20795	0.21621	0.21818	0.23568	0.30215	0.37854	0.45754	0.53345	0.60246	0.68662	0.75392	0.84384	0.91511	1.70214	6.24969	11.22784	12.68118	22.0778	26.16898	28.36539	31.00767	36.36566
6MB	0.16558	0.17224	0.16977	0.15099	0.16749	0.17004	0.16329	0.14969	0.17375	0.17934	0.17234	0.18099	0.19141	0.2041	0.20873	0.21607	0.21802	0.2316	0.23625	0.245	0.31467	0.40256	0.46533	0.54604	0.62075	0.70344	0.77316	0.85396	0.92696	1.71098	6.41084	10.50954	12.59855	22.23979	26.02119	28.35127	31.12257	36.68585
7MB	0.19226	0.18428	0.1882	0.183	0.18188	0.19204	0.19476	0.16159	0.19302	0.19444	0.18628	0.20177	0.19963	0.20363	0.22639	0.23215	0.2362	0.24423	0.2542	0.26154	0.32465	0.40597	0.48654	0.55843	0.6404	0.72422	0.79334	0.87013	0.94701	1.7277	6.19018	9.58254	12.66177	22.74835	26.18809	28.61475	30.92485	36.8237
8MB	0.20241	0.19864	0.20763	0.20306	0.20971	0.20409	0.20456	0.17528	0.20932	0.20872	0.20669	0.20716	0.23031	0.23292	0.23807	0.24386	0.25883	0.25169	0.27432	0.28201	0.34354	0.42977	0.50213	0.57445	0.66166	0.73146	0.81573	0.89246	0.96318	1.74513	6.12889	9.10956	13.9614	22.15977	26.13712	28.69047	30.43751	37.10289
9MB	0.2147	0.21899	0.21676	0.22382	0.22096	0.22407	0.21752	0.20109	0.22541	0.23329	0.22645	0.22193	0.23665	0.24401	0.25614	0.26756	0.27889	0.26389	0.28694	0.29295	0.35652	0.43874	0.52289	0.59245	0.66408	0.75382	0.83381	0.89749	0.96658	1.8787	6.20027	9.74983	12.76466	22.20315	26.18533	28.75907	30.60287	36.4887
10MB	0.23857	0.24437	0.24577	0.23543	0.24836	0.23915	0.22991	0.23387	0.24088	0.24798	0.24459	0.25084	0.25743	0.26037	0.27473	0.28109	0.28612	0.29426	0.30004	0.31889	0.3823	0.46494	0.53622	0.60668	0.68583	0.76256	0.84408	0.91088	0.99546	1.88037	6.12658	9.81776	13.06896	22.15892	26.08421	28.77791	29.90753	36.59212
20MB	0.38822	0.39197	0.38338	0.38539	0.39273	0.39457	0.37556	0.38939	0.39004	0.39658	0.39073	0.39989	0.41819	0.41022	0.40921	0.42598	0.44243	0.44443	0.45064	0.45788	0.534	0.60319	0.68137	0.7651	0.83698	0.92844	0.98859	1.07173	1.13844	2.34668	8.32499	9.7006	13.64111	22.22923	26.31063	28.89896	30.46369	36.33845
30MB	0.54607	0.54212	0.54348	0.54448	0.55374	0.54555	0.55722	0.54534	0.54991	0.54797	0.55032	0.56202	0.57451	0.57424	0.57582	0.58612	0.59852	0.61517	0.59882	0.61307	0.67757	0.77783	0.82645	0.90064	0.99173	1.06902	1.13769	1.21977	1.29614	2.15403	7.2501	10.22523	13.46034	22.42996	26.46959	29.2454	30.87663	36.39836
40MB	0.71092	0.69627	0.71256	0.69348	0.70593	0.75651	0.74864	0.67185	0.7003	0.70411	0.70462	0.70773	0.7231	0.74048	0.73146	0.7324	0.74312	0.74986	0.74895	0.76967	0.83736	0.92224	0.99196	1.0648	1.14667	1.21548	1.30546	1.38017	1.4548	2.28958	7.79947	10.07983	13.76513	22.79189	26.62206	29.05149	30.79216	36.64594
50MB	0.88758	0.84054	0.8463	0.84093	0.84655	0.85552	0.86769	0.84355	0.84757	0.85095	0.85392	0.8667	0.87032	0.87131	0.88425	0.89472	0.87124	0.90048	0.92238	0.92418	0.98832	1.06532	1.1419	1.22221	1.30342	1.37563	1.44362	1.52446	1.59805	2.40293	7.50545	11.05185	13.57112	22.80175	26.81118	29.5351	30.66964	36.70849
60MB	1.00508	1.00085	0.98169	1.01015	0.97493	1.03608	1.0172	0.98239	0.98821	1.00537	1.00197	1.01116	1.02979	1.0243	1.0441	1.04617	0.9739	1.03841	1.04554	1.08182	1.13556	1.21491	1.28536	1.35173	1.4293	1.52559	1.59627	1.67131	1.74361	2.55355	7.70784	10.81652	13.51761	22.90094	26.94471	29.74985	30.77907	37.99589
70MB	1.16065	1.16865	1.14066	1.18198	1.13337	1.18271	1.16845	1.15233	1.15973	1.18527	1.1944	1.16325	1.1748	1.1863	1.18553	1.18163	1.17419	1.2263	1.28213	1.21461	1.28784	1.37484	1.43922	1.53242	1.58527	1.67769	1.74354	1.81984	1.89825	2.89745	7.69337	10.62649	13.94677	23.23938	27.19783	30.16016	30.56114	38.56815
80MB	1.29046	1.29637	1.31295	1.29639	1.33989	1.28327	1.28784	1.32277	1.22084	1.35615	1.29168	1.31824	1.32251	1.32061	1.33394	1.32973	1.27044	1.35104	1.36203	1.36518	1.44197	1.51207	1.58014	1.66673	1.73283	1.82014	1.89183	1.96935	2.03067	2.89988	9.03346	12.54341	14.29739	23.41337	27.34719	29.94524	30.42617	38.67983
90MB	1.43971	1.44438	1.50852	1.45396	1.43923	1.45836	1.45192	1.54254	1.41406	1.47077	1.46867	1.45499	1.4668	1.48683	1.54407	1.48438	1.47418	1.49226	1.50176	1.50524	1.63252	1.65564	1.72621	1.80558	1.89492	1.99615	2.02989	2.11381	2.19195	2.98398	8.32533	11.33801	14.36799	23.72713	27.62521	30.02708	30.86658	38.86982
100MB	1.57748	1.57782	1.5982	1.59419	1.6203	1.59445	1.59411	1.60858	1.60871	1.60197	1.59667	1.60416	1.62054	1.64061	1.61406	1.61425	1.65107	1.64922	1.65651	1.6448	1.73353	1.8061	1.90756	1.95786	2.03662	2.13458	2.18307	2.26591	2.35726	3.1508	8.73546	11.08371	14.35731	23.64501	27.80628	30.1006	30.33835	38.97127
200MB	3.09728	3.06603	3.11904	3.07508	3.09058	3.1222	3.13911	3.18819	3.16323	3.10193	3.09243	3.14137	3.14061	3.16412	3.20139	3.14268	3.18038	3.19908	3.18431	3.18039	3.2413	3.53112	3.3619	3.46735	3.5968	3.67753	3.74197	3.74873	3.80988	4.7776	10.55924	12.76977	15.81772	25.39553	29.54347	31.68196	32.01995	40.21079
300MB	4.63659	4.63452	4.69618	4.62683	4.62227	4.60448	4.64273	4.73035	4.73857	4.64281	4.6142	4.66097	4.65257	4.66411	4.70437	4.681	4.67093	4.75371	4.731	4.6697	4.77863	4.98689	4.94357	5.02226	5.14271	5.1622	5.24822	5.2563	5.37269	6.12214	12.20258	14.67934	18.07933	27.27437	31.45431	33.16864	33.90017	41.65298
400MB	6.1878	6.13356	6.20511	6.16472	6.23738	6.13559	6.22199	6.31275	6.17557	6.25053	6.13627	6.30994	6.21067	6.21881	6.14756	6.28814	6.25415	6.30424	6.2716	6.30573	6.31963	6.45168	6.59346	6.67486	6.57233	6.833	6.75789	6.96833	6.91403	7.84271	14.9488	16.57421	19.90211	29.09545	33.63065	34.71513	35.24583	42.74852
500MB	8.15589	7.74298	7.67682	7.75869	7.82908	7.8071	7.86582	7.89276	7.81817	7.93753	7.79823	7.73852	7.76344	7.84074	7.7857	7.8536	7.87176	7.81799	7.78206	7.75813	7.94073	8.08628	8.01299	8.19625	8.1881	8.43261	8.36601	8.77206	8.66382	9.70308	17.24909	18.44515	22.40151	30.68563	35.48842	36.42334	37.12771	44.31765
600MB	9.28593	9.37113	9.36251	9.33631	9.28947	9.34944	9.36203	9.37571	9.34346	9.41304	9.39826	9.39018	9.37199	9.43201	9.43009	9.54108	9.37638	9.41589	9.44259	9.34047	9.60395	9.7151	9.77462	9.76187	9.8305	10.17634	9.89638	9.98623	10.31357	11.73833	18.96783	20.83543	24.21706	32.96737	37.3604	38.00882	38.37231	45.56927
700MB	10.88782	10.83744	11.02819	10.88454	10.84057	10.8141	10.99467	10.8647	10.7752	10.91835	11.49851	10.97735	11.09207	10.90766	10.92566	11.28461	10.9174	11.07102	11.11343	10.91518	11.31474	11.31606	11.19434	11.2041	11.36328	11.55816	11.42605	11.74508	12.42571	13.81295	19.75938	22.92768	25.78899	34.87988	39.41251	39.38995	40.57697	47.33485
800MB	12.31133	12.37069	12.3923	12.52797	12.37517	12.72843	12.45718	12.61534	12.32674	12.57413	13.30024	12.63444	12.53031	12.59171	12.49777	12.76346	12.80225	12.54456	12.6221	12.56396	12.81692	12.86668	13.00708	12.91834	13.07201	13.32977	13.31249	13.0961	14.13393	14.97431	22.07245	24.40245	27.69571	36.96704	41.32163	41.09236	42.0085	48.8553
900MB	13.8803	14.14631	14.06441	13.99265	14.00932	14.08659	14.3171	14.13518	14.0748	14.01762	15.01695	14.24082	14.25906	14.12086	14.35268	14.41424	14.32971	14.13577	13.98981	14.47655	14.25489	14.617	14.6889	14.68053	14.47652	14.87604	14.73987	14.88341	15.8624	17.00912	24.08343	26.82677	30.59813	39.22175	43.31174	42.85689	43.7039	50.72032
1000MB	15.65394	15.53714	15.34629	15.7773	15.57042	15.5256	15.73531	15.7109	16.03323	15.64868	16.67941	15.6198	15.91376	15.98253	16.01248	16.10645	15.8085	15.77195	15.97411	15.78066	16.38772	16.18402	16.46624	16.30226	16.3017	16.31808	16.55122	16.54294	16.34959	19.25264	25.94471	29.21613	34.12198	41.06104	45.28166	44.80757	44.83676	52.38386

*** 32bytes output length was calculated only one time, the gap between std (32b) and 1kb was accepted.**

On system 3 – XEON*

input output	1KB	1MB	2MB	3MB	4MB	5MB	6MB	7MB	8MB	9MB
std (32b)	0.00046	0.00053	0.00058	0.00059	0.00066	0.00068	0.02246	0.00068	0.00062	0.00085
1kb	0.00237	0.00184	0.00355	0.0032	0.00345	0.00357	0.00405	0.00414	0.00475	0.00454
10kb	0.00309	0.00219	0.00369	0.0039	0.00402	0.00416	0.00431	0.00445	0.00466	0.00435
100kb	0.00473	0.00379	0.00525	0.0051	0.00491	0.00545	0.00501	0.00532	0.00593	0.00619
1MB	0.01645	0.01476	0.01623	0.01524	0.01545	0.0157	0.01664	0.01873	0.01676	0.01593
2MB	0.02466	0.02529	0.02507	0.02699	0.02527	0.02545	0.02663	0.03025	0.02633	0.02655
3MB	0.03323	0.03444	0.03628	0.03421	0.03418	0.0353	0.03832	0.03431	0.03469	0.03458
4MB	0.04282	0.0424	0.04216	0.04322	0.04316	0.04271	0.04428	0.04278	0.04396	0.04354
5MB	0.07434	0.07447	0.07518	0.07332	0.07414	0.07471	0.07502	0.07967	0.08254	0.08243
6MB	0.08828	0.08691	0.08755	0.08535	0.08827	0.08765	0.09267	0.096	0.10128	0.10055
7MB	0.10083	0.10329	0.09877	0.09817	0.09845	0.10614	0.10944	0.1083	0.11072	0.11404
8MB	0.11068	0.10776	0.10362	0.10346	0.10173	0.10957	0.11784	0.11948	0.11953	0.12437
9MB	0.1111	0.10868	0.12339	0.11375	0.11627	0.11003	0.1232	0.12551	0.12826	0.12952
10MB	0.11912	0.11669	0.12195	0.12169	0.12095	0.11684	0.13433	0.12913	0.14338	0.13894
20MB	0.24393	0.25155	0.2582	0.24954	0.25996	0.25445	0.26662	0.26837	0.2931	0.30154
30MB	0.38792	0.39347	0.40255	0.38835	0.39213	0.40839	0.40536	0.4126	0.44525	0.44076
40MB	0.5079	0.51777	0.52883	0.53405	0.51693	0.54583	0.55458	0.56336	0.61587	0.62662
50MB	0.64795	0.65421	0.66922	0.67184	0.67503	0.7151	0.7176	0.72844	0.76222	0.79295
60MB	0.77882	0.8075	0.81107	0.81174	0.82007	0.8084	0.87196	0.86803	0.91557	0.94286
70MB	0.90992	0.93688	0.92981	0.94971	0.97242	0.97857	1.00132	1.03719	1.06552	1.1132
80MB	1.05761	1.06783	1.0506	1.11578	1.08754	1.0991	1.14897	1.1825	1.23673	1.26977
90MB	1.16608	1.21951	1.2481	1.19645	1.24557	1.28566	1.32872	1.31201	1.42829	1.42518
100MB	1.33152	1.36031	1.34746	1.38578	1.39778	1.41988	1.46674	1.51023	1.58653	1.58538
200MB	2.64846	2.65427	2.72765	2.76556	2.80377	2.81448	2.8938	2.95219	3.07792	3.14429
300MB	3.79809	4.02465	4.10814	4.12554	4.07844	4.2054	4.33037	4.44883	4.65322	4.75227
400MB	5.27921	5.33675	5.43407	5.52961	5.65431	5.68931	5.5054	5.95021	6.22751	6.32301
500MB	6.57253	6.70656	6.82083	6.87729	7.00385	7.0861	7.10018	7.07398	7.77701	8.00503
600MB	7.49434	8.03966	8.20173	7.87975	8.39489	8.28974	8.70919	9.04776	9.23	9.33386
700MB	9.08701	9.07019	9.2186	9.42609	9.35381	9.38201	9.35487	9.70468	10.76641	11.42977
800MB	10.35042	10.70726	10.62061	10.65397	11.27367	11.21891	11.91184	12.17624	12.63271	12.99279
900MB	12.03259	12.19364	12.29584	12.47212	12.68155	12.7611	13.07173	13.03423	13.34276	13.32712
1000MB	12.92685	12.77448	12.96934	12.90153	12.70353	12.49631	13.59851	15.11645	15.40785	16.29785

