

# The OrionX Constellation Blockchain

## The Sixth CryptoSuper 500 List

CryptoSuper mining nears \$40 Billion annual value

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**Note:** This paper is an analysis of the technologies and trends surrounding blockchain and cryptocurrencies. It is not, and must not be considered as, financial, investment, or legal advice.

### Purpose of Cryptocurrencies

"Money has become information. Bitcoin is energy securely encapsulated as information. Electrons to eternal bits. Money in the Internet, and only in the Internet." – @moneyordeb

Cryptocurrencies are not just idle, speculative assets. They represent new monetary and financial technology, underpinnings of aspects of, or even a foundation for, a more efficient and honest financial system.

| Attribute of Money | Gold (Money 1.0)                | Fiat (Money 2.0)                             | Bitcoin (Money 3.0)                 |
|--------------------|---------------------------------|--|-------------------------------------|
| Durability         | Millennia                       | Computer and paper                           | Eternal in principle                |
| Portability        | Small amounts                   | Local, or international, a few days          | Global less than 1 hour, any amount |
| Divisibility       | Moderate                        | High   | 100 million Sats                    |
| Scarcity           | Increase 2% per year            | Varying rates of increase                    | Fixed maximum, 21 million BTC       |
| Fungibility        | Requires weighing, assay        | Fully within national borders, exchange fees | Fully                               |
| Private / Public   | Private / Government            | Government                                   | Private                             |
| Geography          | Local, National, Multi-national | National and Multi-national                  | Global                              |

*Table 1: The four necessary attributes of money were enumerated by Aristotle over two millennia ago. This table adds a fifth, fungibility, which means one coin or piece of paper of a certain denomination is as good as another. Bitcoin scores favorably on all attributes.*

Our current financial system is built on debt and fiat currencies, with many intermediaries, and is increasingly creaky. In the 21st century it still takes days to wire money internationally. In the US, it can still take days to move money from one account to another person's account, even within the same bank.

Inflation is returning as the world gradually (in some places, quickly) recovers from the COVID-19 pandemic and yet interest rates remain extremely low due to central bank policies. People are looking at alternatives other than the stock market to deal with concerns about rising inflation and the need for sufficient returns on their retirement funds.

Cryptocurrencies have reached \$1.6 trillion in aggregate market cap because they are addressing store of value as a new asset class, and medium of exchange (payments) gaps in our current system. With smart contract capability they are allowing greater automation of

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financial products and financial transfers; this goes by the name of DeFi (decentralized finance) within the Fintech realm.

### Only a Few Matter

There are some 10,000 cryptocurrencies in existence today. Only a few really matter. The market cap of all combined is some \$1.6 trillion, but 43% of that is in Bitcoin's roughly \$700 billion market cap and another 19% is in Ethereum's \$300 billion market cap. Numbers three to ten account for another 19%, such that only 19% remains for all of the 10,000 cryptocurrencies not in the top 10.

The distribution of market cap is thus steeper than a Zipf's law relation, which would have the rank order and market cap related as  $r \sim 1/M$ , where  $r$  is the rank (#1 highest) and  $M$  is the market cap of a particular cryptocurrency. In fact, a fit to the market caps for ranks 1, 2, 4, ..., up to 1024 and differing by powers of 2 suggests a steep power law index -1.59 (rather than -1) with an  $R^2$  for the power law fit of 0.994.

Furthermore, the vast majority of cryptocurrencies have been artificially created, with no real work done, other than promotion. This is true for any air drop, user incentive program, or consensus algorithm that does not involve proof-of-work (PoW) mining. The creators gladly accepted dollars or Bitcoin or Ethereum, of course. The exception is stable coins that have fiat reserves backing them.

That does not mean that some value cannot accrue from utility network effects, but the best assurance of value is through proof-of-work. Only some 700 or so of the 10,000 cryptos are mined via PoW. Only a very few of these account for the vast bulk of mining revenue.

### Only Three Cryptocurrencies Produce Most of the Value Presently

Our CryptoSuper lists are created twice per year; the first list was in November 2018. The information for this sixth edition of the CryptoSuper 500 list was collated during the last few days of May 2021.

