

BCH-SV Professional Stress Test

After the successful creation of the first blocks larger than 32MB, the stress test team identified a number of changes to the architecture of the Satoshi Shotgun to better enable the successful generation of a longer string of big blocks on the BCH-SV network. These changes were implemented, and from the 17th to 19th of November a sustained, high volume stress test was conducted that demonstrated the network’s ability to sustain high volume traffic and to mine big block, as well as demonstrating its robust nature when faced with volume well outside its normal usage.

Miners, users and services were all impacted however the Stress Test team believe that performing this nature of work is necessary to proving not just the validity of the scaling path laid out in Satoshi’s Vision, but the long term viability of services which need to scale with the network.

Over 24 million transactions were sent over a 5 day period leading to the mining of the largest block ever on a public blockchain. Despite the impacts to businesses and services, real world testing has proven again to be one of the best ways of generating feedback on system performance. We believe this demonstrates how useful stress tests can be when properly scheduled, advertised and conducted in a transparent and thoughtful manner.

The report goes through the design of the Satoshi Shotgun and covers three separate testing periods:

- 1) A 1.4 million tx blast immediately after the fork at around 7pm UTC on the 15th of November
- 2) 10 million txs sent as part of the main test on the 17th and 18th of November
- 3) A further 16 million transactions sent as a follow up test on the 19th and 20th of November

Contents

The Satoshi Shotgun	2
Main Node	2
Node Cluster.....	2
Shotgun Software	2
Future improvements	3
Test period 1: Post upgrade blast	3
Test period 2: November 17 th Stress Test.....	4
Extended Test.....	5
Test period 3: 19 th of November, and the first blocks over 32MB.....	6
Conclusion.....	7
The Satoshi Shotgun Design Overview	8

The Satoshi Shotgun

For this test, we decided to go all out. In the event of a split, we wanted a way to ensure that transactions would be replayed on both chains so we set up numerous nodes with different BCH implementations to ensure our testing would cover all potential outcomes of the split.

Main Node

For this test our main node, which generates all the addresses, transactions and handles the dispatching process, was configured as a 64-core machine with 240GB of RAM. This was to handle a transaction load in excess of our 1 million per hour target. The main node was running Bitcoin Unlimited at the time of the fork, however some early testing indicated that it was having issues making P2P connections with the Bitcoin SV nodes in our cluster so we transitioned to a Bitcoin SV node for the main test.

NOTE: See the final page of the report for a diagram detailing the workflow of the Shotgun from when funds are received to when transactions are sent.

Node Cluster

We included nodes using Bitcoin SV, Bitcoin BAB and Bitcoin Unlimited, configured to operate under both the Bitcoin SV and Bitcoin BAB rulesets.

The nodes were distributed as shown in the following table:

Country	Total QTY	QTY BAB	QTY BU-BAB	QTY BU-SV	QTY SV
<i>Australia</i>	6	1	1	1	3
<i>Belgium</i>	6	1	1	1	3
<i>Brazil</i>	6	1	1	1	3
<i>Canada</i>	6	1	1	1	3
<i>Germany</i>	6	1	1	1	3
<i>Finland</i>	6	1	1	1	3
<i>Hong Kong</i>	6	1	1	1	3
<i>India</i>	6	1	1	1	3
<i>Japan</i>	6	1	1	1	3
<i>Netherlands</i>	6	1	1	1	3
<i>Singapore</i>	6	1	1	1	3
<i>Taiwan</i>	6	1	1	1	3
<i>UK</i>	6	1	1	1	3
<i>USA</i>	6	1	1	1	3
Total	84	14	14	14	42

Shotgun Software

The blaster system itself is a combination of BASH script and Javascript which has been constantly improved and updated by our developer. Currently it is a very manual process to operate however we are constantly working on new ways to make the shotgun easier to use and more scalable.

Notable improvements include:

- On-demand scaling system to allow rapid assembly of a shotgun of any size, using nodes of any client or setting
- Automatic distribution of funds from collection accounts in packages for tx creation and sending
- Automatic connection of nodes within the Shotgun cluster to each other after establishment of connections to the P2P network

- Automated recovery system to re-start transaction batches which have failed (work in progress)

Future improvements

We believe that the Satoshi Shotgun is a potent tool that can be used to demonstrate the performance of the Bitcoin SV network in a highly visible and public way and plan to continue building on the platform to make it easier to use and more capable. So far, we have identified the following features in the development roadmap towards the next iteration of the Shotgun, scaling its capability and utility in line with that of the Bitcoin SV network:

- Ability to accurately calibrate the rate at which transactions are sent
- Plugins to change the type of transaction
 - Transactions that use only confirmed funds
 - Transactions with randomized numbers of inputs/outputs and values
 - Transactions with data carrier (OP_RETURN) included
 - Transactions including tokens and bitcoin script
- Ability to support any node client that supports the required RPC calls (including other coins)
- Web facing panel for simple operation
- Simple and fast consolidation of funds post test

Test period 1: Post upgrade blast

In the hours prior to the network upgrade a member of the community paid 4BCH into our collector wallet and reached out to ask us to use the funds in a blast immediately following the first block following the new consensus rules. We did this and created some of the first big blocks seen on the BCH-SV network. These were as follows:

Table 1: Post Fork Blast Results

Block Height	Miner Name	Block Size (Bytes)	Tx Count	Miner Reward
556818	Mempool.com	20,071,520	45,931	12.7296
556809	SVPool	31,999,118	73,315	12.866
556802	SVPool	31,998,523	73,298	12.8662
556788	SVPool	31,998,833	77,652	12.8883
556786	SVPool	21,425,444	56,284	12.7814
556785	SVPool	29,780,234	81,252	12.9064
556784	coingeek.com	27,601,569	63,854	12.8193
556782	coingeek.com	31,999,128	73,310	12.8667
556778	SVPool	20,100,104	46,004	12.73
556777	coingeek.com	28,415,972	65,030	12.8251
556776	coingeek.com	31,999,031	77,239	12.9063
556772	coingeek.com	27,181,966	141,044	12.7744
Total transactions mined into big blocks:			874,213	

This blast was successful in sending over 1,400,000 transactions onto the network over a duration of 3 and a half hours. At this point, nodes the network was already split in two, with nodes following the BAB ruleset banning nodes following the SV ruleset leading to slower transaction propagation. The result of this was that it took approximately 16 hours for all transactions to be mined into blocks.

While the network was not performing as well as it should have, the test demonstrated the performance of the Shotgun delivering similar performance metrics to what we had seen with the pre-test in the previous week and giving us confidence that we would be able to demonstrate large block capacity at the time of the main stress test.

It seemed at this time that our transactions were being replayed on the BAB network however none of the miners on the BAB network were allowing blocks of greater than 8MB to be mined, with the vast majority using block sizes configured to 4MB and below. We are disappointed to see that more than 6 months after the upgrade to 32MB blocks that miners would still refuse to enable the network to perform at its true limits. We also encountered the first instance of transaction malleation in the electron cash wallet, resulting in some funding transactions playing with different txids on each network. This was caused by our wallet sending transactions twice with disparate nLockTime parameters resulting in different TXIDs for spending the same funds on each network. In short, our coins were split, and the blaster was only configured to detect the funds arriving on the SV network. This was an oversight on our part and we then began work on a separate shotgun to for the BAB network rather than a single system for both.

Once this coin split occurred the blaster stopped playing transactions on the BAB network, resulting in just 337,690 transactions being mined during the test.

Block Height	Miner Name	Block Size (Bytes)	Tx Count	Miner Reward
556783	Bitcoin.com	1,336,614	6950	1251375521
556782	Bitcoin.com	3,999,080	18464	1254002656
556781	Bitcoin.com	3,999,013	20821	1254155254
556780	BTC.com	3,998,993	20853	1254007549
556779	Bitcoin.com	7,998,695	41699	1258054537
556778	BTC.com	3,998,905	20878	1254009515
556777	Bitcoin.com	3,999,164	20886	1254106553
556776	Bitcoin.com	7,999,073	41781	1258135818
556775	BTC.com	3,998,993	20883	1254172528
556774	BTC.com	3,998,945	20818	1254029138
556773	Bitcoin.com	235,772	1231	1250236296
556772	Bitcoin.com	562,779	2423	1250565799
556771	Bitcoin.com	4,506,515	16843	1254517377
556770	Bitcoin.com	482,842	2342	1250485069
556769	Bitcoin.com	7,999,013	41331	1258120653
556768	Bitcoin.com	3,609,263	18626	1254029298
556767	Bitcoin.com	3,998,758	20861	1254122865
Total transactions mined:			337,690	

Test period 2: November 17th Stress Test

While it was our intention to play transactions onto both the Bitcoin BAB and Bitcoin SV networks in the event of a split, the fund split made this more difficult and the decision was made to focus on testing the Bitcoin SV network only rather than both networks at once. There had already been news reports calling our pre-test blast on the BAB network a ‘Spam Attack’, so rather than fanning the flames of discontent, the team discussed options and decided the more responsible decision was to focus on testing the Bitcoin SV network only. We knew we had the support of miners and businesses

on the network to attempt to generate big blocks, and that the BAB network miners would not support any attempt to create big blocks so we powered down the BAB shotgun.