input output	10MB	20MB	30MB	40MB	50MB	60MB	70MB	80MB	90MB	100MB
std (32b)	0.00087	0.0009	0.0011	0.0012	0.00215	0.00162	0.00188	0.00241	0.00211	0.00249
1kb	0.00498	0.00661	0.00844	0.00997	0.01558	0.01357	0.01543	0.01705	0.01945	0.02213
10kb	0.00496	0.00659	0.00833	0.0101	0.01186	0.01373	0.01543	0.01735	0.01945	0.02144
100kb	0.00618	0.00754	0.00944	0.01102	0.01316	0.01453	0.01714	0.01814	0.02031	0.02246
1MB	0.01598	0.01786	0.01918	0.02212	0.02287	0.02391	0.02559	0.02658	0.0286	0.03008
2MB	0.02599	0.02813	0.02897	0.03056	0.0322	0.03348	0.03551	0.03793	0.03788	0.0399
3MB	0.03964	0.04253	0.03861	0.04069	0.04096	0.04246	0.04394	0.04778	0.0474	0.05065
4MB	0.04382	0.04675	0.06089	0.05942	0.06249	0.06277	0.06568	0.06642	0.069	0.07411
5MB	0.0832	0.08475	0.07164	0.075	0.07168	0.07456	0.07791	0.0785	0.08163	0.08352
6MB	0.09928	0.11341	0.08986	0.09463	0.08715	0.08784	0.08858	0.08852	0.08917	0.09405
7MB	0.12006	0.12036	0.09163	0.09282	0.10438	0.1031	0.10488	0.10287	0.10328	0.10481
8MB	0.13355	0.13754	0.10315	0.10529	0.11156	0.10785	0.1108	0.11565	0.11583	0.12678
9MB	0.13106	0.14701	0.11478	0.11819	0.11749	0.1241	0.12572	0.13103	0.13173	0.13351
10MB	0.14812	0.15447	0.12216	0.12751	0.13102	0.13592	0.13503	0.14353	0.14681	0.14481
20MB	0.30211	0.31514	0.26339	0.25926	0.26372	0.26402	0.26194	0.27893	0.27604	0.28253
30MB	0.44772	0.49537	0.37204	0.38971	0.38869	0.39238	0.40385	0.40445	0.40921	0.42224
40MB	0.64341	0.68075	0.5036	0.51932	0.52464	0.52694	0.5247	0.53282	0.53534	0.54876
50MB	0.82415	0.85017	0.62196	0.63448	0.64409	0.63881	0.66405	0.67782	0.6908	0.69518
60MB	0.96957	1.02797	0.73474	0.77565	0.77267	0.77379	0.78467	0.80487	0.81785	0.829
70MB	1.14184	1.22477	0.89636	0.91125	0.92269	0.90806	0.91741	0.92316	0.9525	0.94667
80MB	1.30816	1.39684	0.99315	1.02451	1.03857	1.03953	1.05409	1.079	1.0885	1.10419
90MB	1.52916	1.59891	1.12254	1.14512	1.18675	1.16857	1.19387	1.22822	1.242	1.27829
100MB	1.67851	1.77456	1.29041	1.27689	1.26998	1.30651	1.32683	1.35572	1.33984	1.37701
200MB	3.34087	3.53681	2.55529	2.57284	2.53972	2.59227	2.53873	2.68085	2.74081	2.76264
300MB	4.88085	5.39692	3.61217	3.78311	3.89102	3.90055	3.94576	3.94234	4.08887	4.12909
400MB	6.68611	7.13607	5.08583	5.15	5.22366	5.01173	5.27892	5.37387	5.24912	5.46067
500MB	8.60536	9.08887	6.06965	6.43811	6.48517	6.5383	6.57387	6.71726	6.77185	6.90701
600MB	10.30657	10.86102	7.23888	7.46789	7.75934	7.521	7.52238	7.78061	8.01472	8.27166
700MB	12.10127	13.01427	8.84501	8.95659	8.97377	9.09864	9.20102	9.05347	9.07285	9.18209
800MB	13.45198	13.59732	10.2343	10.12213	10.37557	10.36774	10.52941	10.77324	10.6201	11.04486
900MB	15.53927	16.77738	11.62061	11.60158	11.7321	11.90368	12.13169	12.34583	12.4885	12.56023
1000MB	17.77462	16.74138	12.57673	12.69127	12.6664	12.83758	12.98373	12.8184	12.90329	12.93336

input output	200MB	300MB	400MB	500MB	600MB	700MB	800MB	900MB	1GB	2GB
std (32b)	0.00591	0.00624	0.00822	0.0101	0.01222	0.01469	0.01589	0.01871	0.01974	0.03914
1kb	0.03841	0.05623	0.07453	0.09188	0.10998	0.12776	0.14629	0.16508	0.18248	0.36245
10kb	0.03846	0.05625	0.07425	0.09192	0.11053	0.12826	0.14629	0.16522	0.18263	0.36228
100kb	0.03929	0.05697	0.07503	0.09261	0.11076	0.12869	0.14795	0.16693	0.18415	0.36288
1MB	0.0483	0.0651	0.08305	0.10119	0.12017	0.13689	0.15701	0.17471	0.19097	0.37051
2MB	0.05823	0.07445	0.09251	0.11042	0.12806	0.14578	0.16418	0.18387	0.20053	0.37981
3MB	0.06759	0.08353	0.10294	0.12283	0.1387	0.15827	0.17364	0.19609	0.21176	0.38893
4MB	0.08804	0.09937	0.11345	0.13419	0.15122	0.17407	0.18254	0.21499	0.22682	0.4
5MB	0.09681	0.1116	0.13135	0.1492	0.17901	0.18731	0.19855	0.23718	0.24129	0.4185
6MB	0.10768	0.12967	0.14771	0.16426	0.18224	0.19916	0.21124	0.25762	0.24851	0.4355
7MB	0.12284	0.14376	0.16308	0.18002	0.20674	0.21897	0.23568	0.27559	0.26509	0.4399
8MB	0.13938	0.15707	0.17478	0.19664	0.21685	0.24103	0.23545	0.2892	0.27776	0.45569
9MB	0.15699	0.17027	0.19113	0.20708	0.23645	0.25346	0.26513	0.30919	0.29185	0.4691
10MB	0.16722	0.18485	0.20463	0.2247	0.24593	0.27483	0.27046	0.32798	0.29946	0.47761
20MB	0.3013	0.32934	0.3532	0.37731	0.41258	0.42303	0.45439	0.49281	0.42279	0.60561
30MB	0.45016	0.47081	0.48474	0.53269	0.55353	0.59911	0.61928	0.68224	0.54732	0.73503
40MB	0.57678	0.6051	0.62964	0.67133	0.70124	0.75736	0.80127	0.85555	0.67606	0.89625
50MB	0.73501	0.75959	0.78161	0.82343	0.86874	0.925	0.98403	1.05379	0.79631	1.00172
60MB	0.86277	0.90256	0.92562	0.98752	1.02393	1.08565	1.16796	1.23275	0.92876	1.13296
70MB	1.00761	1.04072	1.06312	1.12475	1.18964	1.27994	1.32082	1.44001	1.0764	1.2502
80MB	1.15529	1.181	1.22772	1.31	1.34121	1.4311	1.52496	1.61594	1.18804	1.36134
90MB	1.30359	1.33698	1.38351	1.45442	1.50239	1.59738	1.6971	1.80978	1.30195	1.52102
100MB	1.43242	1.50945	1.54268	1.6049	1.67257	1.74155	1.86691	1.98464	1.4406	1.66262
200MB	2.79575	2.9205	2.95578	3.11417	3.09907	3.39052	3.60925	3.79648	2.63968	2.85229
300MB	4.1434	4.18624	4.38667	4.58988	4.63863	4.99025	5.16203	5.41739	3.94858	4.10805
400MB	5.66057	5.70255	5.69621	6.1266	6.13472	6.63242	7.05716	7.35571	5.09939	5.29712
500MB	7.01394	6.96943	7.17364	7.36028	7.90691	8.30631	8.51795	9.30797	6.33517	6.60823
600MB	8.49842	8.67386	8.98697	9.07969	9.24062	9.33184	10.42911	11.33697	7.87365	7.8748
700MB	9.09236	9.18928	10.18294	10.65603	11.16122	11.81186	12.51324	13.18777	8.95425	8.9326
800MB	11.12248	11.72684	11.97701	12.50416	12.79289	13.17735	13.52109	15.14356	10.36844	10.16178
900MB	12.67001	13.01198	12.90876	13.2028	13.16949	14.10415	16.07179	11.75701	11.77879	11.99605
1000MB	12.41235	13.50825	13.60318	15.60688	15.68439	16.89775	18.21933	12.58801	12.68717	12.65936

input output	3GB	4GB	5GB	6GB	7GB	8GB	9GB	10GB
std (32b)	0.05792	0.07661	0.09693	0.11531	0.13512	0.15931	0.1775	0.19711
1kb	0.5406	0.71906	0.90143	1.08205	1.25973	1.44126	1.61999	1.80659
10kb	0.54056	0.71861	0.90132	1.08031	1.25958	1.44115	1.62081	1.80284
100kb	0.54106	0.719	0.90243	1.08118	1.26787	1.44246	1.62019	1.80513
1MB	0.54837	0.72663	0.91024	1.0879	1.26712	1.44988	1.62882	1.81123
2MB	0.56049	0.73866	0.92255	1.10449	1.27792	1.46261	1.63951	1.82791
3MB	0.57135	0.75145	0.93162	1.10794	1.29218	1.48079	1.64731	1.82862
4MB	0.5908	0.75822	0.94159	1.12636	1.30383	1.48168	1.67149	1.84406
5MB	0.60328	0.78798	0.96479	1.14263	1.31904	1.49647	1.68452	1.86055
6MB	0.62077	0.81016	0.97588	1.16047	1.34313	1.51866	1.7031	1.86865
7MB	0.63642	0.81488	0.99508	1.17488	1.3553	1.53408	1.71075	1.89563
8MB	0.63993	0.82733	1.02152	1.18867	1.36288	1.55119	1.73195	1.909
9MB	0.65951	0.82709	1.02932	1.20361	1.37683	1.57655	1.75234	1.91394
10MB	0.67069	0.84926	1.04773	1.21788	1.38065	1.5665	1.7542	1.94056
20MB	0.81734	0.97231	1.17316	1.3485	1.52813	1.70922	1.88799	2.07496
30MB	0.91395	1.0865	1.305	1.45753	1.6589	1.84741	2.05188	2.2266
40MB	1.0542	1.23179	1.43118	1.60341	1.78694	1.9941	2.14704	2.37772
50MB	1.19963	1.37345	1.58106	1.74375	1.94137	2.13892	2.31631	2.51623
60MB	1.33449	1.49015	1.68846	1.88155	2.07925	2.26193	2.44476	2.6715
70MB	1.45523	1.64229	1.81511	2.02796	2.21815	2.40535	2.60592	2.80151
80MB	1.56496	1.75323	1.95109	2.15974	2.35765	2.55201	2.74876	2.93933
90MB	1.72847	1.87906	2.06349	2.28294	2.46856	2.67602	2.88285	3.09897
100MB	1.81343	2.03067	2.23143	2.43022	2.58623	2.80374	3.01699	3.24158
200MB	3.14859	3.33413	3.54685	3.65594	3.94068	4.18131	4.41533	4.66506
300MB	4.31466	4.59881	4.77789	5.07402	5.30595	5.52923	5.76826	6.10285
400MB	5.65026	5.83988	6.01846	6.43293	6.61223	6.8549	7.04755	7.36934
500MB	6.93703	6.90518	7.22999	7.73122	7.92504	8.16529	8.42312	8.78601
600MB	8.35325	8.63146	8.86256	8.81173	8.84477	9.37706	10.03753	10.36218
700MB	8.91764	9.56384	10.12434	10.36759	10.52452	11.09137	11.36379	11.86892
800MB	10.39283	11.26462	11.71086	11.89374	12.3135	12.43128	12.42018	12.01851
900MB	12.37286	12.45197	12.53004	12.14974	12.55771	12.49206	13.86128	14.24136
1000MB	11.8625	12.26815	13.72219	14.42562	14.82003	15.21611	15.66378	16.11408

*** 32bytes output length was calculated twice and the second result was used.**

Appendix c) Complete speed results for KangarooTwelve

General hint: each hash pair was repeated 10 times and the average time was calculated.

