Benchmarking the GIGI cryptocurrency

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Abstract - The rise of cryptocurrency has led to a large use of energy which requires fossil fuels because of the type of proof it uses to make the blockchain. These cryptocurrencies utilize GPUs and ASICs to compute hashes which require a lot of power. For instance, Bitcoin uses approximately 0.5% of the global electricity. Other alternatives have been developed to use more efficient proofs such as stake and space which are friendly for the environment. This report shows the performance of the Green LightninG CoIn (GIGI) which uses proof of space for its blockchain, utilizing storage drives to save what is known as vaults, which can be looked up to determine who the winner is to advance the blockchain. This new type of cryptocurrency could be a sustainable replacement for the traditional cryptocurrencies that are currently used in the world. The benchmarking of the GIGI cryptocurrency will look at the CPU usage, the time taken, file write throughput and power consumption compared to another proof of space cryptocurrency called Chia.

Introduction:

Cryptocurrency may be the future of monetary transactions and business around the world as it provides a decentralized and secure method to transfer money. However, it requires a lot of power to work and has not achieved transaction speeds as fast as Visa or Mastercard. Currently, the most used validation system is proof of work which requires computing hashes done by high power driven GPU and CPUs. Other alternative validation systems like proof of space can provide a greener solution to this type of online currency. GIGI provides such a solution as it uses proof of space utilizing storage drives which are less power intensive. However, this prototype needs to be tested to see whether it is efficient. Therefore, testing GIGI against another proof of space cryptocurrency such as Chia gives a good benchmark for CPU usage, disk throughput and power usage.

Background:

A cryptocurrency is a decentralized, digital, and encrypted form of money. A cryptocurrency's value is not managed and maintained by a single entity like the US dollar or the euro. Instead, via the internet, these tasks are widely divided among users of a cryptocurrency. Although most individuals invest in cryptocurrencies the same way they would in other assets like stocks or precious metals, you may use cryptocurrency to purchase conventional products and services. Although cryptocurrency is a new and fascinating asset class, investing in it can be dangerous since it takes some study to properly grasp how each system operates. Transactions that are validated and documented on a blockchain serve as the cryptographic evidence. An open, distributed ledger that stores transactions in code is known as a blockchain. It functions much like a checkbook that is dispersed across several computers all around the world. The recording of transactions takes the form of

"blocks," which are then connected by a "chain" of earlier bitcoin transactions. A blockchain allows for the creation of a single transaction record by ensuring that each coin user has their own copy of the book. Every new transaction is recorded as it occurs, and every copy of the blockchain is concurrently updated with the new data to maintain the consistency and accuracy of all records. Each transaction is examined using a validation mechanism, such as proof of stake or proof of labor, to avoid fraud. The two most popular consensus procedures for validating transactions before adding them to a blockchain are proof of work and proof of stake. Following that, the verifiers receive a coin as payment for their work. A blockchain transaction may be verified via the proof of work technique, in which an algorithm presents a mathematical task that computers compete to solve. Each miner completes a mathematical challenge that aids in the verification of a collection of transactions, after which they are added to the blockchain ledger. A modest sum of coins are awarded to the first computer to complete the task successfully. Blockchain puzzle-solving competitions demand a lot of computing power and electricity. In order to limit the amount of processing power required to verify transactions, certain cryptocurrencies employ the proof of stake technique. The amount of coin that each participant is prepared to "stake," or momentarily lock up in a shared safe, in exchange for the opportunity to take part in the process, determines the maximum number of transactions that they can verify. Everyone who wagers cryptocurrency is qualified to verify transactions, but the likelihood that you will be picked rises generally with the quantity you front. A third and less common verification system is Proof-of-capacity (PoC), sometimes known as proof-of-space or proof-of-storage, which is a consensus technique that is closely linked to proof-of-spacetime (PoST).
The purpose of proof of space is to mandate that network users show a financial stake in the network's success by dedicating memory or disk space to it. The decentralized consensus in a blockchain network or other decentralized protocol may then be reached using the proof. A decentralized system requires proof of financial interest in the network to ward off sybil assaults. Proof of elapsed time (PoET) is a consensus technique for the blockchain network that reduces resource and energy consumption while maintaining process efficiency by using a fair lottery system. On a blockchain network, the algorithm decides who gets to mine coins and who wins a block using a randomly generated amount of time. The PoET method increases transparency by ensuring lottery outcomes may be verified by outside parties by executing a trusted code in a secure environment.