This is a semiannual accounting of crypto supercomputer mining pools, and utility coins and stable coins are not relevant. Proof-of-work mining is a special form of high performance computing wherein mining rigs compete to solve a cryptographic problem, thereby winning the block subsidy and any associated transaction fees for a given block. In most cases, the pools attract hash power contributed by individuals across the globe. We list the host country when known, but they may have proprietary operations in several countries.

Miners compete to deploy as much hash rate (PoW) mining power for the lowest operating costs possible, those costs are dominated by electricity and the crypto mining computer capital cost. Miner profitability is very high currently. The Bitcoin price has increased from \$13,000 at the end of October 2020 when the last list was collated to \$37,000 currently. Ethereum's ETH has increased from under \$400 to \$2500 as of May 29, 2021 when we took the snapshot for this sixth CryptoSuper list.

We looked at the top nine mined coins and narrowed those down first to the top six based on daily production value. Then we looked at mining pools and placed a cutoff at \$100 million minimum production per year per pool, including transaction fees and block subsidy rewards of new coins. That left us with only the top three coins on the list, Ethereum (ETH), Bitcoin (BTC), and Dogecoin. The next three coins that are not tabulated are Litecoin, Bitcoin Cash, and Zcash respectively.

| Coin               | Algorithm | Block time | Block subsidy | Price \$ | Hash rate | units |
|--------------------|-----------|------------|---------------|----------|-----------|-------|
| ETH                | EtHash    | 13 sec.    | 2             | 2,537    | 563       | Tera  |
| Bitcoin (BTC)      | SHA256    | 10 min.    | 6.25          | 36,723   | 143.5     | Exa   |
| Dogecoin           | Scrypt    | 1 min.     | 10000         | 0.313    | 349       | Tera  |
| LTC                | Scrypt    | 2.5 min.   | 12.5          | 184      | 412       | Tera  |
| Bitcoin Cash (BCH) | SHA256    | 10 min.    | 6.25          | 705      | 3.08      | Exa   |
| Zcash (ZEC)        | Equihash  | 1.25 min.  | 3.125         | 178      | 6.93      | Giga  |

Table 2: Top 6 Mined Coins (5/29/21 snapshot)

In Table 2, the first column has the coin name and the second one the algorithm for the cryptographic puzzle. The third column has the block time and the fourth the block subsidy in coins/block. Among the six coins only ETH and BTC gather significant additional transaction fees, which are currently 0.99 and 0.77 on average in coins / block. The fifth column shows the recent price and the last two columns the hash rate per second for the network, which can vary all the way from the Gigahash range through Terahash, Petahash, and Exahash. Only Bitcoin and Bitcoin Cash reach into Exahashes/sec territory. These top 6 mined coins have an annual run rate of \$39 billion economic value, respectively, whereas the top 3 alone have a run rate of \$38 billion. Thus almost all the produced value is in Ethereum’s ETH coin, Bitcoin, and Dogecoin. Data was captured 5/29/21.

We end up with 45 mining pools in our lists. Both Ethereum (20 large pools) and Bitcoin (17 pools) are being mined at a rate of about \$50 million economic value per day, and Dogecoin (8 pools) is approaching \$5 million per day.

Comparing to our last list (Fifth cryptosuper list of November 2020) ETH has moved to first place in mining revenue with a small lead over Bitcoin, and Dogecoin has quickly moved into third place due to greater interest, largely fueled by Elon Musk, who acts as if he is trying to control it. Dogecoin has passed Bitcoin Cash and Bitcoin SV as well as Litecoin and Zcash in the past half year.

Ethereum has benefited greatly from the growth in DeFi, as well as the recent surge in NFTs. NFTs are primarily artworks or collectibles stored on blockchains, although they could be any sort of document with limited or unique ownership as well.

While Dogecoin started as a joke and has a huge supply, it does have a slowly disinflationary monetary policy. The biggest concern may be that Musk is looking to tamper with its development for even faster transactions and thus it could be pushed further away from any store of value attribution. And even at present, its supply is four orders of magnitude higher than Bitcoin, and its hash rate is six orders of magnitude lower.