On system 1 – x64*

input / output	1KB	1MB	2MB	3MB	4MB	5MB	6MB	7MB	8MB	9MB	10MB	20MB	30MB	40MB	50MB	60MB	70MB	80MB	90MB	100MB	200MB	300MB	400MB	500MB	600MB	700MB	800MB	900MB	1GB	2GB	3GB	4GB	5GB	6GB	7GB	8GB	9GB	10GB
std (32b)	0.00275	0.01094	0.01161	0.01217	0.01278	0.01325	0.01344	0.01705	0.01586	0.01531	0.01584	0.02479	0.0289	0.05595	0.04521	0.04091	0.04743	0.05181	0.05577	0.06154	0.10928	0.15544	0.20332	0.25215	0.347	0.36462	0.38873	0.43442	0.48192	0.95387	1.42076	1.89617	2.38066	2.82973	3.30378	3.76273	4.29606	4.59177
1kb	0.00104	0.00147	0.002	0.00264	0.00287	0.00342	0.00397	0.00435	0.00486	0.00529	0.00597	0.01807	0.01552	0.03216	0.03536	0.0304	0.03647	0.04418	0.04414	0.04964	0.09587	0.13963	0.18771	0.23385	0.34324	0.32338	0.36853	0.41569	0.4585	0.90616	1.36361	1.82037	2.28249	2.72706	3.16716	3.61148	4.1595	4.59945
10kb	0.00095	0.00138	0.00189	0.00238	0.00283	0.00334	0.00385	0.00447	0.00487	0.0053	0.00595	0.0121	0.01561	0.02444	0.03269	0.03067	0.03826	0.04411	0.04404	0.05	0.0954	0.14074	0.18665	0.2372	0.29863	0.32735	0.37119	0.41402	0.45923	0.91481	1.36928	1.82593	2.27754	2.71461	3.16515	3.61119	4.16459	4.60576
100kb	0.00139	0.00191	0.00235	0.00288	0.00341	0.00388	0.00437	0.00475	0.00524	0.00574	0.00648	0.01147	0.01668	0.02159	0.03583	0.03129	0.03716	0.04046	0.04456	0.05007	0.09589	0.14079	0.1866	0.23785	0.28334	0.32659	0.36929	0.4148	0.46344	0.91722	1.37509	1.82528	2.27031	2.71541	3.19367	3.62776	4.1326	4.60849
1MB	0.00637	0.00694	0.00732	0.00776	0.0085	0.00877	0.00918	0.00964	0.0102	0.01066	0.01135	0.01655	0.02152	0.03277	0.03843	0.03619	0.04247	0.04566	0.04925	0.05498	0.10115	0.1462	0.19151	0.24378	0.28986	0.32713	0.37947	0.42025	0.46374	0.92091	1.37224	1.81309	2.29484	2.72306	3.2048	3.6317	4.16884	4.61519
2MB	0.01185	0.01244	0.0128	0.01335	0.01379	0.01433	0.01489	0.01547	0.01569	0.01598	0.01693	0.02195	0.02683	0.04897	0.04516	0.04145	0.05093	0.051	0.05521	0.06043	0.10736	0.151	0.19718	0.24702	0.29413	0.33565	0.38285	0.42483	0.47136	0.91954	1.37352	1.82349	2.29657	2.72962	3.17108	3.68372	4.12932	4.63499
3MB	0.01707	0.0178	0.01811	0.01856	0.019	0.0195	0.02029	0.02083	0.021	0.02166	0.02224	0.02813	0.03371	0.05522	0.05242	0.04699	0.06046	0.05651	0.05985	0.06557	0.11145	0.1569	0.20233	0.25354	0.30738	0.33873	0.38698	0.43138	0.47511	0.92701	1.37247	1.83433	2.29906	2.72365	3.17849	3.62018	4.13908	4.67336
4MB	0.02244	0.02327	0.02331	0.02431	0.0246	0.02521	0.02559	0.02617	0.02638	0.02669	0.02773	0.03797	0.0454	0.08356	0.05795	0.05219	0.06023	0.06207	0.06529	0.07065	0.11704	0.16201	0.20736	0.2541	0.32587	0.34805	0.39522	0.43644	0.4792	0.93679	1.37798	1.83084	2.3193	2.7492	3.19255	3.63223	4.15982	4.74411
5MB	0.0279	0.02894	0.02889	0.02964	0.03027	0.0307	0.03148	0.03159	0.03209	0.03221	0.03336	0.05334	0.05093	0.08449	0.06477	0.05739	0.08581	0.06736	0.07074	0.0767	0.12304	0.1673	0.21365	0.26058	0.31243	0.35617	0.39827	0.44048	0.48348	0.93612	1.39956	1.83914	2.31982	2.77274	3.1863	3.64547	4.15925	4.75106
6MB	0.03409	0.03401	0.03398	0.03524	0.03598	0.03622	0.03647	0.03696	0.03779	0.03738	0.03851	0.04939	0.04923	0.07904	0.07362	0.06244	0.07997	0.07311	0.07613	0.08196	0.1289	0.17312	0.21808	0.26627	0.31917	0.35877	0.40017	0.44715	0.48996	0.93926	1.40247	1.84243	2.30724	2.73187	3.18579	3.64173	4.16977	4.79644
7MB	0.03914	0.03963	0.03951	0.04053	0.04071	0.04138	0.04196	0.04222	0.04265	0.04276	0.04389	0.05005	0.05456	0.0719	0.08578	0.06864	0.08608	0.07804	0.08104	0.08696	0.13394	0.1783	0.22539	0.27131	0.32225	0.36635	0.41052	0.45105	0.49629	0.95009	1.39874	1.86331	2.29479	2.75387	3.25127	3.65256	4.20872	4.69421
8MB	0.04451	0.04508	0.0448	0.04641	0.04635	0.04681	0.04758	0.04759	0.04858	0.04849	0.04932	0.05978	0.06268	0.0823	0.12484	0.07472	0.08065	0.08279	0.08608	0.09236	0.13854	0.18325	0.22983	0.27711	0.32995	0.37454	0.41189	0.45561	0.50353	0.95748	1.42035	1.88686	2.30248	2.74432	3.29831	3.67822	4.19574	4.69214
9MB	0.05064	0.05099	0.05081	0.05274	0.05235	0.05284	0.0534	0.05389	0.05402	0.05397	0.05529	0.07101	0.0696	0.08453	0.11527	0.0799	0.08727	0.08863	0.09367	0.09779	0.14364	0.18843	0.23628	0.28504	0.33879	0.38376	0.42169	0.46543	0.50537	0.96784	1.40581	1.85942	2.30519	2.7536	3.25824	3.68823	4.21072	4.71985
10MB	0.05589	0.05596	0.05643	0.07945	0.05798	0.05801	0.05864	0.0586	0.05915	0.05902	0.06034	0.08744	0.0713	0.08597	0.11519	0.08489	0.09158	0.09375	0.09802	0.1028	0.15041	0.1938	0.24156	0.29111	0.34169	0.38474	0.42221	0.46889	0.51591	0.96915	1.41612	1.86683	2.32013	2.7663	3.25887	3.66856	4.22707	4.72917
20MB	0.10917	0.11031	0.10953	0.11103	0.11229	0.11146	0.11264	0.11285	0.1123	0.11185	0.116	0.16339	0.133	0.15751	0.17254	0.13793	0.15932	0.14693	0.15101	0.15574	0.20112	0.24521	0.29712	0.3473	0.39276	0.43866	0.47118	0.521	0.56775	1.01385	1.46756	1.90939	2.37788	2.82392	3.28315	3.73223	4.27181	4.72753
30MB	0.16268	0.16804	0.16091	0.17201	0.1651	0.16565	0.16602	0.16604	0.16582	0.16481	0.16878	0.20179	0.21641	0.27346	0.23296	0.19227	0.19596	0.20074	0.20412	0.20901	0.25535	0.2995	0.35324	0.40686	0.45076	0.48975	0.52679	0.5765	0.62042	1.07879	1.52902	1.9669	2.41868	2.89719	3.32076	3.77334	4.34382	4.77553
40MB	0.21591	0.21815	0.2142	0.23686	0.21783	0.21873	0.21917	0.22236	0.21958	0.21806	0.22483	0.27608	0.25373	0.29973	0.29697	0.24897	0.24859	0.25493	0.25603	0.26197	0.32307	0.35478	0.40686	0.48847	0.50746	0.53857	0.5809	0.62714	0.67399	1.13635	1.5787	2.0209	2.48049	2.94463	3.39934	3.81724	4.38383	4.83514
50MB	0.26714	0.26997	0.26803	0.29041	0.27469	0.27216	0.27408	0.27622	0.27277	0.27044	0.2796	0.4336	0.34547	0.35829	0.36914	0.30835	0.31434	0.32576	0.3093	0.31951	0.366	0.40961	0.45541	0.53188	0.55133	0.58816	0.63621	0.68024	0.72558	1.19113	1.6349	2.09441	2.52814	2.97466	3.42201	3.86157	4.43368	4.8968
60MB	0.32856	0.32661	0.32264	0.34959	0.33713	0.32601	0.32928	0.33251	0.32762	0.32697	0.33057	0.44437	0.37598	0.53548	0.43629	0.40734	0.36625	0.36976	0.36311	0.37145	0.41555	0.46175	0.51055	0.56307	0.61608	0.64779	0.68822	0.73386	0.77699	1.23002	1.69328	2.15047	2.57847	3.05574	3.48402	3.93874	4.46741	4.94662
70MB	0.39032	0.37784	0.37593	0.40949	0.40003	0.38787	0.38266	0.39334	0.38789	0.38072	0.38621	0.51086	0.41746	0.49591	0.50021	0.44184	0.42412	0.42657	0.42272	0.4276	0.47522	0.51672	0.56323	0.6112	0.67317	0.69105	0.74577	0.78515	0.82852	1.29988	1.73634	2.17888	2.6331	3.14881	3.56703	3.98671	4.47141	4.97232
80MB	0.46223	0.43507	0.43356	0.4573	0.46994	0.44335	0.4476	0.45	0.44158	0.43503	0.445	0.52059	0.49101	0.51664	0.55729	0.50165	0.47442	0.4996	0.47746	0.47804	0.52864	0.57115	0.6157	0.68402	0.73782	0.75018	0.80197	0.8412	0.88261	1.35491	1.78736	2.24575	2.69141	3.14314	3.61025	4.0428	4.59649	5.08424
90MB	0.50622	0.49196	0.49206	0.5066	0.49752	0.49775	0.4927	0.50417	0.50536	0.48896	0.49499	0.57213	0.5478	0.5424	0.54936	0.68379	0.52403	0.55036	0.5354	0.52886	0.58023	0.63963	0.67615	0.73052	0.77239	0.80106	0.85291	0.89688	0.93329	1.3902	1.85282	2.28418	2.74565	3.21767	3.65989	4.09288	4.65448	5.09843
100MB	0.54845	0.54941	0.5407	0.54613	0.56008	0.56562	0.56018	0.54913	0.55682	0.54632	0.57576	0.6083	0.60114	0.65131	0.59631	0.66259	0.57037	0.58903	0.58867	0.59139	0.63516	0.67894	0.72469	0.79859	0.82596	0.85555	0.90353	0.95539	0.98388	1.44766	1.89923	2.32234	2.79685	3.26374	3.71597	4.14055	4.71675	5.19547
200MB	1.09607	1.10698	1.07904	1.15569	1.09801	1.09951	1.11917	1.09966	1.11794	1.11019	1.12472	1.28007	1.14494	1.56544	1.23779	1.23574	1.14413	1.1219	1.11542	1.12929	1.19335	1.21387	1.29114	1.35045	1.40119	1.3885	1.43876	1.48846	1.53696	1.98855	2.39426	2.8768	3.35133	3.77088	4.20927	4.67561	5.16385	5.71954
300MB	1.64232	1.62407	1.61014	1.71581	1.6977	1.62681	1.66966	1.63064	1.64374	1.61723	1.65478	1.94412	1.93342	2.25882	1.89505	1.86194	1.68088	1.67219	1.69378	1.68003	1.73468	1.76876	1.83983	1.8422	1.95571	1.93948	1.98945	2.04291	2.05599	2.43795	2.92383	3.41681	3.86366	4.2986	4.75826	5.21026	5.67871	6.24885
400MB	2.21909	2.16445	2.15662	2.20642	2.16266	2.18525	2.19348	2.19271	2.20613	2.1704	2.19631	2.41404	2.27066	2.94813	2.30059	2.28746	2.38268	2.20089	2.17749	2.19593	2.22499	2.22206	2.37497	2.33955	2.38701	2.38036	2.42637	2.47451	2.55052	3.1351	3.46259	3.93716	4.36732	4.82792	5.32108	5.72325	6.11911	6.75892
500MB	2.95377	2.61409	2.62525	2.71964	2.78172	2.65753	2.64594	2.80872	2.68811	2.60711	2.64326	3.18755	2.79262	3.76482	2.81537	2.67233	2.71912	2.69951	2.6568	2.69876	2.66556	2.72497	2.80879	2.85139	2.95561	2.92307	2.97567	2.98465	3.01024	3.51385	3.97305	4.40656	4.98025	5.25334	5.7186	6.20431	6.76031	7.2378
600MB	3.52303	3.1507	3.1423	3.41899	3.33553	3.20318	3.21799	3.50446	3.25968	3.1529	3.22553	3.36934	3.52745	3.87617	3.58487	3.33808	3.30274	3.17133	3.20334	3.16887	3.27716	3.25643	3.30126	3.35209	3.45164	3.47542	3.48238	3.51363	3.56301	4.06055	4.44506	4.84628	5.34354	5.83974	6.30139	6.69945	7.22752	7.72625
700MB	3.97264	3.75279	3.63827	3.88679	3.76782	3.75522	3.89179	3.75589	3.88248	3.69829	3.90386	3.88155	4.16869	4.26044	4.00421	3.7963	3.86944	3.68126	3.72115	3.65969	3.73342	3.73539	3.88167	3.90769	4.06281	3.95355	3.98382	4.03036	4.10675	4.5498	4.98382	5.40106	5.90334	6.31174	6.73368	7.18133	7.82999	8.30009
800MB	4.3421	4.3039	4.1729	4.43651	4.27774	4.31079	5.35327	4.26433	4.29848	4.45961	4.31593	4.70144	4.54722	4.67519	4.35026	4.39378	4.43043	4.23829	4.24183	4.21251	4.27048	4.30247	4.37563	4.43222	4.52248	4.43734	4.43307	4.55834	4.57811	5.09267	5.47542	5.93093	6.3889	6.7713	7.27712	7.69316	8.20993	8.7223
900MB	4.8195	4.71631	4.63696	5.1251	4.83651	4.71017	5.34765	4.83349	4.80624	5.41022	4.96138	5.02128	5.22185	5.49962	4.86174	4.86866	4.84188	4.70664	4.69772	4.67584	4.73678	4.78485	4.86753	5.01213	4.99956	5.05769	4.99047	4.9831	5.05123	5.47147	5.88361	6.40155	6.94539	7.34028	7.76032	8.2346	8.7029	9.26917
1000MB	5.22086	5.13885	5.13006	5.36692	5.31833	5.22658	5.53282	5.3537	5.17903	5.31128	6.18107	5.76211	5.94882	6.62896	5.40094	5.41323	5.34125	5.22907	5.17977	5.17471	5.21086	5.26867	5.3851	5.55833	5.50437	5.46332	5.45181	5.5479	5.56795	6.04296	6.46246	6.93577	7.31975	7.77005	8.2812	8.71725	9.26203	9.78375