Component	Power required
CPU	55 – 150 Watts
GPU	25 – 350 Watts
HDD	0.7 – 9 Watts
SSD	0.6 – 3 Watts

Source:https://graphicscardsadvisor.com/how-much-power-should-your-gpu-use/

The table above shows that CPUs and GPUs use a lot of power to operate, which is the primary hardware that proof of work cryptocurrency uses. In comparison, proof of space crypto would mainly utilize HDD and SSD which have lower power consumption.

Green LIghtninG CoIn (GIGI) is a prototype coin that was created using proof of space verification. It works by inputting a target file size, block size, allocated memory and number of threads. It first organizes the data into blocks which is determined by the allocated memory and block size which then stores the hashes into what is called a “vault”. This file is then looked up and compared to check whether it won the lottery system, which will give that wallet a prize and the right to continue the blockchain. This design is similar to another cryptocurrency called Chia which was released in March of 2021 and is useful in comparison to GIGI. The Chia Network is a blockchain and smart transaction platform that is powered by storage space allotted to GIGI’s equivalent of “vaults” known as "plots". It utilizes three different procedures also known as plotters to store these “plots” in drives: Native, Madmax and Bladebit. Each one works differently, however in this investigation only the Native and Madmax plotters were tested, since Bladebit uses 416GiB of memory to run, by storing and organizing first in fast memory and then writing to disk once it is finished. Chia was founded with the purpose of solving the energy-intensive process used by proof-of-work consensus techniques by creating a network using storage devices instead of GPUs and CPUs.

Methodology:

The method that was used to test GIGI was by comparing it to the Chia plotters as a benchmark of performance. Chia has three plotters but only the Native and Madmax were tested. We then compared these to GIGI’s plotter. In order to have sufficient data points and run these tests quickly we chose plots that were around 5.3-5.9 GiB. For Chia the standard file size is given by a “k-size” which accepts a minimum of “k-32” for the network, equivalent to a 103GiB file. However, using a “k-28” plot brings that down to 5.9 GiB which allows for faster processing of data. The plots were tested across all of these plotters, using a different number of threads and writing to either a SATA SSD or a RAID0 over four NVME drives. Varying the conditions allows us to test different parts such as write throughput, CPU usage, power usage, and the time taken to complete the plot. The tests were made on a node with 16 hardware cores with 2 threads each and 63GiB of RAM.

The commands that were used in order to run these plots are the following.

Native plotter: chia plots create -k <k size> -b <buffer size> -r <threads> -u <buckets> -t <temporary storage> -d <final storage> -p <public key> -f <foreign key>

Madmax plotter: ./chia_plot_k34 -k <k-size> -r <threads> -u <buckets> -t <temporary storage> -d <final storage> -p <public key> -f <foreign key>

The k size was kept the same for the chia plotters, while changing the number of threads between 1, 8, and 16, and using a bucket size of 128. The buffer size used for Madmax was around 3.3GB. Chia first stores and organizes the files in a temporary drive and writes the completed plot to the final destination, which was varied from NVME or SATA.

GIGI plotter: ./gigiapp plot <vault size> <block size> <usable memory> <file path> <threads>

For GIGI the vault size was set at 5.3GiB, and tested the block size and usable memory for the fastest time which was 1048576 Bytes for block size and 83886080 of memory.

Results and Evaluations:

CPU usage:

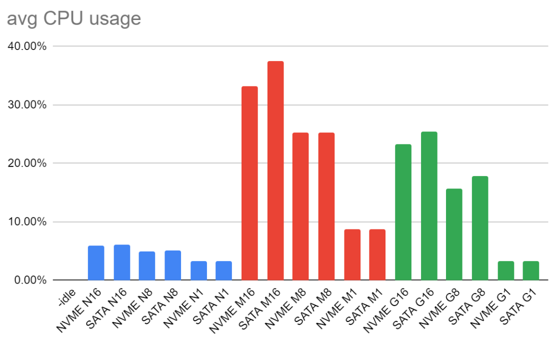

Figure 1 - CPU usage

The graph shows the Native plot in blue, Madmax in red and Gigi in green. Each column is marked with the type of drive used, an N to denote Native, M for Madmax and G for GIGI plots. The last number represents the number of threads used in the test (1,8 or 16) because of the limitations of the server. The CPU usage shows some interesting results as the Native plotter uses the least amount and stays consistent amongst the change of threads. Madmax and GIGI show higher usage of CPU the more threads are used. High usage does not necessarily mean it is a good thing, because although the average usage never surpasses 40% it is optimal if the plotter can use the least amount while completing the plot in less time and with high throughput as it shows that it is not exhaustive on the system. GIGI took on average 3.4x less time compared to Madmax to complete, showing that GIGI is more efficient at CPU usage.