### Ethereum is Giving up on Mining

The Ethereum network faces a similar issue. It has used a PoW coin (called ETH) from the beginning, with a tightening of rewards, initially from 5 to 3, then later from 3 to 2, coins per block. Unlike the baked-in Halvings with Bitcoin this was done by community consensus in a somewhat arbitrary fashion. Now Ethereum is in the midst of a multi-stage upgrade to Ethereum 2.0 with consensus moving to proof-of-stake (PoS) rather than proof-of-work. It will also implement the sharding of workload across multiple blockchains.

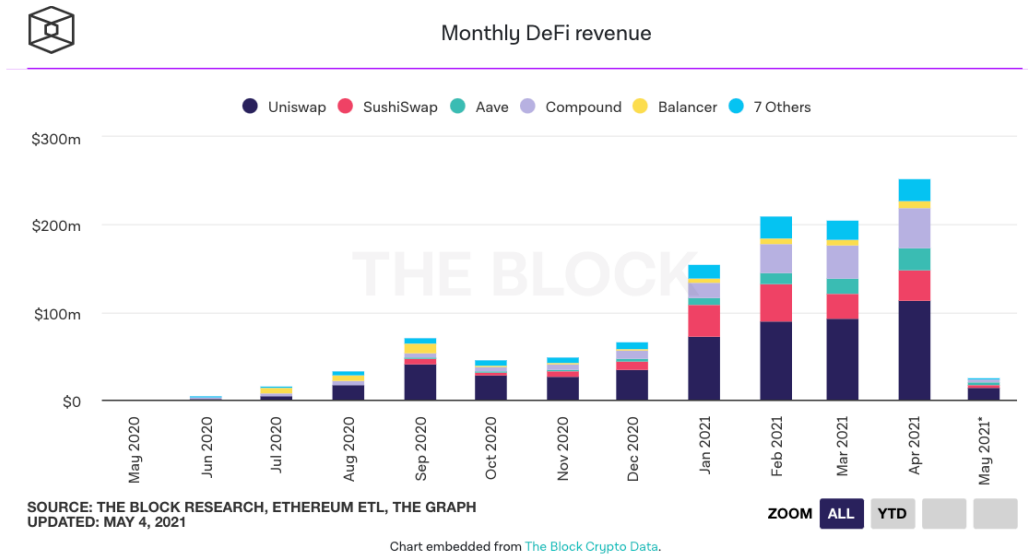


Figure 1: Growth in DeFi revenue. Most DeFi is about crypto lending and staking for yield.

Over five million ETH have already been staked to support the PoS protocol. The 2.0 upgrade roadmap also implements a burn policy with EIP 1559 for the majority of miner reward fees, which will tighten supply but cut miner fee earnings.

The larger problem for miners will come when the PoW reward is dropped entirely and then miners will only earn transaction rewards. Although these are relatively high, they still amount to only 1/3 of the total current block reward. The miners can move to become validators, or abandon ETH mining for other coins.

With a full shift to Ethereum 2.0 blocks will be validated by a 2/3 majority vote of ETH staked by validators. The minimum stake is a rather expensive 32 ETH, but staking pools are being formed to allow for smaller contributors, and are currently advertising yields around 6% per annum.

The move away from PoW by Ethereum is going to have a serious impact on the mining community over the next year or two as Ethereum implements this multiphase plan. While in principle half or more of miners' revenue could evaporate, they will seek to mine more Bitcoin, Dogecoin, Bitcoin Cash, Litecoin and other cryptocurrencies to make up for the loss of ETH as a target reward.

ETH mining is now done primarily with ASICs implementing Ethash and while there are other coins using that algorithm, they are much less rewarding, so much hardware could be obsolete. There is an ETC classic fork which will probably benefit. But ETH miners have known for a long time that this is coming and presumably they are prepared.

### Is Bitcoin Dirty?

Now the reason Ethereum is moving to PoS is they want to use less energy for validating transactions on their blockchain, for creating new ETH tokens, and for executing smart contracts.

And recently Bitcoin has come under renewed attack for using 0.4% of the world's electricity. This attack is highly overwrought unless you believe Bitcoin has no economic value at all. The history, with over 12 years since its inception and remaining in first place during that entire period, indicates otherwise.