*** 32bytes output length was calculated only one time, the gap between std (32b) and 1kb was accepted.**

On system 2 – ARM*

input / output	1KB	1MB	2MB	3MB	4MB	5MB	6MB	7MB	8MB	9MB	10MB	20MB	30MB	40MB	50MB	60MB	70MB	80MB	90MB	100MB	200MB	300MB	400MB	500MB	600MB	700MB	800MB	900MB	1GB	2GB	3GB	4GB	5GB	6GB	7GB	8GB	9GB	10GB
std (32b)	0.02568	0.07183	0.06315	0.07819	0.08112	0.06715	0.10186	0.108	0.11438	0.11044	0.11201	0.15234	0.1845	0.21262	0.23756	0.27741	0.31156	0.33931	0.39055	0.43627	0.76595	1.11229	1.4329	1.76355	2.13108	2.97249	3.31565	3.65583	4.04407	8.03136	13.7607	17.73052	23.30142	28.26187	33.53003	38.59029	42.09887	46.9642
1kb	0.02706	0.03223	0.04395	0.04867	0.05353	0.0472	0.06959	0.07773	0.08505	0.07904	0.08315	0.10696	0.14295	0.16643	0.20911	0.24628	0.26694	0.31553	0.34014	0.38013	0.71393	1.05582	1.36381	1.66814	2.01603	2.33059	2.64768	3.00088	3.29803	6.70414	12.5656	17.47331	22.31403	26.90445	32.54211	38.21501	42.12488	46.71092
10kb	0.02646	0.03091	0.04366	0.04805	0.05585	0.0444	0.06968	0.06498	0.05738	0.06053	0.08251	0.10004	0.13233	0.18201	0.22033	0.25544	0.2846	0.32153	0.35944	0.39673	0.71415	1.04565	1.37331	1.67807	1.99798	2.35034	2.66124	2.98421	3.32625	6.62241	13.11333	17.6476	22.10144	26.63495	32.17854	37.2431	41.87546	46.90778
100kb	0.01426	0.0343	0.04733	0.04967	0.04888	0.04306	0.05223	0.0563	0.06227	0.06094	0.08101	0.11063	0.1561	0.18723	0.22421	0.25947	0.28568	0.32028	0.3591	0.39997	0.7077	1.06098	1.36577	1.69441	2.01419	2.33954	2.68146	2.98856	3.306	6.63784	13.15911	17.60154	22.31775	27.19349	31.91669	37.5276	42.30921	47.08497
1MB	0.05029	0.05072	0.05898	0.06775	0.0596	0.06346	0.06838	0.06956	0.07236	0.07728	0.0824	0.1322	0.16617	0.20133	0.23795	0.26658	0.30218	0.32812	0.36716	0.40811	0.7205	1.06759	1.38758	1.70011	2.02774	2.34264	2.64581	2.99384	3.28415	6.62502	13.48193	17.48438	22.31705	26.87463	32.8563	37.04229	42.12912	46.74822
2MB	0.06839	0.06242	0.06946	0.06977	0.07244	0.0721	0.08252	0.10308	0.09123	0.09568	0.09331	0.14801	0.18012	0.21682	0.24756	0.28038	0.31788	0.3495	0.38183	0.42242	0.73365	1.08166	1.38807	1.71508	2.03108	2.36641	2.70297	3.00782	3.2922	6.58861	13.0615	17.65711	22.13012	26.9079	32.16301	37.57326	41.59679	46.47431
3MB	0.07431	0.07583	0.10324	0.10331	0.10352	0.08279	0.11065	0.12143	0.11823	0.12522	0.11428	0.16207	0.19608	0.22766	0.26216	0.3	0.32881	0.36263	0.39989	0.43765	0.74883	1.09529	1.41422	1.72989	2.05055	2.38268	2.73654	3.01516	3.34611	6.61317	13.25981	17.5155	22.1446	27.01597	31.86704	37.6677	41.39972	47.04592
4MB	0.08902	0.12239	0.09887	0.10244	0.11804	0.10167	0.13656	0.13011	0.13453	0.14189	0.13813	0.17646	0.21039	0.24097	0.27764	0.30851	0.34489	0.37892	0.41183	0.45201	0.76205	1.10386	1.43101	1.72797	2.06562	2.3923	2.72594	3.03603	3.36748	6.67783	13.04854	17.67164	22.70437	27.11984	32.05917	37.45498	41.79634	46.93361
5MB	0.12182	0.12215	0.12638	0.14286	0.12947	0.13029	0.14984	0.14143	0.14878	0.14955	0.15425	0.18497	0.22223	0.25726	0.2903	0.32221	0.35547	0.38998	0.42201	0.46202	0.77444	1.12155	1.44563	1.74328	2.06778	2.40074	2.74473	3.06241	3.36843	6.73797	12.97619	17.83057	22.41361	27.13086	32.2035	37.87223	41.92364	47.0187
6MB	0.097	0.13531	0.1348	0.1553	0.14424	0.1292	0.16429	0.16057	0.16133	0.16049	0.16911	0.20063	0.23705	0.26779	0.30177	0.3401	0.37115	0.40526	0.44002	0.47812	0.78894	1.13506	1.45458	1.75072	2.08375	2.4025	2.75219	3.0843	3.40057	6.72248	13.29758	17.79604	22.53403	27.02912	32.48585	38.21298	42.29303	46.81134
7MB	0.13967	0.15699	0.1448	0.17047	0.16046	0.14772	0.18282	0.16721	0.16988	0.17746	0.18225	0.21805	0.243	0.28507	0.31735	0.34327	0.38341	0.4201	0.44653	0.49034	0.80566	1.14769	1.4746	1.78765	2.1098	2.44648	2.79331	3.09397	3.3996	6.99805	13.14196	17.63759	22.58234	27.13889	32.22153	38.44114	42.39549	47.86143
8MB	0.13561	0.16125	0.18424	0.17823	0.17577	0.15417	0.19879	0.176	0.18307	0.18445	0.19803	0.22242	0.26208	0.29975	0.32293	0.36198	0.40259	0.42665	0.46226	0.50237	0.80715	1.15944	1.47259	1.78621	2.12752	2.45112	2.77961	3.10518	3.38882	6.96463	13.52959	17.81065	22.22659	26.86719	32.1016	38.52241	42.08605	47.6258
9MB	0.1808	0.18288	0.1678	0.20245	0.18216	0.18531	0.20812	0.20244	0.20017	0.20317	0.20231	0.2439	0.27851	0.3032	0.34304	0.37763	0.40726	0.44294	0.4798	0.51516	0.83345	1.17618	1.49366	1.81174	2.09972	2.45676	2.79698	3.0998	3.4092	6.86143	13.26584	17.54323	22.42026	27.06724	32.26983	37.42613	42.92644	46.67221
10MB	0.16073	0.19579	0.19537	0.22002	0.19935	0.22099	0.22274	0.20266	0.2135	0.21965	0.21895	0.25635	0.28527	0.31808	0.35972	0.38379	0.42351	0.45434	0.488	0.52524	0.83988	1.19697	1.50907	1.8082	2.12975	2.47495	2.79855	3.11953	3.46155	6.78663	13.60846	17.40102	22.2813	26.96	34.42342	37.47604	41.93071	46.37319
20MB	0.31799	0.31758	0.33049	0.35595	0.32603	0.30742	0.36663	0.34025	0.33672	0.33657	0.3422	0.38221	0.41991	0.4489	0.48285	0.52252	0.54652	0.58391	0.61084	0.66137	0.96427	1.30622	1.63913	1.93286	2.28478	2.60657	2.93393	3.24964	3.57369	6.97919	13.35918	17.53442	22.62116	27.3097	32.60855	37.47855	42.38918	46.88789
30MB	0.56841	0.46816	0.51102	0.50955	0.47051	0.44495	0.52974	0.47072	0.47713	0.49074	0.47172	0.51629	0.55052	0.58971	0.61359	0.66032	0.68671	0.72258	0.75915	0.78937	1.09866	1.44645	1.77604	2.09359	2.41844	2.75744	3.07815	3.39596	3.73577	7.08412	13.96978	17.67022	22.55763	27.58461	32.60746	37.60145	42.56434	47.09878
40MB	0.7404	0.59876	0.70634	0.65936	0.59075	0.61843	0.67839	0.62381	0.62045	0.64716	0.63274	0.66745	0.67748	0.72394	0.74654	0.77842	0.8189	0.84771	0.90941	0.91436	1.24836	1.57184	1.87287	2.2144	2.53576	2.86517	3.20477	3.48958	3.86479	7.3314	14.11099	17.73415	22.60573	27.70662	33.00546	37.76542	42.65347	47.32632
50MB	0.76884	0.72064	0.89631	0.8227	0.72318	0.76712	0.83196	0.73636	0.75933	0.78173	0.75861	0.80123	0.84675	0.85545	0.88481	0.93302	0.98646	1.01759	1.04849	1.05141	1.38999	1.71613	2.03548	2.34346	2.67273	3.0111	3.33056	3.63755	3.95461	7.38691	14.13422	18.18522	22.98014	27.87043	32.93519	38.01901	42.56185	47.30454
60MB	0.95429	0.85153	1.02224	0.97788	0.85284	0.91779	0.99679	0.92105	0.87557	0.90808	0.93468	0.94193	1.03979	1.0242	1.06142	1.09366	1.08866	1.12213	1.21155	1.26149	1.55612	1.83345	2.187	2.50346	2.73901	3.14965	3.46043	3.78002	4.10047	7.55372	14.15631	18.6367	23.51104	27.97269	33.18434	38.69816	42.39611	47.33472
70MB	1.09236	0.99621	1.14182	1.12935	1.00015	1.11104	1.14922	0.98971	1.01902	1.0463	1.08261	1.06549	1.10044	1.15058	1.17493	1.23507	1.28541	1.27357	1.33804	1.36889	1.71449	2.04017	2.36394	2.60874	3.0546	3.30045	3.61224	3.935	4.30207	7.7563	14.82089	18.80816	23.33577	27.75425	32.82455	38.88413	42.51837	47.68719
80MB	1.18819	1.17053	1.29951	1.30301	1.12945	1.27504	1.2271	1.1604	1.18899	1.22603	1.2	1.27578	1.24194	1.30035	1.28738	1.34129	1.40347	1.36698	1.45202	1.46292	1.76202	2.17774	2.5146	2.74602	3.12412	3.40646	3.76889	4.06749	4.43815	7.93419	14.90868	19.3889	23.82898	28.01947	33.40976	39.05833	42.81611	48.29388
90MB	1.34876	1.2927	1.47636	1.41601	1.29352	1.45691	1.32148	1.28522	1.30994	1.35141	1.29466	1.41954	1.41498	1.40647	1.45243	1.47395	1.50857	1.58623	1.62269	1.68159	1.89501	2.26044	2.62374	2.87908	3.24754	3.54257	3.84287	4.17796	4.52837	7.99635	14.93501	19.33971	24.07437	28.16077	33.45502	39.09562	42.6935	48.52658
100MB	1.51487	1.41763	1.5739	1.5341	1.42936	1.57627	1.45448	1.41217	1.41082	1.47257	1.45949	1.51347	1.58014	1.5516	1.61049	1.62352	1.6179	1.65462	1.69827	1.74349	2.06478	2.40414	2.72703	3.07658	3.33801	3.68217	4.01743	4.32379	4.72255	8.17269	15.07927	19.54076	24.30232	28.775	33.72957	39.71001	42.91523	48.78827
200MB	2.92358	2.88891	3.09029	2.77239	2.74684	3.15969	2.87739	2.86543	2.80736	2.87572	2.89864	2.89285	3.07444	2.96785	2.9566	2.96575	3.05661	3.10184	3.07216	3.12638	3.4876	3.82901	4.09961	4.49279	4.876	5.2029	5.35021	5.70293	6.06103	9.9128	17.24955	21.61117	25.94912	30.11432	35.28321	39.99684	44.78327	49.97062
300MB	4.37324	4.39027	4.67603	4.15195	4.15969	4.69362	4.28967	4.21301	4.20652	4.20921	4.21242	4.29854	4.29609	4.30848	4.26705	4.37742	4.41513	4.64813	4.67888	4.53293	4.87448	5.27812	5.69751	5.96573	6.14939	6.44254	6.69891	6.99936	7.45382	11.46521	18.95921	23.78152	28.17886	31.97392	37.35705	41.50897	47.177	51.69782
400MB	5.89932	6.35339	6.29104	5.58686	5.53176	6.41777	5.72444	5.74021	5.83824	5.76605	5.65335	5.84024	5.87018	5.83342	5.75412	5.85018	5.8972	5.85376	6.00102	6.02942	6.35667	6.88566	7.09146	7.5198	7.93873	7.97468	8.26073	8.54432	8.83222	14.06414	20.70331	25.23454	29.64789	33.08333	39.4288	43.69544	47.50675	53.56771
500MB	7.30212	9.03939	7.88842	7.02693	7.03149	8.06558	7.11357	7.12535	7.18278	7.25433	7.05258	7.24325	7.29518	7.14428	7.23701	7.40024	7.43332	7.3543	7.2841	7.5085	7.78456	8.17671	8.54067	8.74121	9.0829	9.64662	9.59145	10.06669	10.49322	15.50029	22.42818	27.12819	31.48522	35.5986	41.24189	45.53916	48.81473	54.53166
600MB	9.07205	10.58524	9.47156	8.39186	8.53688	9.72549	8.54413	8.54904	8.62892	8.64942	8.50946	8.6471	8.58639	8.51732	8.76972	8.7388	8.76136	8.7845	8.87621	8.81035	9.27802	9.61282	10.0284	10.45096	10.88229	10.94016	11.21578	11.57955	11.64326	18.07469	24.1593	28.73431	32.76646	37.27492	42.5944	46.27199	50.31018	56.78195
700MB	10.16392	13.01902	11.08632	9.90556	9.84512	11.51565	10.01471	10.00717	10.01744	10.07058	10.40391	10.11448	10.11648	10.03459	10.12721	10.28196	10.18527	10.28068	10.22922	10.3128	10.6929	11.22061	11.50376	11.78561	11.8653	12.07333	12.54478	12.94998	13.07567	20.42548	25.2258	30.16311	34.12102	39.09157	44.6849	46.90264	52.42076	60.40829
800MB	11.70867	13.88704	12.59489	11.24185	11.38891	12.62543	11.41825	11.43528	11.37154	11.48449	11.74468	11.74297	11.40179	11.48597	11.5098	11.60475	11.57263	11.82341	11.69688	11.9188	12.13948	12.57168	12.92839	13.55356	13.757	13.73818	14.27157	14.61355	14.72658	21.88143	26.86478	32.44483	36.44364	40.71444	46.7779	48.35847	53.85085	59.69845
900MB	13.29171	15.93621	14.19678	12.86078	12.88055	14.3611	12.98665	13.12514	12.75217	13.01808	12.87002	12.95317	12.87368	13.00675	13.20043	13.15571	13.14406	13.36958	12.97413	13.24501	13.39307	13.8482	14.47037	14.39684	15.35987	15.12437	16.03927	16.33386	16.26431	24.06791	28.48788	33.60775	38.46449	42.86646	47.58527	50.72457	54.14802	59.93899
1000MB	14.82229	18.85235	15.9493	14.37383	14.54363	16.1251	14.56257	14.42386	14.48248	14.75148	14.42681	14.38198	14.34736	14.60884	14.42213	14.6247	14.65786	14.64299	14.45021	14.60785	15.19798	15.31645	15.7473	16.35833	16.74828	17.07465	17.00197	17.50092	18.55928	25.76076	30.13482	35.25295	40.54706	43.98062	49.35014	51.33432	56.13468	61.6535