The official test was kicked off at Midday on the 17th of November and ran for a full 24 hours. We quickly saw large numbers of transactions arriving in mempools and some large blocks mined almost straight away, however we did not see any blocks bigger than 32MB. Highlights included the following blocks:

Table 2: Big blocks mined between midday 17/11 and midday 18/11

Block Height	Miner Name	Block Size (Bytes)	Tx Count	Miner Reward
557133	SVPool	25,877,348	135,131	12.759452
557118	SVPool	26,479,789	136,733	12.765493
557097	SVPool	23,854,188	57,106	12.743125
557093	SVPool	25,155,896	75,253	12.754637
557092	SVPool	31,998,915	86,831	12.885483
557091	bmgpool	20,885,322	53,831	12.712
557090	coingeek.com	24,400,178	72,308	12.747176
557059	coingeek.com	31,999,177	73,288	12.825575
557056	coingeek.com	31,998,775	73,892	12.828093
557055	coingeek.com	31,998,457	80,049	12.855448
557054	coingeek.com	31,998,913	79,638	12.853675
557053	SVPool	27,023,496	75,894	12.8242
557052	coingeek.com	31,998,571	79,936	12.854928
557048	coingeek.com	31,999,157	127,506	12.863133
Total transactions mined in big blocks:			1,937,330	
Total transactions sent onto network:			5,691,847	
% of transactions mined into big blocks:			34%	
Total Blocks Mined during the test:			128	
% of blocks over 20MB:			11%	

Early on we realised very quickly that the BCH-SV network was still operating in a highly fractured state and that transactions were not being propagated in an efficient manner. We also encountered some issues with the Shotgun that led to our master node not detecting incoming transactions, leading to the shotgun running out of funds several times, requiring time intensive rescanning of the blockchain to recover funds each time.

Extended Test

After 24 hours we decided to continue the test beyond the original 24 hour timeframe, sending a further 5,152,218 transactions onto the network over the next 13 hours. We successfully generated more large blocks but still none over 32MB. Notable blocks included:

Table 3: Large blocks mined during extended test

Block Height	Miner Name	Block Size (Bytes)	Tx Count	Miner Reward
557216	SVPool	20,670,150	107232	12.707358
557215	SVPool	26,296,582	135439	12.763803
557196	coingeek.com	20,853,072	108,591	12.709165

557190	SVPool	31,999,162	166,123	12.821356
557187	coingeek.com	31,999,078	166,915	12.821139
557183	coingeek.com	28,715,423	148,845	12.789544
557166	SVPool	26,715,009	139,460	12.767927

After over 36 hours of continuous testing, we decided that the network was not going to be able to keep up with the tests we were performing so we decided to wait another day, and to use the time to perform some modifications to the shotgun to improve its reliability.

Test period 3: 19th of November, and the first blocks over 32MB

Starting from around 10am on the 19th of November, we began testing again, with an updated and improved Shotgun cluster. We added more nodes, changing the 42 unused Bitcoin ABC nodes over to Bitcoin SV, giving us a total of 84 nodes on the Bitcoin SV network.

Using this setup we were able to reliably send onto the network for over 18 hours without stop, generating and transmitting 15,463,369 transactions onto the network.

The analysis of the data that we have conducted shows that while transactions were being pushed onto the network at an average rate of almost 1 million per hour (sometimes hitting up to 2000 per second) the mining nodes were only able to capture and mine around 25% of them.