Disk Throughput:

Disk throughput is very important when considering proof of space, just as hashing power would be crucial for proof of work. We measured the writing to disk throughput in different ways for the Chia plotters. Since Chia writes to a temp file first and then sorts and writes to a final destination later, we considered data such as the average throughput to write the final plot, and the total throughput for all of the writes.

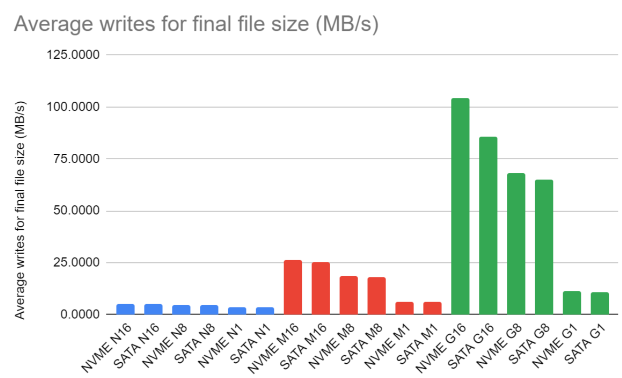

Figure 2 - Average writes (MB/s)

The average writes reflect the average MB/s to complete the final plot size. In figure 2 the graph shows a much larger throughput and write speed for GIGI as it completes the plots in less time and does not write to a temporary file but previously sorts in buckets and writes directly to the final drive. These results show that GIGI has 4x more throughput than Madmax for writing the plots which is a large difference as it means that disks can be filled up with plots faster.

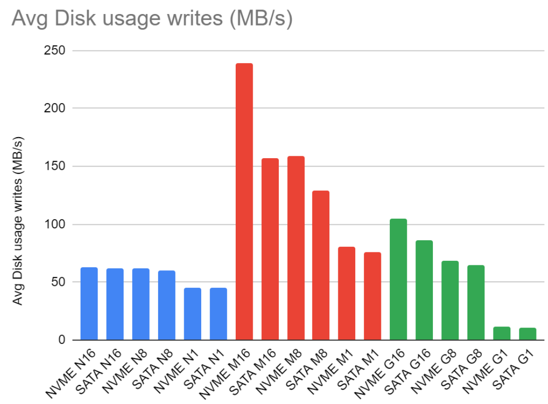

Figure 3 - Average total writes (MB/s)

This graph shows that Madmax did have the highest total throughput as it wrote a lot of data to the temporary files and sorted it. We can also observe that as the threads increased to 16 for Madmax there was a large difference in the speeds for the NVME drive versus the SATA drive. GIGI still shows good throughput, but it also uses a more efficient protocol to create the vault.

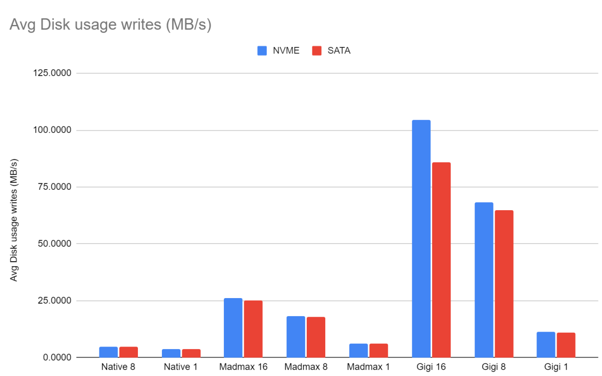

Figure 4 - NVME vs SATA

As previously discussed, this figure shows the average write throughput for the final file size and the comparisons from NVME to SATA. It would have been expected to see larger differences between the two types of drives however this could be due to the smaller file sizes which we tested and lower CPU usage these plots required.

Power usage:

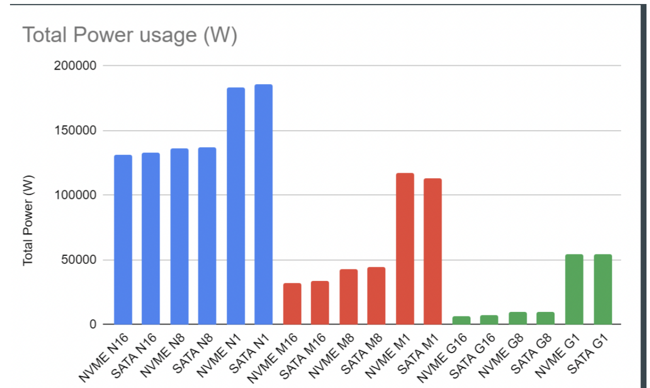

Figure 5 - Power Usage (Ws)

The power usage of the server was measured using the linux ipmitool. The graph shows that the results of each increase when using one thread, which is logical since there is not as much CPU being allocated to complete the tasks and therefore takes longer to complete. There is a large difference between the plotters showing a high consumption for native reaching up to 185589 Ws for 1 threaded plotting. Madmax is lower, showing it to be the better plotter for Chia, but GIGI is still the lowest at 54448 Ws for 1 thread. These results reflect a power efficient plotter which is essential as it tries to prove a greener system than proof of work.