*** 32bytes output length was calculated only one time, the gap between std (32b) and 1kb was accepted.**

On system 3 – XEON*

1kb	0.00175	0.00382	0.00557	0.00854	0.00861	0.01154	0.01192	0.01448	0.01585	0.017	0.01891	0.02987	0.04079	0.05144	0.06088	0.07533	0.08438	0.09605	0.10492	0.12276	0.2297	0.34148	0.45435	0.5717	0.6819	0.79684	0.90447	1.01665	1.12833	2.26068	3.39485	4.52479	5.6423	6.7846	7.89613	9.03392	10.17991	11.27339
10kb	0.0048	0.00477	0.00564	0.00746	0.00845	0.01221	0.01364	0.01281	0.016	0.01793	0.02012	0.03056	0.041	0.05244	0.06208	0.07528	0.08436	0.09592	0.10609	0.1192	0.23077	0.34275	0.45802	0.56894	0.68185	0.79274	0.90462	1.01632	1.12942	2.25819	3.39701	4.51083	5.63894	6.76793	7.89237	9.03144	10.18018	11.28143
100kb	0.00273	0.0043	0.00638	0.00864	0.00922	0.01194	0.01247	0.01581	0.01539	0.01841	0.01899	0.03071	0.04097	0.05344	0.06297	0.07554	0.0855	0.09699	0.10824	0.12094	0.23026	0.34321	0.45577	0.57157	0.68225	0.79274	0.90946	1.01947	1.13437	2.2609	3.39359	4.50518	5.64281	6.76779	7.8918	9.04262	10.16203	11.29133
1MB	0.01511	0.01674	0.01856	0.02035	0.01924	0.02069	0.02421	0.02268	0.02532	0.02774	0.02674	0.03783	0.04994	0.05991	0.07155	0.08313	0.09348	0.10408	0.11524	0.12685	0.23945	0.35089	0.46373	0.57562	0.69103	0.80482	0.91583	1.0267	1.13799	2.26623	3.40487	4.51589	5.64938	6.81162	7.89728	9.03836	10.17496	11.29515
2MB	0.02586	0.02596	0.02808	0.02861	0.02963	0.03122	0.03269	0.03418	0.03591	0.03549	0.03701	0.04789	0.05916	0.0696	0.0805	0.09231	0.10254	0.11359	0.12505	0.13976	0.24687	0.3588	0.47422	0.58486	0.69964	0.81371	0.92489	1.03761	1.1462	2.27656	3.40927	4.53588	5.66884	6.80788	7.90498	9.0512	10.17928	11.30178
3MB	0.03391	0.03693	0.04146	0.03514	0.04131	0.0413	0.04415	0.04068	0.04291	0.04543	0.04771	0.05886	0.06759	0.08296	0.09397	0.10829	0.1211	0.12883	0.13965	0.15533	0.26902	0.37541	0.48866	0.59523	0.70982	0.83351	0.95111	1.06309	1.17027	2.28838	3.44192	4.541	5.67867	6.79558	7.94719	9.05564	10.21067	11.30279
4MB	0.04376	0.04419	0.04513	0.04699	0.06058	0.05052	0.05092	0.05325	0.05216	0.05466	0.055	0.06707	0.07848	0.09707	0.1137	0.12312	0.13624	0.1462	0.16066	0.17821	0.28697	0.38958	0.50348	0.60592	0.7189	0.84968	0.95923	1.07356	1.1937	2.29784	3.46852	4.55435	5.70416	6.81121	7.95777	9.08571	10.23357	11.33196
5MB	0.07862	0.08481	0.08704	0.08917	0.09773	0.08	0.07956	0.08145	0.08806	0.07827	0.08713	0.08948	0.09712	0.11276	0.12575	0.1388	0.14961	0.16577	0.17714	0.19548	0.31158	0.40349	0.51311	0.64509	0.73764	0.87094	0.97959	1.08661	1.20278	2.36098	3.47813	4.57889	5.71971	6.84741	7.9764	9.10663	10.24991	11.35027
6MB	0.09679	0.09859	0.09978	0.10504	0.11071	0.08956	0.08825	0.09306	0.09236	0.09365	0.08966	0.0936	0.09879	0.1302	0.1411	0.15588	0.16725	0.18195	0.20564	0.21288	0.33033	0.41708	0.52922	0.65745	0.75544	0.88835	1.00085	1.10328	1.22055	2.37101	3.49643	4.61652	5.73162	6.86087	8.00467	9.12019	10.26343	11.38946
7MB	0.10814	0.10907	0.11818	0.11016	0.12967	0.10012	0.09452	0.10132	0.09953	0.10272	0.10299	0.09801	0.11296	0.14369	0.15807	0.16964	0.19713	0.19674	0.21356	0.23609	0.35532	0.42756	0.5427	0.67165	0.77925	0.89791	1.0139	1.11502	1.24146	2.37843	3.51083	4.62424	5.74953	6.91535	8.0296	9.15958	10.28509	11.39528
8MB	0.11391	0.12264	0.12212	0.12869	0.1503	0.11033	0.10774	0.10937	0.11022	0.11077	0.11049	0.11346	0.1266	0.16048	0.17515	0.18955	0.22926	0.21696	0.2309	0.25378	0.37002	0.44514	0.55817	0.69291	0.79326	0.91203	1.03037	1.14135	1.25099	2.40094	3.53364	4.63151	5.76547	6.91587	8.01946	9.19755	10.33741	11.3946
9MB	0.12361	0.13333	0.13749	0.13878	0.14389	0.11617	0.1118	0.1146	0.11282	0.11622	0.11356	0.13055	0.1449	0.17446	0.19086	0.201	0.24035	0.22758	0.24783	0.27091	0.39051	0.45468	0.56897	0.7035	0.80711	0.92751	1.05039	1.15276	1.26389	2.41144	3.53544	4.64322	5.7784	6.93198	8.05886	9.19534	10.32726	11.40796
10MB	0.15432	0.14604	0.14543	0.16078	0.16944	0.12741	0.1329	0.12794	0.12231	0.12806	0.1333	0.1435	0.15291	0.19181	0.20173	0.215	0.2916	0.24673	0.26416	0.28837	0.40875	0.46981	0.58211	0.7079	0.82947	0.9452	1.05764	1.18259	1.29331	2.42654	3.56645	4.67431	5.79515	6.95857	8.05689	9.19343	10.34201	11.42318
20MB	0.28586	0.29934	0.31043	0.32872	0.3486	0.25945	0.26434	0.28428	0.27485	0.28074	0.27697	0.30647	0.31956	0.33388	0.35261	0.3734	0.50271	0.42074	0.44319	0.47422	0.60676	0.61349	0.75239	0.85555	0.97671	1.08229	1.2019	1.3139	1.43743	2.54799	3.69838	4.81664	5.95456	7.08873	8.23855	9.3759	10.52609	11.57274
30MB	0.44265	0.4664	0.5	0.52343	0.5548	0.40949	0.3938	0.4144	0.41057	0.41523	0.42197	0.44269	0.44422	0.48035	0.5117	0.52048	0.60406	0.58078	0.6158	0.64858	0.8058	0.74547	0.86841	0.97676	1.08513	1.22076	1.33999	1.45212	1.57667	2.68687	3.84623	4.96997	6.11862	7.26907	8.38921	9.53652	10.69627	11.72459
40MB	0.61412	0.64369	0.67387	0.7173	0.75046	0.55175	0.53516	0.54989	0.55252	0.57451	0.58664	0.60281	0.5991	0.62833	0.66522	0.68184	0.72444	0.72602	0.78299	0.85148	1.01383	0.89299	0.99939	1.12078	1.23507	1.35889	1.48604	1.58835	1.71564	2.85438	3.98715	5.11369	6.27522	7.41743	8.55368	9.7081	10.89897	11.89591
50MB	0.77281	0.81869	0.85323	0.94592	0.9499	0.67909	0.68719	0.70229	0.6993	0.7176	0.72886	0.71323	0.76649	0.77253	0.80564	0.82382	0.86615	0.90489	0.97795	1.02907	1.23136	1.02843	1.15566	1.25446	1.37101	1.47297	1.64528	1.72072	1.84421	2.99824	4.14337	5.27251	6.43673	7.57006	8.71757	9.87916	11.06967	12.01151
60MB	0.94055	1.01169	1.04721	1.10078	1.13378	0.82705	0.82324	0.81749	0.82598	0.83693	0.86767	0.89144	0.90419	0.91491	0.96256	0.9897	1.04739	1.08395	1.14901	1.21075	1.42782	1.14859	1.26627	1.38899	1.52654	1.63732	1.76924	1.88418	2.00853	3.15617	4.30743	5.41117	6.59205	7.74716	8.89618	10.0507	11.26231	12.17425
70MB	1.10281	1.17741	1.1918	1.25291	1.33367	0.96749	0.94914	0.96607	0.98245	1.00531	1.02758	1.03443	1.04965	1.08292	1.12247	1.18569	1.2322	1.24812	1.34276	1.38658	1.61886	1.28494	1.40505	1.54458	1.67337	1.8125	1.93104	2.00621	2.14632	3.28662	4.46835	5.59631	6.75522	7.85204	9.07666	10.259	11.45072	12.33597
80MB	1.26464	1.33153	1.3885	1.47525	1.53242	1.09129	1.0931	1.12344	1.12271	1.14217	1.1631	1.16818	1.17623	1.25608	1.29146	1.32129	1.37985	1.43995	1.49475	1.57586	1.66521	1.42362	1.52011	1.68437	1.78221	1.94066	2.04728	2.17196	2.29505	3.44343	4.60496	5.75139	6.92128	8.0846	9.21836	10.42518	11.64475	12.47701
90MB	1.42919	1.51442	1.57785	1.66496	1.74346	1.24711	1.23963	1.25788	1.26833	1.25714	1.28909	1.3393	1.35822	1.39952	1.43361	1.46057	1.54407	1.58708	1.61727	1.77363	1.45085	1.54714	1.68914	1.81638	1.94166	2.06962	2.20671	2.31831	2.41574	3.59096	4.74485	5.91917	7.04388	8.22643	9.41318	10.54849	11.80652	12.6367
100MB	1.62444	1.65003	1.74396	1.82996	1.89717	1.37824	1.3796	1.36114	1.38433	1.41483	1.4655	1.47769	1.45726	1.50596	1.52831	1.5761	1.7073	1.75738	1.89779	2.00302	1.54749	1.72452	1.79787	1.92076	2.07226	2.19973	2.31576	2.46541	2.51879	3.73975	4.87297	6.00438	7.21054	8.38633	9.57426	10.59579	11.95249	12.78333
200MB	3.19654	3.2946	3.49275	3.67377	3.95931	2.69385	2.66897	2.72657	2.76803	2.79303	2.87666	2.9365	2.95131	2.92977	3.0884	3.16972	3.22026	3.40247	3.52727	3.67854	2.8935	2.96794	3.15039	3.21378	3.45566	3.61179	3.75868	3.91816	4.03208	5.23132	6.37427	7.54004	8.73196	9.85337	11.00346	12.42652	13.7568	14.23393
300MB	4.82173	4.84813	5.25005	5.44473	5.84584	3.95405	3.88387	4.1258	4.09529	4.19261	4.2872	4.39272	4.34385	4.3491	4.60951	4.5616	4.80137	5.01081	5.33673	5.64405	4.11628	4.37397	4.37736	4.66356	4.62832	5.01892	5.1099	5.31956	5.34443	6.53299	7.88509	9.09016	10.278	11.45272	12.93567	14.22013	15.66496	15.82151
400MB	6.44973	6.65742	6.81682	7.18801	6.28286	5.44032	5.41991	5.36536	5.34273	5.45203	5.51108	5.68001	5.72911	6.07477	5.98134	6.13852	6.61772	6.39763	7.20188	7.06923	5.5662	5.62594	5.74634	6.02401	5.96747	6.43083	6.62048	6.79041	6.76809	8.22433	9.41403	10.70255	11.58656	13.27762	14.63644	16.01322	17.62193	17.04613
500MB	8.08826	8.28146	8.69608	9.22383	6.47586	6.8288	6.77949	6.66931	6.71119	6.94504	6.99265	7.09225	7.20436	7.19281	7.18809	7.71479	8.23007	8.31636	8.7939	9.33995	6.80184	6.94579	6.93663	7.24888	7.58527	7.74858	7.31747	8.22686	8.55096	9.51785	10.96547	11.70323	13.50977	14.79029	16.25695	18.07552	19.14896	18.57794
600MB	8.90059	8.96565	10.44335	10.91939	7.96896	8.11306	8.15485	8.07962	8.1873	7.98554	8.60013	8.54231	8.86066	8.80403	8.43845	9.21598	9.22975	10.25982	11.01279	11.24491	8.32863	8.54163	8.70316	8.73213	8.82233	8.78812	8.73921	9.27182	9.56562	11.27179	11.99074	13.51917	14.69942	16.74856	18.23123	19.55253	21.38638	20.3251
700MB	11.44915	11.68445	12.25227	13.07971	8.88179	9.03179	8.9418	9.08253	9.02238	9.321	9.72959	9.7725	10.26508	10.38664	10.53092	11.12637	11.42167	12.09412	12.7542	13.11588	9.01652	9.46306	9.91511	10.01618	10.35281	10.67025	11.16091	10.9314	11.52217	12.39235	13.50798	14.91057	17.02924	18.40135	19.09722	21.41153	23.40566	21.91477
800MB	12.82168	13.02025	12.84792	14.05619	10.24738	10.64462	10.57789	10.30908	10.74849	11.01736	11.47223	11.71785	11.86264	12.04939	12.49878	12.6994	12.87296	13.2864	13.01278	14.79259	10.49749	11.15132	11.46018	11.70985	11.80376	12.18824	12.25974	12.36108	12.40243	13.82241	15.48775	16.96949	18.71467	19.48032	20.39434	23.29753	25.33426	23.51871
900MB	13.52356	14.70431	15.36474	17.22843	12.13476	12.26961	12.38302	12.43816	12.42311	12.56514	12.53651	12.60464	12.85651	12.75281	12.6835	13.53083	14.08841	15.41111	16.31972	17.53898	12.37131	12.288	12.38994	12.77639	12.44589	12.42518	12.80052	13.2558	14.12938	15.7163	17.08905	18.88028	19.72006	20.24472	23.29275	25.44892	27.71232	24.91841
1000MB	16.57513	16.85633	18.02937	19.51978	12.26328	11.73484	12.10598	12.40371	13.02588	13.05405	12.80936	13.33035	14.17496	14.62198	14.85522	15.69864	16.65141	17.81205	18.63619	19.67889	12.80974	12.94658	13.32853	13.95484	14.20998	14.67802	15.00522	15.15604	15.81195	17.36384	18.94248	20.02398	21.03604	22.7379	25.25366	26.55179	28.45468	26.78162

*** 32bytes output length was calculated twice to overcome HDD reading and caching; the second result was used.**

Appendix d) Complete speed results for Shake

General hint: each hash pair was repeated 10 times and the average time was calculated.

On System 1 – x64*

input output	1KB	1MB	2MB	3MB	4MB	5MB	6MB	7MB	8MB	9MB	10MB
std (32b)	0.01096	0.01508	0.01715	0.02166	0.02493	0.02807	0.03183	0.03543	0.03866	0.04229	0.04724
1kb	0.00096	0.00446	0.00778	0.01119	0.01464	0.01839	0.02148	0.02482	0.02823	0.03152	0.03583
10kb	0.00112	0.0046	0.00791	0.0113	0.01521	0.01818	0.02167	0.02499	0.02865	0.0319	0.03595
100kb	0.00335	0.00681	0.01024	0.01356	0.01702	0.02034	0.02391	0.02736	0.03086	0.03443	0.0382
1MB	0.02649	0.02939	0.0328	0.03657	0.03949	0.04284	0.04663	0.0503	0.05385	0.05618	0.06023
2MB	0.05126	0.05409	0.05744	0.06057	0.06496	0.06786	0.07247	0.07577	0.07834	0.0814	0.08491
3MB	0.07619	0.07973	0.08161	0.08625	0.08911	0.0924	0.09827	0.10028	0.10547	0.10561	0.11362
4MB	0.10588	0.10376	0.10635	0.11685	0.1158	0.11937	0.1239	0.12716	0.12983	0.13277	0.13707
5MB	0.13017	0.12805	0.13098	0.13479	0.13946	0.14237	0.1507	0.15189	0.15812	0.1547	0.16049
6MB	0.15945	0.15306	0.15546	0.16247	0.16358	0.16625	0.17663	0.17826	0.17965	0.18772	0.19243
7MB	0.18434	0.18474	0.17967	0.18643	0.19051	0.19712	0.20386	0.20315	0.20323	0.20931	0.21844
8MB	0.21077	0.20796	0.20421	0.20964	0.22532	0.21669	0.23504	0.22961	0.22842	0.22911	0.24104
9MB	0.23693	0.23111	0.23191	0.24111	0.24752	0.24687	0.25457	0.25575	0.25075	0.25689	0.25872
10MB	0.26216	0.25518	0.26433	0.26859	0.27184	0.27299	0.28393	0.27873	0.28525	0.28108	0.28867
20MB	0.51264	0.49949	0.49537	0.52148	0.53317	0.51057	0.5353	0.53853	0.53332	0.53172	0.52749
30MB	0.74835	0.7575	0.7469	0.7812	0.79417	0.75942	0.78508	0.78452	0.79837	0.79625	0.82625
40MB	0.99674	1.02727	1.02878	1.02982	1.05894	1.02876	1.02598	1.00793	1.03367	1.06072	1.03175
50MB	1.25323	1.24829	1.26576	1.3047	1.30492	1.25463	1.28737	1.25282	1.28903	1.29246	1.31541
60MB	1.52895	1.50216	1.49383	1.56172	1.57754	1.5074	1.50968	1.54853	1.55923	1.52588	1.54464
70MB	1.76496	1.74864	1.74967	1.80723	1.79311	1.74996	1.78425	1.80913	1.79556	1.74945	1.81386
80MB	2.0175	2.03559	1.99391	2.05784	2.02823	1.99535	2.02444	2.04113	2.04047	2.09492	2.04047
90MB	2.29935	2.30008	2.24953	2.27653	2.28296	2.26004	2.3644	2.33851	2.33265	2.31986	2.30884
100MB	2.54161	2.48687	2.53338	2.51195	2.55859	2.50347	2.56473	2.55214	2.5517	2.59572	2.53898
200MB	4.96579	5.02167	5.03612	5.02606	5.17655	5.06924	5.10958	5.16952	5.04129	5.19286	5.06767
300MB	7.60431	7.50835	7.57985	7.59896	7.62172	7.60347	7.58514	7.70006	7.65348	7.73825	7.51747
400MB	10.09484	10.10886	9.98468	10.38891	10.03527	10.16255	10.01075	10.26965	10.49442	10.31411	10.2351
500MB	12.91115	12.70888	12.51175	12.66124	12.93817	12.73367	12.58479	12.59796	12.64544	12.69233	12.60245
600MB	15.52717	15.34473	14.93678	15.53928	15.40759	15.36031	15.34178	15.0564	15.06773	15.36414	15.05516
700MB	18.60336	17.6728	17.54519	17.86102	17.79459	17.84178	17.60298	17.81378	17.82357	17.91261	17.79396
800MB	21.07131	20.12696	20.13209	19.84308	20.33976	20.28178	20.25993	20.48867	20.57471	20.32317	20.35636
900MB	22.66971	22.79	22.80338	23.04156	22.6361	22.77388	23.07377	22.75503	23.91974	22.97488	22.63447
1000MB	25.6254	25.144	24.89057	25.34419	25.28817	25.44934	25.60887	25.54664	25.66092	24.8724	25.63152