But Bitcoin not only underpins the entire cryptocurrency ecosystem as the final settlement asset, it is the world's most efficient way to move large amounts of money. On May 28, 2021 a transaction for \$630 million was committed on the blockchain. The fee was \$5. Confirmation happens within an hour. This is breakthrough monetary technology, both with Bitcoin and for cryptocurrencies more generally.

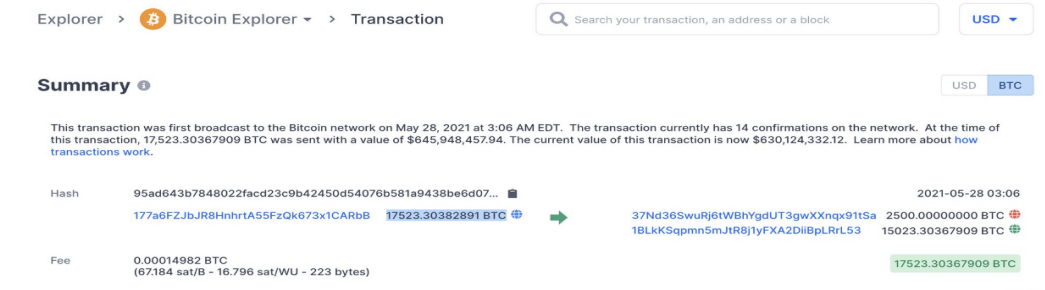


Figure 2: A transaction of over \$600 million on the Bitcoin blockchain was executed for \$5 in fees.

Value has been created with each Bitcoin, and the rapid rise in Bitcoin price over the past decade demonstrates that this is the case. New Bitcoins minted just last year are already worth much more today. Bitcoin, although highly volatile, has proven to be a store of value, par excellence.

Becoming such a store of value is a result of proof-of-work due to the high security it enables and the real input costs that effectively place a floor under prices.

In fact, Bitcoin electrons, that create long-lasting value while confirming transactions on the blockchain as well, are cleaner than, say, Tesla charging electrons, which are used only for immediate consumption. Tesla electrons reflect the grid average, in US and China, in particular.

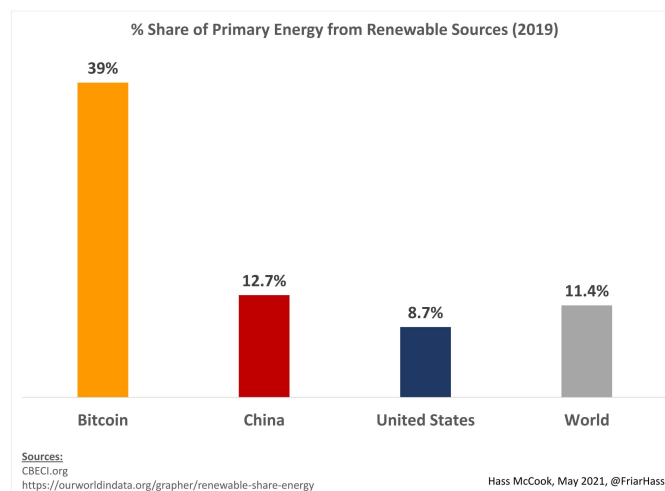


Figure 3: Share of primary energy from renewable sources (as of 2019)

You can read more about this issue here: <https://endthefud.org>. A Bitcoin Mining Council has just been formed in North America to help push the efficient renewable frontier of mining. Models suggest that Bitcoin can supplement batteries as load balancer components in solar farms, allowing for higher ROI and better scaling for large installations.

Figure 3 data is from the Cambridge Centre for Alternative Finance, the most authoritative source for Bitcoin electricity consumption. Bitcoin mining uses large amounts of hydropower and other renewables. This estimate has it at 39% renewables based, over three times higher than the world average. The Bitcoin mining industry is even capturing natural gas in the field that would otherwise be flared into the atmosphere. Methane is 25 times worse than CO<sub>2</sub> in its greenhouse effect.