Conclusions

Chia and GIGI are two cryptocurrencies that are perfect to run up against each other as they both use proof of space and a similar plotting system. Running these tests showed interesting results and superiority of GIGI over Chia as it had higher throughput, uses less CPU and took less time to complete the plots which ultimately led to lower power usage. These tests show an efficient cryptocurrency method that is both fast and a healthier alternative for the environment than proof of work.

Finally, some shortcomings in this investigation were the testing of small plot sizes instead of the larger k-32 (103GiB plots). This could show different results that were not present in the smaller plots. In addition, testing Chia's third plotter Bladebit would have given faster speeds than Madmax since it uses memory and is an interesting plotter to test against Chia. Also, switching the type of server and performing tests on it could give a more rounded benchmark for instance on a more powerful server, and a smaller one like a Raspberry Pi.

References

Gene Hoffman (2021, February 10). *The Chia Business White Paper*. Chia Network. Retrieved July 27, 2022, from https://www.chia.net/2021/02/10/chia-businesss-whitepaper.html

GitHub - Chia-Network/chia-blockchain: Chia blockchain python implementation (full node, farmer, harvester, timelord, and wallet)

Walton, J. (2021, August 3). *How to farm chia coin, now with pooling*. Tom's Hardware. Retrieved July 27, 2022, from https://www.tomshardware.com/how-to/how-to-farm-chia-coin-the-new-storage-based-cryptocurrency

Appendix: Data tables

	Chia Native					
K - size	28	28	28	28	28	28
# Thread	16	16	8	8	1	1
Disk Drive	NVME	SATA	NVME	SATA	NVME	SATA
Avg CPU	5.94%	6.04%	4.90%	5.09%	3.30%	3.36%
Avg Disk usage writes (MB/s)	62.7	62.3	61.84	59.8	44.8	45.24
Total writes (GB)	73.89	74.89	81.67	78.99	73.95	76.00
Average writes for final file size (MB/s)	4.86	5.10	4.65	4.63	3.71	3.65
File size (GiB)	5.598112832	5.98476728	5.992935947	5.978376423	5.981392332	5.993639432
Time taken (s)	1178.46	1202.13	1320.66	1320.85	1650.65	1679.95
Total Power (W)	131615	133023	135893	137004	183224	185589

Table 1 - Native plot tests

	Chia Madmax					
K - size	28	28	28	28	28	28
# Thread	16	16	8	8	1	1
Disk Drive	NVME	SATA	NVME	SATA	NVME	SATA
Avg CPU	33.20%	37.56%	25.34%	25.27%	8.67%	8.79%
Avg Disk usage writes (MB/s)	238.8	157.3	158.8	128.9	80.64	75.97
Total writes (GB)	55.80	38.52	52.94	44.33	79.19	75.26
Average writes for final file size (MB/s)	26.27	25.06	18.41	17.83	6.25	6.19
File size (GiB)	5.994615368	5.993258943	5.994615368	5.989082244	5.993639017	5.989916549
Time taken (s)	233.68	244.87	333.39	343.93	982.07	990.60
Total Power (W)	32465	33865	42971	44093	117374	113501

Table 2 - Madmax plot tests

	GIGI Plotter					
K - size						
# Thread	16	16	8	8	1	1
Disk Drive	NVME	SATA	NVME	SATA	NVME	SATA
Avg CPU	23.24%	25.37%	15.74%	17.86%	3.33%	3.24%
Avg Disk usage writes (MB/s)	104.38	85.75	68.12	64.83	11.23	10.99
Total writes (GB)	5.50	5.50	5.50	5.50	5.50	5.50
Average writes for final file size (MB/s)	104.38	85.75	68.12	64.83	11.23	10.99
File size (GiB)	5.36870912	5.36870912	5.36870912	5.36870912	5.36870912	5.36870912
Time taken (s)	52.67	64.11	80.70	84.80	489.72	500.17
Total Power (W)	6303.11	7682.4	9670	10161	54406	54448

Table 3 - GIGI plotter