input output	20MB	30MB	40MB	50MB	60MB	70MB	80MB	90MB	100MB	200MB	300MB
std (32b)	0.08074	0.11657	0.15398	0.18594	0.21885	0.25448	0.29236	0.33495	0.37384	0.72322	1.06942
1kb	0.0682	0.10233	0.13813	0.16971	0.20157	0.23819	0.26848	0.31209	0.34937	0.686	1.00839
10kb	0.06912	0.10335	0.13961	0.16865	0.20495	0.2382	0.26927	0.30759	0.35153	0.68262	1.00499
100kb	0.07384	0.10535	0.14128	0.17123	0.20697	0.23817	0.27123	0.31084	0.3479	0.68335	1.01533
1MB	0.09403	0.12749	0.16551	0.19573	0.22728	0.26039	0.29294	0.33635	0.37018	0.70318	1.04459
2MB	0.11801	0.15371	0.19207	0.21791	0.25164	0.2859	0.32114	0.35889	0.39632	0.74134	1.0664
3MB	0.14348	0.17847	0.21062	0.24313	0.27552	0.3122	0.35018	0.38047	0.42063	0.76754	1.10633
4MB	0.16961	0.20155	0.23799	0.27105	0.29954	0.33554	0.37205	0.4087	0.45818	0.79393	1.13347
5MB	0.19579	0.22761	0.25841	0.29562	0.32362	0.36342	0.39927	0.43987	0.48497	0.82051	1.13121
6MB	0.22281	0.2508	0.29122	0.31559	0.35052	0.39026	0.41986	0.45238	0.51228	0.84747	1.15612
7MB	0.25047	0.28653	0.3254	0.3435	0.38329	0.41534	0.44394	0.48411	0.54443	0.86386	1.17658
8MB	0.27279	0.30927	0.33351	0.37332	0.40609	0.44179	0.47869	0.51764	0.56199	0.87282	1.20385
9MB	0.29579	0.3261	0.37101	0.39087	0.43408	0.4648	0.49962	0.54096	0.57725	0.90349	1.25698
10MB	0.32072	0.34841	0.39079	0.4256	0.45916	0.49307	0.53462	0.56676	0.59976	0.93075	1.25821
20MB	0.56617	0.59872	0.63278	0.67551	0.69945	0.74093	0.77947	0.81383	0.84228	1.19261	1.50191
30MB	0.80802	0.84307	0.94657	0.95839	0.9543	0.98447	1.02646	1.06343	1.09121	1.46052	1.73983
40MB	1.05254	1.09661	1.16709	1.20829	1.20705	1.24256	1.27757	1.33662	1.35029	1.73788	2.03587
50MB	1.30302	1.41773	1.37868	1.47331	1.43183	1.49068	1.54388	1.57483	1.62698	1.97463	2.29102
60MB	1.57905	1.67169	1.66317	1.74689	1.7118	1.7609	1.82103	1.86492	1.86739	2.2009	2.53571
70MB	1.84752	1.87566	2.02648	1.98412	1.92996	2.00147	2.07783	2.06031	2.08953	2.48498	2.77091
80MB	2.11557	2.13627	2.34824	2.17872	2.20452	2.28111	2.3381	2.33941	2.35495	2.71943	2.97505
90MB	2.36925	2.45259	2.41746	2.43428	2.51712	2.45067	2.60905	2.58893	2.64281	2.971	3.28019
100MB	2.67647	2.6879	2.7004	2.6615	2.78042	2.71667	2.8795	2.82881	2.91399	3.2347	3.5218
200MB	5.19063	5.1226	5.15239	5.20578	5.24137	5.29107	5.4838	5.35726	5.62075	5.68989	6.06845
300MB	7.70138	7.64587	7.69506	8.05209	7.74867	7.76349	7.94109	7.90019	8.00715	8.1775	8.53137
400MB	10.23723	10.27008	10.45276	10.14809	10.31086	10.35569	10.51261	10.19974	10.66384	10.86596	11.27164
500MB	12.98637	12.75621	13.21094	12.73817	12.88834	13.09639	12.95793	12.75652	13.37399	13.30872	13.78727
600MB	15.35169	15.24447	15.47492	15.39067	15.44548	15.39389	15.41609	15.3301	15.72775	16.32826	16.06707
700MB	18.11486	17.70943	17.97605	18.02201	18.26015	17.9436	17.88218	17.58164	18.19735	18.82989	18.61889
800MB	20.63339	20.55649	21.02176	20.25707	20.56858	20.5141	20.41489	20.46848	20.75639	21.27415	21.36508
900MB	23.25291	23.07395	23.11308	23.74584	23.10361	22.82431	23.38485	23.41148	23.20444	23.63717	23.62363
1000MB	26.30462	26.70432	26.02734	25.31512	25.33159	25.90453	25.74029	25.79314	25.9797	25.89144	26.63962

input output	400MB	500MB	600MB	700MB	800MB	900MB	1GB	2GB	3GB	4GB	5GB	6GB	7GB	8GB	9GB	10GB
std (32b)	1.44833	1.78949	2.16598	2.59965	2.92154	3.1553	3.5393	6.98853	10.53037	13.95613	17.34732	20.98099	24.56752	28.25945	31.78718	33.37358
1kb	1.37358	1.67679	2.06061	2.68249	2.78677	2.97842	3.30973	6.63065	9.93918	13.20076	16.50519	19.86196	23.30453	26.50947	31.81704	33.25745
10kb	1.33588	1.66526	2.06079	2.95317	2.90656	2.97611	3.30335	6.60401	9.90116	13.18766	16.51921	20.02554	23.47698	26.57443	31.8852	33.43657
100kb	1.34111	1.68228	2.0515	2.80409	2.70769	2.97375	3.3156	6.61763	9.89776	13.23631	16.57887	20.28925	23.42602	26.65553	32.00359	33.34913
1MB	1.35742	1.69857	2.05651	2.99161	2.75447	2.99426	3.32579	6.6244	9.98875	13.2292	16.4999	20.12739	24.0165	27.08658	30.42282	33.44964
2MB	1.38764	1.71192	2.08474	2.53449	2.7316	3.02099	3.36878	6.66728	9.96539	13.27531	16.56341	19.99327	24.08931	27.09007	30.80182	33.34004
3MB	1.41151	1.73902	2.13746	2.75285	2.73106	3.0558	3.39044	6.67938	10.06479	13.27805	16.61272	20.01189	23.32323	26.9715	30.70368	33.23898
4MB	1.43622	1.77298	2.09947	3.12703	2.80176	3.07391	3.4114	6.76328	10.02856	13.3796	16.77018	19.91929	23.36005	26.96484	31.34574	33.46603
5MB	1.46432	1.7886	2.14204	3.21537	2.81508	3.10868	3.43655	6.74789	10.11207	13.38024	16.63627	20.00729	23.2662	26.71677	31.97089	33.48448
6MB	1.49495	1.87472	2.17382	3.18472	2.79387	3.13189	3.47219	6.75956	10.06912	13.4614	16.77055	20.25719	23.27007	26.95718	31.31901	33.52154
7MB	1.51392	1.83779	2.16926	3.22658	2.82074	3.15705	3.50311	6.77976	10.08873	13.4043	16.70436	20.0974	23.35356	26.99003	32.24516	33.6436
8MB	1.5744	1.86922	2.19175	2.99945	2.84603	3.18085	3.50445	6.81312	10.08952	13.42592	16.76128	20.21773	23.51189	27.11565	32.0303	33.50402
9MB	1.56254	1.89019	2.21996	3.11385	2.88105	3.19945	3.56513	6.84269	10.12269	13.44378	16.71412	20.16229	23.36285	27.53505	33.98256	33.49983
10MB	1.60251	1.93367	2.26067	2.93132	2.90668	3.22446	3.55145	6.90032	10.25943	13.47224	16.83753	20.29815	23.50238	27.8644	34.64115	33.45755
20MB	1.91024	2.22061	2.62145	3.19127	3.17192	3.4796	3.81121	7.10804	10.53294	13.73388	17.04551	20.47717	23.66388	26.97053	37.15154	33.62762
30MB	2.15446	2.41616	2.77626	3.92197	3.39007	3.75564	4.05403	7.38602	10.68782	13.99686	17.25704	20.6361	23.88314	27.17969	35.03238	34.07465
40MB	2.38261	2.67201	3.0562	4.19688	3.65896	4.00223	4.37326	7.62265	10.97437	14.29647	17.46679	20.97892	24.18776	27.43176	35.41145	34.19593
50MB	2.62197	2.91106	3.31589	4.55991	3.89997	4.24589	4.57873	7.84578	11.23941	14.50031	17.78915	21.37188	24.64458	27.80098	36.3629	34.41771
60MB	2.88405	3.17334	3.56091	5.05854	4.14425	4.48183	4.80866	8.07656	11.53019	14.81543	17.9831	21.4476	24.74764	27.99986	35.83154	34.64847
70MB	3.18586	3.40964	3.9282	4.50259	4.38637	4.771	5.03992	8.33422	11.76634	15.09955	18.44455	21.53081	24.88874	28.38384	35.06974	34.89444
80MB	3.39015	3.67297	4.1961	4.42364	4.63578	5.00064	5.33746	8.57833	11.90026	15.25467	18.51333	21.79514	26.42965	28.45496	31.72284	35.31928
90MB	3.6421	3.94625	4.64082	4.87281	4.88126	5.17981	5.55044	8.86823	12.2568	15.49821	18.83535	22.01879	26.26357	28.76826	32.06599	35.45971
100MB	3.92572	4.4002	5.00045	5.78804	5.16381	5.44697	5.80737	9.08287	12.36593	15.74917	18.95513	22.29949	26.02622	29.25001	32.67259	35.76721
200MB	6.48976	6.78454	7.58975	10.2681	7.63511	7.9378	8.38868	11.58544	14.97422	18.2958	21.57063	24.67332	28.52188	31.56731	34.92079	38.0881
300MB	8.84324	9.16805	11.43766	11.776	10.17361	10.48345	10.85909	14.06284	17.34814	20.59041	24.02498	27.21707	31.02054	34.45989	37.60427	40.76087
400MB	11.41247	11.77456	13.60733	14.45765	12.66438	12.98657	13.32954	16.51677	19.82035	23.15711	26.4913	29.67308	33.45114	37.52679	39.70109	43.3546
500MB	14.06822	14.47683	15.79911	17.39309	15.05251	15.48245	15.73907	19.18311	22.24849	26.38448	28.83108	32.10302	37.01288	40.11653	42.56118	45.58029
600MB	16.88429	16.82002	17.55243	20.8089	17.54456	18.22526	18.21656	21.48719	24.75437	28.21723	31.43728	34.46276	39.22646	41.95076	45.00013	48.06438
700MB	19.4792	19.71999	20.20579	25.73785	19.97718	20.62715	20.73476	24.50692	27.25872	30.50822	33.76684	36.93598	41.69795	44.86212	47.01072	50.97543
800MB	21.7121	22.17978	22.80499	28.7352	22.37595	22.85367	23.05361	26.4851	29.56921	33.15148	36.57091	41.11028	43.90437	46.64842	49.54959	54.29691
900MB	24.22473	24.93275	26.60804	29.08062	24.80383	25.70485	26.22052	29.31441	32.24707	35.65278	39.42101	42.98253	46.65049	48.83062	52.69619	55.75612
1000MB	26.69318	26.27415	30.52843	28.7739	27.73942	27.84726	28.15401	31.86088	34.56534	38.07417	42.25836	44.92987	49.17581	51.51479	55.07799	58.78856

*** 32bytes output length was calculated only one time, the gap between std (32b) and 1kb was accepted.**

On system 2 – ARM*

input output	1KB	1MB	2MB	3MB	4MB	5MB	6MB	7MB	8MB	9MB	10MB
std (32b)	0.0166	0.06882	0.07587	0.09783	0.11094	0.09653	0.10912	0.1297	0.13816	0.12863	0.14243
1kb	0.02623	0.0465	0.05475	0.0783	0.08238	0.07241	0.07441	0.10288	0.11383	0.10255	0.1109
10kb	0.03508	0.04555	0.04882	0.07855	0.08343	0.07245	0.07715	0.10369	0.11634	0.10871	0.11452
100kb	0.05649	0.04956	0.06013	0.08365	0.09094	0.08198	0.08585	0.09481	0.10512	0.13183	0.14006
1MB	0.12443	0.12982	0.13725	0.14982	0.16479	0.18027	0.1811	0.17518	0.18181	0.21444	0.22211
2MB	0.21277	0.22349	0.22242	0.23327	0.23902	0.26646	0.27874	0.27954	0.2886	0.29949	0.30568
3MB	0.29654	0.3295	0.31298	0.34285	0.35159	0.36065	0.36639	0.3752	0.37895	0.39136	0.40196
4MB	0.38464	0.40699	0.42306	0.43718	0.4423	0.44827	0.45803	0.46267	0.45669	0.48289	0.49156
5MB	0.49368	0.477	0.51003	0.52206	0.52685	0.53812	0.54178	0.55225	0.55521	0.56456	0.57751
6MB	0.5852	0.58284	0.60359	0.60759	0.61691	0.62224	0.632	0.63911	0.64292	0.65558	0.66055
7MB	0.67387	0.68033	0.68866	0.68921	0.70311	0.71413	0.72227	0.72392	0.73818	0.74522	0.75571
8MB	0.75716	0.7621	0.77871	0.7822	0.7939	0.80475	0.80679	0.80748	0.82317	0.8313	0.84138
9MB	0.84469	0.83423	0.85901	0.84842	0.88213	0.88874	0.90008	0.89439	0.90638	0.92139	0.92201
10MB	0.94191	0.9362	0.94446	0.95797	0.96751	0.97202	0.98012	0.98403	0.99399	1.00361	1.01151
20MB	1.80963	1.79964	1.82021	1.82192	1.83795	1.84147	1.85353	1.8514	1.86733	1.87674	1.88788
30MB	2.6796	2.68816	2.70904	2.69366	2.7206	2.72499	2.7334	2.7296	2.75247	2.75454	2.76899
40MB	3.57296	3.58058	3.59629	3.5808	3.60046	3.59215	3.64509	3.62349	3.62805	3.65518	3.6744
50MB	4.51189	4.48775	4.50721	4.4984	4.51433	4.5333	4.56627	4.53397	4.55327	4.58867	4.57985
60MB	5.55746	5.41631	5.50397	5.47067	5.50406	5.51393	5.49728	5.47572	5.49072	5.50551	5.53283
70MB	6.36735	6.40776	6.32939	6.32923	6.35068	6.33278	6.45615	6.34882	6.33904	6.39106	6.43208
80MB	7.2223	7.25633	7.33234	7.25742	7.3717	7.22624	7.28053	7.34175	7.24161	7.22566	7.4061
90MB	8.25777	8.14494	8.13171	8.16302	8.12094	8.22635	8.14228	8.10539	8.11656	8.17847	8.20512
100MB	9.03535	9.052	9.1592	9.06072	9.16894	9.09133	9.18627	9.03957	9.06892	9.14986	9.09948
200MB	🟥	18.0149	18.12493	17.97558	18.08083	18.05031	18.02205	18.06544	18.07335	18.05554	18.08445
300MB	27.27655	27.0791	27.25889	27.13365	27.06637	27.24916	27.08015	27.08922	27.07095	27.14188	27.0867
400MB	36.17339	36.04044	36.0324	36.0856	36.16222	36.11476	36.05646	36.03837	36.12723	36.03584	36.09416
500MB	45.27438	45.19666	45.01214	45.08627	45.10642	45.22251	45.06467	45.22887	45.07281	45.18739	45.1175
600MB	54.35726	54.55364	54.33173	54.27855	54.31509	54.50359	55.00834	54.6044	54.19534	54.28828	54.23756
700MB	63.28305	63.21428	63.35201	63.48894	63.4097	63.42047	63.34848	63.37953	63.45084	63.23808	63.25142
800MB	72.48172	72.09542	72.31287	72.37273	72.09159	72.04983	72.1151	72.1316	72.1687	72.96305	72.95243
900MB	81.54489	81.31515	81.23946	81.45138	81.1716	81.67271	80.99879	81.00927	81.17995	81.90795	81.25186
1000MB	90.23894	90.96605	90.28292	91.2735	90.76347	91.27623	91.03754	91.04327	91.18026	90.79181	90.19736