### Bitcoin Electricity Encodes Value

Most electricity is used for residential consumption purposes, anything from cooking and air-conditioning, to operating computers, to charging Tesla batteries. Electricity that goes to factories and businesses as an input to production of goods or services and does not overall “go to waste” if it is part of an efficient business model.

Bitcoin uses electricity as part of a production process that creates value. The market today says a Bitcoin is worth around \$37,000. Bitcoins that were produced five years ago are now worth \$37,000. New Bitcoins mined today are worth \$37,000. But Bitcoins that were produced five years ago were at that time worth just \$529. They are 70 times as valuable as when originally mined.

Bitcoin mining is a value-producing industry, and the value produced far exceeds the electricity input, especially as Bitcoin trends higher longer term. Bitcoin gets a bum rap on electricity usage relative to that used residentially for consumption or by the compute-intensive finance industry, that moves money in large volumes, for a price, but does not generally produce anything of value.

Our first CryptoSuper list came out in November 2018. At that time the aggregate hash rate on the network was 41.5 million Terahash/s and the fastest mining rig available, the Antminer S11, was rated at 20.5 Terahash/s and required 1530 Watts of electrical power.

The block reward subsidy at that time was 12.5 BTC every 10 minutes, or 1800 per day.

Thus, a mining farm with 1000 S11s and an aggregate of 20,500 Terahash/s would be expected to on average yield 0.889 Bitcoin per day. That is, it would take on average just over two weeks for it to win one block reward of 12.5 Bitcoin given its power relative to the whole network of competitive miners.

The daily average value would have been worth  $0.89 \times \$6341$  or \$5643, the equivalent of \$5.64 per day per mining rig. The daily electricity consumption would have been \$1836 for 1000 mining rigs with access to power at 5 cents per kWh.

The operating profit after paying the electric bill was about \$3807. Capital costs for the rigs were probably similar to the electricity bill if spread over two to three years (operating S11s can still be profitable at today's high prices), so miner profit might have been around \$2000 per day for the 1000 mining rigs.

If they held on to their margin in Bitcoin their profit was even higher. That \$2000 per day in November 2018, if held in Bitcoin would have risen to over \$11,000 per day or \$11 per rig per day.

If they were smart they financed their mining rigs at low interest rates and paid off the loan after about two years and kept the remainder in Bitcoin. Then they would be in a much better position to upgrade their systems and increase their number of mining rigs.

But whether it was the miners or someone else they sold their Bitcoin to, the value grew substantially.

That \$11,000 per day realized profit from mining from a 1000 node farm is real value. That ROI can also enable miners to relocate to lower costs of energy input, now that renewables are becoming less expensive than traditional sources of electricity as documented here: <https://ourworldindata.org/cheap-renewables-growth>. Miners reflexively seek out the lowest cost energy and that is more and more realized from sources like hydropower, solar photovoltaic, flared natural gas, and wind power.

Cryptocurrency mining is a natural load balancer (and effectively a battery) for off-peak hours of electricity supply.

### Great Chinese Mining Shutdown

We had to revise this section on June 21st. During late May and early June information came out that China was planning to ban cryptocurrency mining. It wasn't the first time it had been rumored, but this time they are serious. Regulations were issued in Inner Mongolia, and there were reports from Xinjiang. It all came to a head at midnight on June 19, when authorities in Sichuan, one of the key provinces for mining, forced shutdown of a number of pools.

As mining hashrate was extinguished rapidly, the Bitcoin blockchain hiccupped, with the block time increasing to 70 minutes for the block that spanned midnight. But it quickly reverted to form with block times back around 10 minutes soon after.

Bitcoin's difficulty changes every two weeks, and is a measure of average global hashrate during the prior interval. It is just a number, in the trillions, fed into the cryptographic puzzle, and adjusts up or down with hashrate in order to keep block times close to 10 minutes. It was 25 trillion in mid-May and had dropped to 20 trillion by mid-June. As of June 20 it was projected to drop another 10% at the next adjustment near the end of the month.