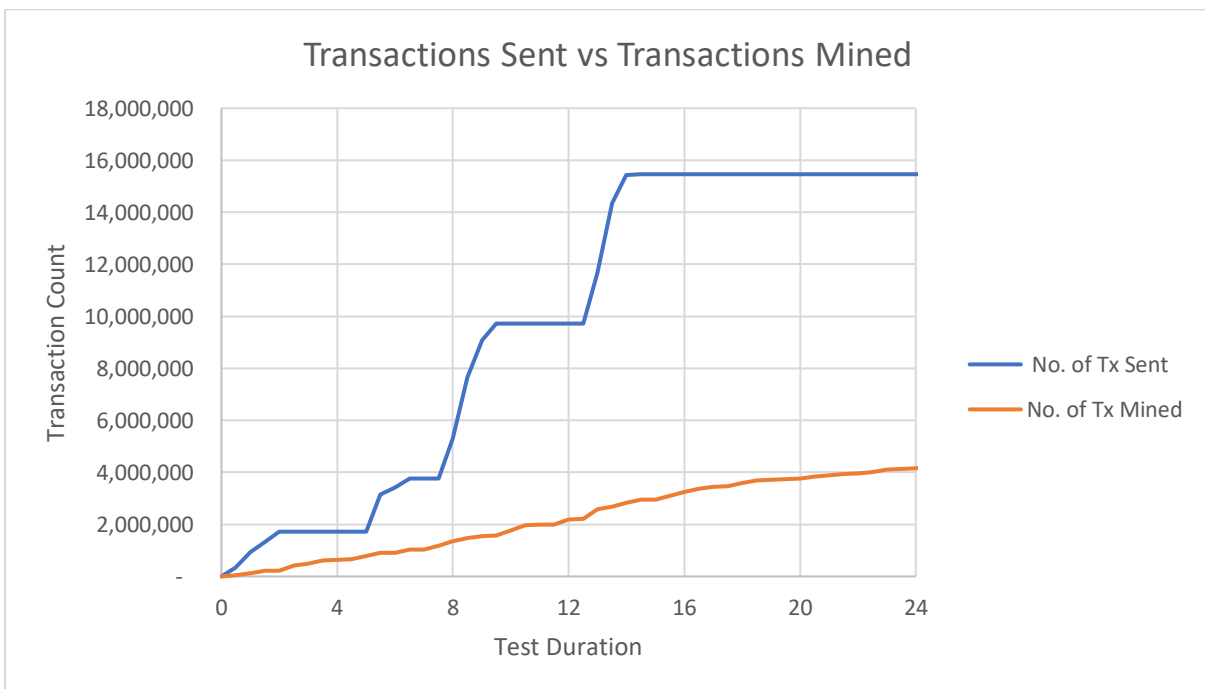


Figure 1: Transactions sent vs transactions mined

During this run, we saw a larger number of big blocks than in previous tests, but only 2 that were over the 32MB limit.

At 11:01PM, block 557,333 was mined by SVPool, which included 198,430 transactions and measured just over 38.0MB in size. This was the first ever block over 32MB and included 0.38526938BSV in fees.

Just 2 blocks later, at 11:54pm, block number 557,335 was mined by Coingeek, coming in at 63,999,195 bytes. This was the largest block ever mined on a public blockchain and included 334,074 transactions. This earned Coingeek 0.65140036 in fees and demonstrated the capacity of the network to break through the 32MB threshold.

We received reports that these two blocks caused the most issues, especially for non-mining nodes on the network, with some users reporting validation timeframes well over 1 hour for the 64MB block. This clearly highlights the need for a new software implementation that provides faster validation and better handling of large transaction volumes. This issue will only be further exacerbated as blocks grow to 512MB and beyond with the next Bitcoin SV upgrades planned for May and November 2019.

The breakdown is as follows:

Block Height	Miner Name	Block Size (Bytes)	Tx Count	Miner Reward
557348	SVPool	21,911,553	107,986	12.721526
557346	SVPool	20,563,808	93,921	12.707821
557343	SVPool	21,576,551	98,495	12.717313
557335	coingeek.com	63,999,195	334,074	13.1514
557333	SVPool	38,000,875	198,430	12.885269
557331	coingeek.com	20,347,898	98,967	12.705584
557330	SVPool	24,538,013	103,884	12.747005
557329	SVPool	31,999,026	158,547	12.821839
557322	coingeek.com	28,753,434	136,930	12.788253
557321	SVPool	31,059,511	158,658	12.812207
557320	SVPool	31,999,079	156,248	12.828504
557319	SVPool	22,153,991	108,791	12.722218
557318	SVPool	25,399,811	125,730	12.76854
557317	SVPool	21,418,627	109,891	12.716151
557311	SVPool	24,345,646	126,974	12.744396
557308	coingeek.com	21,856,629	113,983	12.719831

Conclusion

At the conclusion of the test, we had numerous Bitcoin SV application developers contact us thanking us for conducting the test and letting us know that we had shown them the limitations of their own systems, which they are now working hard to improve.

This tells us that the Stress Test has proven very valuable to the network and is a worthwhile and useful service. As a public demonstration these tests serve to show businesses and users where we are in terms of the network's evolution into the ledger for all.

The Satoshi Shotgun team thank all Bitcoiners for your support during this test and for the kind words and useful tips given by many in the community. We hope to conduct a new test each time the Bitcoin SV network is upgraded to demonstrate its capacity to scale in-line with the original Satoshi Vision and look forward to the excitement of generating bigger and bigger blocks.

The Satoshi Shotgun