input output	20MB	30MB	40MB	50MB	60MB	70MB	80MB	90MB	100MB	200MB	300MB
std (32b)	0.21615	0.29809	0.38636	0.46167	0.5253	1.02425	0.68568	0.76543	1.25178	1.98613	2.35636
1kb	0.18601	0.27039	0.34553	0.42028	0.5067	0.58277	0.6605	0.74209	0.83066	1.58023	2.31153
10kb	0.2066	0.28144	0.35718	0.43689	0.50856	0.58394	0.65992	0.74331	0.83194	1.57238	2.314
100kb	0.21268	0.28682	0.35811	0.43981	0.51929	0.59605	0.67068	0.74493	0.8449	1.58338	2.3221
1MB	0.29592	0.3722	0.44007	0.52253	0.60123	0.67818	0.75286	0.82473	0.92247	1.66606	2.39996
2MB	0.37877	0.45787	0.53491	0.60846	0.68053	0.76213	0.84317	0.91491	1.00616	1.75273	2.49173
3MB	0.47532	0.54949	0.62501	0.69994	0.77953	0.85578	0.93323	1.00998	1.10225	1.84287	2.57937
4MB	0.56302	0.64228	0.71905	0.79049	0.86842	0.94326	1.02521	1.09834	1.19141	1.93416	2.66773
5MB	0.65006	0.72521	0.80281	0.8785	0.95276	1.03298	1.10236	1.18262	1.27634	2.02209	2.75436
6MB	0.73815	0.81357	0.88884	0.96536	1.04053	1.12114	1.19596	1.27187	1.36291	2.10237	2.84136
7MB	0.82728	0.90216	0.98324	1.05462	1.13025	1.20876	1.28437	1.36242	1.45225	2.19696	2.92054
8MB	0.91614	0.98747	1.06437	1.14002	1.22038	1.30085	1.37277	1.44462	1.54223	2.27424	3.0117
9MB	1.00249	1.07916	1.14981	1.23063	1.30258	1.38437	1.46505	1.5448	1.62567	2.3637	3.09758
10MB	1.08842	1.16266	1.2414	1.31999	1.3883	1.46843	1.53985	1.622	1.72151	2.45388	3.18445
20MB	1.96114	2.03789	2.1103	2.18645	2.25327	2.34179	2.41649	2.49855	2.58352	3.32349	4.05461
30MB	2.83814	2.91685	2.99164	3.07943	3.14307	3.21234	3.29872	3.38405	3.45597	4.19905	4.91743
40MB	3.70768	3.81537	3.88079	3.95195	4.00796	4.12803	4.16319	4.26143	4.32161	5.08597	5.80874
50MB	4.67062	4.73641	4.80268	4.91775	5.05495	5.12075	5.13089	5.17672	5.26509	5.9846	6.70128
60MB	5.6044	5.66389	5.73154	5.84635	5.8797	5.96676	6.01689	6.11112	6.17714	6.92741	7.63986
70MB	6.43359	6.53544	6.6136	6.68555	6.80227	6.8957	6.91286	7.00831	7.10826	7.78978	8.56854
80MB	7.41485	7.51731	7.5166	7.56363	7.73798	7.75258	7.90885	7.95024	8.08656	8.70053	9.43468
90MB	8.25762	8.34465	8.49956	8.46797	8.56406	8.72251	8.73305	8.77384	8.8807	9.70656	10.30819
100MB	9.19526	9.26896	9.42368	9.34135	9.48954	9.54344	9.59901	9.69214	9.8516	10.46182	11.29015
200MB	18.17699	18.17758	18.51987	18.39341	18.47096	18.47494	18.64144	18.67714	18.73631	19.50408	20.16844
300MB	27.17035	27.2622	27.32662	27.33836	27.48661	27.61294	27.73277	27.68514	27.78084	28.58142	29.33741
400MB	36.13038	36.17549	36.43576	36.31546	36.64338	36.44292	36.70538	36.64494	36.79207	37.4881	38.22927
500MB	45.30999	45.22265	45.35462	45.37822	45.51558	45.54381	45.75631	45.9045	45.74499	46.57323	47.33801
600MB	54.3601	54.57586	54.63801	54.70605	54.78274	54.72865	54.83306	54.85019	55.06099	55.70266	56.51495
700MB	63.46258	63.59281	63.6749	63.46062	63.68685	63.74862	63.77119	63.80074	63.8729	64.68514	65.3723
800MB	72.40061	72.77734	72.23797	72.66231	72.72188	72.66973	72.77278	72.91359	73.13232	74.25215	75.75962
900MB	81.45515	81.50298	81.47366	81.87685	81.96503	82.32125	82.04845	81.5354	82.02077	85.3465	85.97495
1000MB	90.35619	90.43969	90.60217	91.4364	91.30921	91.01723	91.58792	90.65494	93.46928	94.87436	95.01601

input output	400MB	500MB	600MB	700MB	800MB	900MB	1GB	2GB	3GB	4GB	5GB	6GB	7GB	8GB	9GB	10GB
std (32b)	3.47626	3.85932	4.9672	5.66923	6.36846	7.17902	7.99821	15.86021	24.92819	33.23568	41.61539	50.04148	59.34401	69.18541	75.86764	83.1189
1kb	3.05123	3.78901	4.50052	5.22704	5.94214	6.67924	7.41219	15.03031	24.5354	32.94471	41.27561	49.5985	58.75692	68.08683	75.73304	84.28681
10kb	3.05665	3.79833	4.50392	5.23494	5.94872	6.70023	7.41023	15.14206	24.73223	33.20619	41.37258	49.93509	59.6136	68.58272	76.29275	84.62174
100kb	3.06024	3.79061	4.51071	5.23889	5.94953	6.70821	7.42028	15.12641	24.83916	33.5901	41.57525	50.41537	64.41236	68.63068	76.15434	84.04099
1MB	3.14276	3.88059	4.59697	5.32386	6.0254	6.7882	7.50409	15.06398	25.09894	33.63908	41.76401	50.64645	62.85574	68.77444	75.74101	84.66976
2MB	3.22991	3.96603	4.6809	5.40303	6.11902	6.87666	7.58885	15.2251	25.34059	33.81284	42.18014	50.64326	61.24864	68.57617	76.3962	85.91858
3MB	3.32451	4.05815	4.76627	5.45662	6.20758	6.96881	7.68219	15.99437	25.54136	33.96999	42.15455	50.71435	61.58526	68.44251	76.19577	85.18758
4MB	3.37674	4.14673	4.86034	5.58396	6.29216	7.05354	7.72421	16.23859	25.73305	33.98583	42.38824	51.00617	61.53639	68.70163	76.80216	85.3029
5MB	3.48771	4.23331	4.94329	5.67376	6.38453	7.1431	7.85652	16.0698	25.80975	34.22471	42.46131	50.95719	61.77304	68.80078	76.95299	85.39677
6MB	3.57998	4.31657	5.02904	5.73409	6.47214	7.22951	7.94272	15.81602	25.94567	34.29174	42.55876	51.09292	62.05223	69.30574	76.87867	85.90443
7MB	3.67309	4.40792	5.12124	5.84865	6.55878	7.31722	8.03334	15.72554	26.16679	34.46241	43.07027	50.93318	61.63435	69.98269	76.93544	86.55303
8MB	3.75579	4.49439	5.21029	5.93667	6.64246	7.36847	8.10489	16.20636	26.35009	34.5316	43.03074	50.9533	61.72712	69.32872	77.26115	86.26651
9MB	3.84292	4.57879	5.29232	6.02021	6.73396	7.22871	8.21031	15.8928	26.20097	34.55558	42.86377	51.44948	61.56684	69.50303	77.306	86.57088
10MB	3.93099	4.66396	5.38052	6.10664	6.82168	7.373	8.30004	16.48204	26.21867	34.8552	43.09843	51.62565	61.65941	69.53849	77.44076	87.13736
20MB	4.79846	5.53443	6.24035	6.97268	7.68719	8.29979	9.16609	17.05233	26.98132	35.68747	44.04319	52.36074	62.69456	70.38583	79.01731	87.04912
30MB	5.65457	6.41402	7.12251	7.85233	8.5487	9.21856	10.03957	18.88108	27.9633	36.65702	45.25504	53.46385	63.68343	71.10184	79.17547	88.00732
40MB	6.5602	7.28305	7.99496	8.73218	9.44582	10.22077	10.90701	19.46584	28.78409	37.49146	45.93408	54.45147	64.38049	71.87349	79.77299	88.88594
50MB	7.47175	8.17113	8.90864	9.61886	10.34387	11.12089	11.79033	19.76582	29.60284	38.19749	46.62971	55.34845	65.22697	72.94291	80.90039	89.82358
60MB	8.41158	9.11868	9.84186	10.58541	11.24971	12.05843	12.75644	21.0119	30.7441	39.1584	47.57036	56.51405	67.17969	73.85482	81.9586	91.00683
70MB	9.2846	10.02602	10.72085	11.45459	12.15333	13.00111	13.68176	21.98706	31.68279	40.20869	48.34864	57.15806	67.40727	74.73774	82.54312	91.71527
80MB	10.30158	10.88621	11.69251	12.33543	13.07729	13.82518	14.63916	23.19108	32.63266	41.03959	49.42935	57.91513	68.47998	75.74767	83.81031	92.95229
90MB	11.02635	11.75956	12.48273	13.20449	13.92583	14.79335	15.43767	23.79848	33.48623	41.83516	50.03292	58.98217	69.36495	76.56081	84.54215	93.96723
100MB	11.94575	12.78681	13.3132	14.11313	14.83745	15.68433	16.277	25.17873	34.38443	42.68214	51.09759	60.52958	70.11187	77.1987	85.08702	95.34837
200MB	21.05325	21.69752	22.35714	23.10895	23.91165	24.69139	25.2931	34.80769	43.73454	51.90744	60.61656	70.30572	79.33914	86.3254	94.39966	102.97944
300MB	30.00332	30.75769	31.40221	32.22362	33.06993	33.79051	34.49388	44.52055	52.91428	60.01841	70.35936	77.70627	88.71479	95.29602	104.16262	113.20349
400MB	39.01784	39.76284	40.37089	41.11852	42.08019	43.0171	43.53408	53.45887	61.33922	69.98405	78.40498	86.14435	97.47483	103.17187	112.35804	121.66898
500MB	47.8495	48.87697	49.67113	50.53569	51.10289	52.43293	52.72935	63.24187	70.9703	78.83083	87.58935	95.83077	106.25243	111.61405	120.24157	130.58027
600MB	57.62421	58.35613	59.77864	60.19146	61.35618	62.51425	63.49621	73.27607	80.2095	88.62365	97.28392	105.17529	116.03687	121.53143	129.81669	138.83679
700MB	67.94333	67.34502	69.696	69.67995	70.9217	73.54181	74.72056	82.5247	90.39645	98.64425	106.82852	115.82755	125.59225	131.46285	139.59289	147.59578
800MB	77.11488	77.38598	78.54571	80.04325	81.57666	82.88054	84.18391	92.74261	99.85383	108.2842	116.57465	124.77423	134.98671	140.78746	148.62179	157.53187
900MB	87.04593	87.89736	88.88529	90.53711	90.97471	92.08407	92.94857	101.11586	109.27236	117.8379	126.15868	134.24795	143.90858	149.55672	157.57373	166.26159
1000MB	95.74037	97.90647	98.01466	99.83714	100.74854	102.28126	102.19257	110.32652	119.51512	127.50434	135.69347	144.56128	153.49975	158.56418	166.35483	175.09385

*** measurement of pair 1KB/200MB failed and was not repeated because Shake was sorted out. 32bytes output length was calculated only one time, the gap between std (32b) and 1kb was accepted.**

On system 3 – XEON*

input output	1KB	1MB	2MB	3MB	4MB	5MB	6MB	7MB	8MB	9MB	10MB	20MB
std (32b)	0.0167	0.02366	0.02966	0.03417	0.0336	0.04528	0.04897	0.05148	0.05875	0.06682	0.0675	0.11698
1kb	0.00414	0.00962	0.01589	0.02279	0.021	0.031	0.03555	0.041	0.04424	0.04817	0.05479	0.09814
10kb	0.00145	0.01044	0.01651	0.02176	0.02207	0.02951	0.03456	0.03965	0.04458	0.04832	0.05459	0.10056
100kb	0.00482	0.01501	0.01988	0.02438	0.03139	0.03473	0.03657	0.04143	0.04825	0.05112	0.05746	0.10234
1MB	0.03779	0.051	0.05232	0.05536	0.06573	0.06541	0.06981	0.07467	0.07954	0.08338	0.0887	0.13438
2MB	0.0768	0.08332	0.08955	0.09153	0.1041	0.10209	0.1079	0.11154	0.11431	0.11793	0.12342	0.18113
3MB	0.11939	0.12022	0.12372	0.1312	0.13056	0.13928	0.1389	0.14355	0.14944	0.15317	0.16695	0.21476
4MB	0.1681	0.15546	0.1589	0.16607	0.17232	0.18156	0.17801	0.18729	0.19045	0.19287	0.19721	0.26544
5MB	0.21305	0.2078	0.20549	0.21093	0.21249	0.2215	0.22217	0.22841	0.256	0.23699	0.24337	0.28419
6MB	0.25716	0.24028	0.24708	0.27376	0.25185	0.26064	0.26796	0.26465	0.27745	0.2804	0.28221	0.32269
7MB	0.29924	0.2812	0.30125	0.3043	0.30378	0.31626	0.31819	0.3124	0.31849	0.32434	0.32376	0.37651
8MB	0.33385	0.32592	0.34082	0.34552	0.35041	0.33932	0.34419	0.36555	0.36067	0.37303	0.392	0.40085
9MB	0.86475	0.38183	0.41236	0.40692	0.42854	0.38471	0.39126	0.40223	0.41976	0.42334	0.41487	0.48864
10MB	0.41762	0.41658	0.43296	0.43933	0.44501	0.47255	0.43325	0.45437	0.44556	0.49099	0.49807	0.5293
20MB	0.8915	0.89628	0.88805	0.96096	0.94911	0.84764	0.86689	0.88183	0.90521	0.90203	0.92416	0.98562
30MB	1.80026	1.34386	1.3904	1.41124	1.40926	1.26646	1.24191	1.278	1.33742	1.37084	1.36348	1.43481
40MB	2.19852	1.77412	1.76	1.84315	1.94154	1.68429	1.68493	1.7352	1.7597	1.75342	1.80287	1.8689
50MB	2.47752	2.15054	2.1989	2.33856	2.30626	2.04334	2.03698	2.20285	2.17947	2.20556	2.22092	2.32577
60MB	3.4375	2.56142	2.65783	2.67937	2.80432	2.50989	2.55847	2.51216	2.5984	2.59014	2.71173	2.85983
70MB	3.91381	3.06989	3.14834	3.13218	3.25251	2.94841	2.89649	3.0553	3.10411	3.1045	3.07202	3.34529
80MB	3.91228	3.6059	3.59887	3.6193	3.75295	3.25749	3.26878	3.41178	3.45577	3.55364	3.66651	3.60479
90MB	5.0747	3.91372	4.00143	4.07193	4.13235	3.67468	3.81751	3.77893	3.91755	3.98313	3.92268	4.12315
100MB	5.46352	4.45108	4.434	4.47539	4.63611	4.16664	4.03832	4.32041	4.48234	4.42905	4.49859	4.55243
200MB	9.32734	8.6426	8.71042	8.9126	9.45911	8.47695	8.04639	8.58261	8.83725	8.75721	8.91946	9.50327
300MB	13.73353	13.22489	13.40084	13.90026	14.24366	12.24125	12.3182	12.73867	12.67742	13.44689	13.13483	13.42356
400MB	18.14982	17.30582	18.15189	17.77391	19.15951	16.39683	16.07522	17.00331	17.95312	17.44108	17.58227	17.88883
500MB	22.03795	21.66688	22.30108	22.57088	21.32033	20.43076	20.93068	21.20012	21.17283	21.34341	22.32621	22.78131
600MB	26.51421	26.52066	26.49831	27.08881	24.07091	24.15583	25.5849	25.37874	25.7532	25.65121	26.05861	27.66614
700MB	29.89152	30.72392	31.44139	31.9053	27.68494	27.71719	29.31051	29.58119	29.65473	31.27154	30.88449	33.94151
800MB	34.36671	35.26911	36.36507	37.04089	32.27236	32.40529	33.20007	35.13341	35.05153	34.83104	35.33645	37.78663
900MB	38.62578	40.03303	39.638	42.66053	37.29169	37.44537	37.90521	38.21688	39.0499	39.08853	40.35757	40.88844
1000MB	44.78728	43.49829	46.23296	47.29658	40.3264	40.26385	41.61707	44.71218	43.52726	43.62753	44.53313	46.08998