The hashrate at the mid-May peak was about 180 Exahashes/sec and is about 110 Exahashes/sec post-shutdown. Ten hours after the Great Mining Shutdown the hashrate distribution of the top miners looked like this (explorer.BTC.com). Four pools had dropped by 25% or more in their hashrate: Antpool, Binance Pool, Huobi Pool, and BTCtop. Most of the rest had single digit percentage drops, and the pool FoundryUSA increased hashrate slightly.

What happens is that miners who drop less than the average will reap greater block rewards and transaction fees going forward. It should be remembered that a pool typically consists of one or several mining farms owned by the operator together with hashrate contributed by many separate individuals or small miners. The pool shares rewards in proportion to contributed hashrate. To the extent these small miners are outside of China or too small to be noticed, they will continue to generate hashrate.

The net effect of all of this is it is good for Bitcoin and good for the growing Bitcoin mining industries in North America and Central Asia. There were concerns that the top four mining pools had over 51% of the hashrate. Bitcoin hashrate now becomes more decentralized requiring five or six pools at present to account for just over half of the total hashrate. This is one more event that illustrates the anti-fragile nature of Bitcoin.

Why would China ban mining? Four reasons: (1) to limit capital flight, (2) to control electricity usage, (3) to better impose regulation and taxes (after restarting) and (4) to promote instead their digital currency, the DC/EP, that they are in the process of introducing. This is a fiat stable coin tied to the Yuan (renminbi). One Chinese economics professor was recently interviewed on a business television show stating (in English) that if Bitcoin becomes a global currency "We will all die!". Literally, he said this. One imagines he was reflecting the 'party line'.



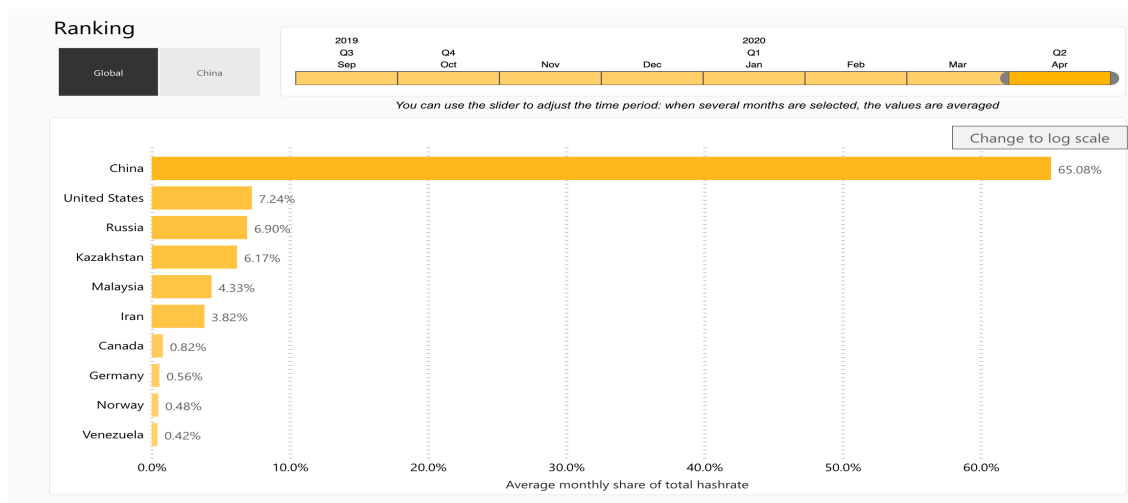


Figure 4: Chart of global distribution of Bitcoin mining from [https://cbeci.org/mining\\_map](https://cbeci.org/mining_map). The top 3 are China, the US, and Russia with 65%, 7% and 7% respectively. However this is only a sample of three large mining pools corresponding to about 37% of the Bitcoin hash rate, so is an imprecise estimate.

Data from the Cambridge Centre for Alternative Finance indicates that China's share has already been declining significantly, falling from 75% at the time of the last crypto super list to 65% in April of this year.

However, traffic on Twitter talks about hundreds of Megawatts of mining capacity (translating to hundreds of thousands of computers) looking for new homes, either through partnership or sale of the mining rigs. Likely locations appear to be North America and central Asian countries including Kazakhstan and Russia. Kazakhstan legalized crypto mining in mid-2020 and the responsible government minister was recently quoted saying that they are considering a modest tax of 1/4 cent per kWh on electricity usage by miners. This seems much more sensible.