input output	30MB	40MB	50MB	60MB	70MB	80MB	90MB	100MB	200MB	300MB	400MB	500MB	600MB	700MB
std (32b)	0.1609	0.2092	0.25984	0.30544	0.35401	0.40427	0.45002	0.5084	0.98217	1.46117	1.94775	2.42783	2.92112	3.39775
1kb	0.14373	0.19074	0.23779	0.28253	0.33167	0.37567	0.42424	0.4798	0.93759	1.39955	1.86177	2.33397	2.7956	3.25028
10kb	0.14444	0.1913	0.23695	0.28269	0.3313	0.37599	0.42218	0.48214	0.93259	1.39664	1.85977	2.32268	2.78925	3.28608
100kb	0.14648	0.19402	0.24247	0.28679	0.33387	0.38149	0.43023	0.48328	0.94222	1.40014	1.88899	2.32659	2.80659	3.25327
1MB	0.18312	0.22696	0.27187	0.31998	0.36559	0.41332	0.45949	0.51937	0.96822	1.43464	1.89637	2.35809	2.82699	3.28498
2MB	0.21848	0.26678	0.31399	0.3537	0.40488	0.44848	0.49542	0.56711	1.01575	1.47207	1.9433	2.42924	2.8645	3.33591
3MB	0.26542	0.30701	0.35238	0.40604	0.4453	0.48939	0.5414	0.6023	1.07256	1.52267	1.98126	2.45722	2.91202	3.41386
4MB	0.31374	0.34393	0.39401	0.44315	0.48574	0.53276	0.58755	0.65627	1.09618	1.57079	2.05521	2.49758	2.96826	3.48497
5MB	0.33649	0.38659	0.43624	0.47561	0.5253	0.58483	0.63176	0.7058	1.1477	1.60806	2.10289	2.56581	2.99896	3.48691
6MB	0.39668	0.43259	0.48675	0.53096	0.57961	0.61442	0.68249	0.74608	1.20733	1.63988	2.10886	2.58632	3.05121	3.54381
7MB	0.43932	0.4704	0.52381	0.56703	0.62598	0.64672	0.72196	0.79621	1.20554	1.67762	2.15951	2.63812	3.08208	3.55631
8MB	0.47701	0.48968	0.58621	0.62358	0.66996	0.70805	0.75794	0.82004	1.25806	1.73782	2.20142	2.71026	3.12742	3.60955
9MB	0.53045	0.53099	0.61657	0.66273	0.69924	0.74106	0.78599	0.88117	1.30499	1.78917	2.27305	2.7046	3.17777	3.65874
10MB	0.56606	0.60556	0.65913	0.71903	0.7459	0.80523	0.84075	0.91879	1.36899	1.81234	2.29435	2.76644	3.24859	3.6952
20MB	1.06088	1.01381	1.06011	1.12183	1.14402	1.22549	1.23571	1.30352	1.78045	2.26401	2.72373	3.23896	3.65399	4.1068
30MB	1.54198	1.37429	1.46401	1.53901	1.52694	1.63594	1.69422	1.74118	2.1956	2.67254	3.19587	3.64139	4.06032	4.53626
40MB	1.99239	1.8154	1.87726	1.87952	1.97089	1.97807	2.13467	2.12526	2.6044	3.0783	3.52017	4.02872	4.4481	4.97369
50MB	2.48306	2.20979	2.31928	2.33723	2.33798	2.50369	2.43857	2.58511	3.01244	3.53052	3.9927	4.41708	4.88433	5.38998
60MB	2.87175	2.59997	2.65837	2.74961	2.71709	2.85236	2.8804	2.9416	3.48253	3.98832	4.35377	4.86072	5.31257	5.78238
70MB	3.39023	2.9451	3.07786	3.16387	3.21004	3.17344	3.27032	3.40918	3.7787	4.4633	4.85645	5.27923	5.74722	6.38777
80MB	3.81813	3.46071	3.41302	3.52654	3.5444	3.64456	3.737	3.90013	4.26336	4.80664	5.11147	5.71959	6.13397	6.75194
90MB	4.168	3.81009	3.85064	3.91211	4.09259	4.05579	4.11432	4.19245	4.69088	5.09846	5.69171	6.09634	6.65726	7.14123
100MB	4.72014	4.19827	4.45634	4.39368	4.36911	4.45627	4.54183	4.5844	5.13513	5.42981	5.93703	6.61715	7.13597	7.52451
200MB	9.2202	8.19629	8.24893	8.23389	8.39249	8.57797	8.90114	9.03393	9.23019	9.79423	10.10875	10.81068	11.47801	11.72854
300MB	14.4114	12.41163	12.425	12.44302	12.28614	12.72577	12.82691	13.1326	13.30872	13.95026	14.34922	14.7493	15.21692	16.07477
400MB	18.71157	16.23046	16.28658	16.74461	16.739	17.10559	16.8552	16.84535	17.64702	17.91306	18.19078	19.20968	19.93919	20.54061
500MB	23.12284	20.90227	21.05213	21.07288	21.04212	20.37686	20.86283	20.71793	21.47611	22.53354	23.59061	23.20013	23.60519	24.70314
600MB	27.77889	24.3356	24.75027	24.09047	25.07391	24.33163	25.19932	26.22485	25.64511	27.07519	27.29779	27.86656	27.6684	29.26257
700MB	32.4706	28.28947	28.28454	29.10676	28.72239	28.39319	30.81304	29.67964	30.0439	30.40359	31.11054	32.4264	32.93318	33.5923
800MB	36.15681	33.89322	32.0774	33.54218	32.55157	34.18783	33.30076	32.90866	33.89396	34.65386	35.48456	36.03102	36.54692	37.955
900MB	36.83885	37.0522	36.67046	37.08757	38.12083	37.42358	38.35736	37.54578	39.57471	39.29406	40.06179	39.96138	40.98124	42.46305
1000MB	40.39959	41.21526	43.62119	40.2312	41.63373	41.17477	41.36447	41.62455	42.88843	42.78526	43.62385	44.26688	46.38532	48.07948

input output	800MB	900MB	1GB	2GB	3GB	4GB	5GB	6GB	7GB	8GB	9GB	10GB
std (32b)	3.88186	4.44818	4.84364	9.68641	15.07164	19.3428	25.13938	29.28891	35.03782	40.80949	45.32501	49.87626
1kb	3.71657	4.19539	4.64546	9.33777	13.92755	18.55734	23.37747	27.84688	32.85771	37.12928	41.79694	46.41248
10kb	3.75842	4.19696	4.64592	9.28172	13.93024	18.55476	23.21077	27.83382	32.50061	37.16456	41.84123	46.4204
100kb	3.71874	4.18424	4.64832	9.28462	13.99924	18.58347	23.34604	27.84122	32.609	37.2638	42.22196	46.41287
1MB	3.75514	4.21607	4.68045	9.31096	13.95421	18.7151	23.24704	27.92148	32.53286	37.14362	41.80017	47.23488
2MB	3.81316	4.25361	4.72061	9.35224	13.99802	18.6314	23.51669	28.1113	32.93241	37.5531	41.83744	46.47985
3MB	3.84613	4.37906	4.7794	9.40747	14.10166	18.68082	23.3344	28.01243	32.98406	37.22895	41.89279	46.53296
4MB	3.9277	4.368	4.82467	9.45142	14.09785	18.84106	23.38169	28.22864	32.66047	37.29411	42.30382	46.57021
5MB	3.93492	4.39097	4.86677	9.50746	14.13804	18.76033	23.57543	28.10129	32.70887	37.33939	42.3744	46.60639
6MB	3.9982	4.49339	4.94438	9.65372	14.18634	18.80331	23.55121	28.1053	32.75212	37.38965	41.99714	46.65458
7MB	4.04638	4.49879	5.05823	9.64508	14.24641	19.18742	23.49593	28.53373	32.77872	37.42052	42.27619	46.72164
8MB	4.07498	4.53221	5.0588	9.61841	14.28352	19.08498	24.00991	28.57015	32.82531	37.82827	42.23387	47.06857
9MB	4.09192	4.5967	5.07577	9.73308	14.41533	18.93862	23.58816	28.23545	32.87749	37.53305	42.39627	46.75801
10MB	4.15183	4.63599	5.11374	9.73019	14.37828	18.96512	23.82945	28.28093	32.91112	37.6209	42.15093	46.88329
20MB	4.57974	5.10024	5.53466	10.20983	14.84031	19.46869	24.04613	28.78258	33.39788	38.25753	42.60435	47.45575
30MB	5.007	5.46671	6.02126	10.66996	15.31474	19.82019	24.46889	29.12459	33.88804	38.94909	43.08309	47.72431
40MB	5.47145	5.90852	6.38896	11.09009	15.7591	20.27862	24.8587	29.62685	34.24895	38.95455	43.56384	48.19124
50MB	5.85948	6.34418	6.87043	11.48652	16.23677	20.57659	25.27048	30.00794	35.16909	39.27012	44.01052	48.96684
60MB	6.36973	6.87082	7.2991	11.92616	16.67315	20.93988	26.09818	30.43261	35.06825	39.9809	44.34729	49.25419
70MB	6.67421	7.30014	7.79734	12.43278	17.20356	21.47765	26.18563	30.82608	35.47537	40.35267	45.12276	49.71797
80MB	7.21276	7.56412	8.29632	12.91831	17.77077	21.79608	26.63195	31.40295	35.99236	40.55253	45.83084	50.02397
90MB	7.61674	8.06254	8.57919	13.45684	18.13129	22.42304	27.1034	31.62071	36.35612	40.93871	45.73606	50.41121
100MB	8.08145	8.43078	9.2267	13.78192	18.48301	22.65029	27.62376	32.12786	36.94145	41.45209	46.13128	50.97256
200MB	12.31452	12.70866	13.46623	18.56625	23.02831	26.65671	31.77027	36.20359	41.33502	46.27461	50.41702	55.42115
300MB	16.99544	16.93418	17.75492	22.96825	27.79988	31.2006	35.65579	41.02884	45.87418	50.0276	55.45449	60.01122
400MB	21.96195	21.22537	21.98691	27.70253	32.62803	34.75444	40.31271	44.78503	50.27808	54.84674	59.70258	66.08115
500MB	25.83993	26.35641	26.98787	31.98757	37.14294	39.51574	43.99743	49.10616	53.89601	58.98996	64.94348	68.61214
600MB	29.16554	30.46702	31.00566	36.3425	40.03927	43.69606	49.18348	53.28174	59.09127	63.28799	68.5704	73.74291
700MB	34.35817	35.36705	36.60829	41.14862	42.31383	48.26501	52.78644	58.67794	63.16518	67.66594	74.83647	79.04071
800MB	39.15466	39.92549	40.39628	47.21666	46.41584	52.18676	57.98109	62.07349	68.82829	72.02204	77.7988	83.98771
900MB	43.14557	44.36729	44.85324	51.90928	50.94013	57.61657	61.44878	67.05306	71.56032	76.68674	81.7661	87.63439
1000MB	48.18149	47.64955	52.97746	55.99573	54.68781	59.81229	65.64394	70.23227	75.63076	81.79122	86.28949	93.63262

*** 32bytes output length was calculated twice to overcome HDD reading and caching; the second result was used.**

## Appendix e)	speedtest-blake3.sh: Sample shell script

```
#!/bin/bash

declare -a input=("key_1kb.file" "key_1MB.file" "key_2MB.file" "key_3MB.file" "key_4MB.file" "key_5MB.file"
"key_6MB.file" "key_7MB.file" "key_8MB.file" "key_9MB.file" "key_10MB.file" "key_20MB.file" "key_30MB.file"
"key_40MB.file" "key_50MB.file" "key_60MB.file" "key_70MB.file" "key_80MB.file" "key_90MB.file"
"key_100MB.file" "key_200MB.file" "key_300MB.file" "key_400MB.file" "key_500MB.file" "key_600MB.file"
"key_700MB.file" "key_800MB.file" "key_900MB.file" "key_1GB.file" "key_2GB.file" "key_3GB.file" "key_4GB.file"
"key_5GB.file" "key_6GB.file" "key_7GB.file" "key_8GB.file" "key_9GB.file" "key_10GB.file" )

declare -a output=("32" "500" "5000" "50000" "500000" "1000000" "1500000" "2000000" "2500000" "3000000"
"3500000" "4000000" "4500000" "5000000" "10000000" "15000000" "20000000" "25000000" "30000000" "35000000"
"40000000" "45000000" "50000000" "100000000" "150000000" "200000000" "250000000" "300000000" "350000000"
"400000000" "450000000" "500000000")

for i in "${input[@]}"
do
key_file=$i
#echo File $key_file


                                        for o in "${output[@]}"
                                        do
                                                output_size=$o



                                                counter=1
                                                start_time="$(date -u +%s.%N)"
                                                #echo STARTTIME $start_time

                                                while [ $counter -lt 11 ];
                                                do

                                                        b3sum $key_file -l $output_size  > speedtest.txt
                                                        #ls -lh speedtest.txt
                                                        #rm speedtest.txt
                                                        #echo "$(date -u +%s.%N)"
                                                        counter=$[$counter+1]

                                                done

                                                end_time="$(date -u +%s.%N)"
                                                elapsed="$(bc <<<"$end_time-$start_time")"
                                                average="$(bc -l <<<"$elapsed/10")"
                                                #echo ENDTIME $end_time
                                                #echo ELAPSED $elapsed

                                                echo -e  Input $key_file "\t\t " Output "$(ls -s
                                                speedtest.txt --block-size=K)" "\t\t "AVERAGE"\t\t ""\t\
                                                t " $average

                                        done


                                        echo ""
                                        echo ""
done
```

Appendix f) SHE.sh: encryption and decryption script as proof of concept

```
read -p "Enter your key file: " key
read -p "Enter your input file: " plaintext
read -p "Enter your output file: " output

# find out the size of the plaintext file in bytes
plain_size=$(stat --format="%s" $plaintext)

# h-BOX: derive the key as long as the plaintext file
echo "========================= STEP 1: derive key"
time b3sum $key -l $plain_size --raw --no-names > derivedkey.txt
derived_key_size=$(stat --format="%s" derivedkey.txt)

echo "========================= STEP 2: XOR the two files together"
time ./xorfiles derivedkey.txt $plaintext > $output
rm derivedkey.txt
echo "========================= STEP 3: en-/decryption finished. Cleaned up. See output."
```