Figure 5: A Kazakhstan crypto mining 'farm'.

Iran is also banning crypto mining until late September at the earliest due to electric grid constraints. The country has had a 4% share of crypto mining due to very low electricity prices.

In North America substantial capital is being invested in growing the cryptocurrency mining base, especially in locations with access to renewables or stranded natural gas. Bans in China and elsewhere will benefit economies in other producing countries around the globe.



### Billion Dollar Pools

Many pools mine multiple coins. For example, the #1 pool globally, F2pool, mines Bitcoin, ETH, and Dogecoin. In Table 3 we show the top 10 pools, that each have over \$1 billion in annual production. These 10 pools are responsible for over 60% of annual economic value of the industry.

There are three pools mining only Ethereum’s ETH., whereas the rest of the pools are mining at least two coins of the three. F2pool is the largest, at over \$5 billion, and ETH only pools Sparkpool and Ethermine are both near \$4 billion in size.

*Pool Summary, for ten multi-coin pools of over \$1 Billion annual*

| Pool          | Country   | BTC           | ETH           | DOGE       | Total \$M     |
|---------------|-----------|---------------|---------------|------------|---------------|
| f2pool        | Global    | 2,493         | 2,373         | 268        | 5,134         |
| sparkpool     | China     | 0             | 3,981         | 0          | 3,981         |
| ethermine     | Global    | 0             | 3904          | 0          | 3,904         |
| poolin        | Global    | 1,951         | 287           | 194        | 2,432         |
| ant pool      | China     | 1,897         | 268           | 126        | 2,291         |
| viabtc        | Hong Kong | 1,409         | 0             | 202        | 1,611         |
| huobipool     | China     | 461           | 1014          | 0          | 1,475         |
| btcdotcom     | Global    | 1,450         | 153           | 117        | 1,720         |
| binance       | US        | 1,206         | 306           | 0          | 1,512         |
| hiveon        | Global    | 0             | 1110          | 0          | 1,110         |
|               |           |               |               |            |               |
| <b>Top 10</b> |           | <b>10,867</b> | <b>13,396</b> | <b>907</b> | <b>25,170</b> |

*Table 3. Top 10 mining pools, showing their production for each of the top three coins. These 10 pools alone are responsible for \$25 billion of the \$38 billion mining production of the top three coins.*

### Summary

We present details of the top 45 pools for Ethereum, Bitcoin, and Dogecoin in the Appendix. Cryptocurrency mining is a specialized domain of decentralized high performance computing. This dynamic, highly competitive, and rapidly growing industry has reached around \$40 billion in annual economic value. Trends to watch include advances in ASIC-based and GPU-based mining rigs, the end of Ethereum mining, the trend of increasing electricity usage offset by increases in the green fraction of mining, and bans in certain countries that cause hash rate to move elsewhere.

### Acknowledgement

I thank Emeritus Professor Prem Jain for comments on the manuscript.

Appendix: Largest Ethereum, Bitcoin, Dogecoin Pools

*Largest Ethereum Pools*

| Rank  | Pool Name     | Percent, last 1000 blocks | Daily \$M | Monthly M\$ | Annualized M\$ | Host Country |
|-------|---------------|---------------------------|-----------|-------------|----------------|--------------|
| 1     | ethermine     | 20.8%                     | 10.91     | 327.17      | 3,981          | global       |
| 2     | sparkpool     | 20.4%                     | 10.70     | 320.88      | 3,904          | China        |
| 3     | f2pool        | 12.4%                     | 6.50      | 195.05      | 2,373          | global       |
| 4     | bee pool      | 5.8%                      | 3.04      | 91.23       | 1,110          | China        |
| 5     | hiveon        | 5.3%                      | 2.78      | 83.37       | 1,014          | global       |
| 6     | huobipool     | 4.1%                      | 2.15      | 64.49       | 785            | China        |
| 7     | nanopool      | 3.8%                      | 1.99      | 59.77       | 727            | global       |
| 8     | spider pool   | 3.8%                      | 1.99      | 59.77       | 727            | China        |
| 9     | babel pool    | 3.3%                      | 1.73      | 51.91       | 632            | US           |
| 10    | 2miners       | 2.7%                      | 1.42      | 42.47       | 517            | global       |
| 11    | miningpoolhub | 2.2%                      | 1.15      | 34.61       | 421            | global       |
| 12    | uupool        | 2.2%                      | 1.15      | 34.61       | 421            | China        |
| 13    | ezil          | 1.6%                      | 0.84      | 25.17       | 306            | Macedonia    |
| 14    | binance       | 1.5%                      | 0.79      | 23.59       | 287            | US           |
| 15    | poolin        | 1.4%                      | 0.73      | 22.02       | 268            | global       |
| 16    | xnpool        | 1.2%                      | 0.63      | 18.88       | 230            | China        |
| 17    | flexpool      | 0.9%                      | 0.47      | 14.16       | 172            | global       |
| 18    | "0xf541c3     | 0.8%                      | 0.42      | 12.58       | 153            | na           |
| 19    | minerall      | 0.7%                      | 0.37      | 11.01       | 134            | Germany      |
| 20    | pandaminer    | 0.6%                      | 0.31      | 9.44        | 115            | China        |
| Total | of network    | 88.4%                     | 41.79     | 1253.65     | 18,276         |              |

Table 4. The top ETH mining pools based on recent winning block distribution. We show the estimated daily, monthly, and annualized revenue and the host country. The cutoff is a minimum \$100 million of annual revenue. There are 5 pools producing over \$1 billion per year each.

Largest Bitcoin Pools

| Rank  | Pool Name      | Percent, last 1000 blocks | Daily \$M | Monthly M\$ | Annualized M\$ | Host Country |
|-------|----------------|---------------------------|-----------|-------------|----------------|--------------|
| 1     | f2pool         | 18.4%                     | 6.83      | 204.92      | 2,493          | global       |
| 2     | antpool        | 14.4%                     | 5.35      | 160.37      | 1,951          | China        |
| 3     | poolin         | 14%                       | 5.20      | 155.91      | 1,897          | global       |
| 4     | viabtc         | 10.7%                     | 3.97      | 119.16      | 1,450          | Hong Kong    |
| 5     | btcdotcom      | 10.4%                     | 3.86      | 115.82      | 1,409          | global       |
| 6     | binance        | 8.9%                      | 3.30      | 99.12       | 1,206          | US           |
| 7     | foundrydigital | 3.8%                      | 1.41      | 42.32       | 515            | US           |
| 8     | huobipool      | 3.4%                      | 1.26      | 37.86       | 461            | China        |
| 9     | slushpool      | 3.2%                      | 1.19      | 35.64       | 434            | US           |
| 10    | 1thash         | 2.4%                      | 0.89      | 26.73       | 325            | China        |
| 11    | btcdotop       | 2.2%                      | 0.82      | 24.50       | 298            | China        |
| 12    | okex           | 1.1%                      | 0.41      | 12.25       | 149            | Hong Kong    |
| 13    | 1NzDBx         | 1%                        | 0.37      | 11.14       | 135            | na           |
| 14    | 35y82t         | 0.9%                      | 0.33      | 10.02       | 122            | na           |
| 15    | 1EKFdx         | 0.9%                      | 0.33      | 10.02       | 122            | na           |
| 16    | emcd           | 0.9%                      | 0.33      | 10.02       | 122            | global       |
| 17    | sbicrypto      | 0.8%                      | 0.30      | 8.91        | 108            | Japan        |
|       |                |                           |           |             |                |              |
| Total | of network     | 94.8%                     | 35.19     | 1055.77     | 12,845         |              |

Table 5. The top Bitcoin mining pools, above \$100 million per annum, based on recent winning block distribution. We show the estimated daily, monthly, and annualized revenue and the host country. The data snapshot, for these three tables for ETH, BTC, and Dogecoin mining, was taken on 5/29/21. We used `miningpoolstats.stream` data for the percentage of hash rate per pool. They tabulate which pools won block subsidy rewards for the last 1000 blocks.

*Largest Dogecoin Pools*

| Rank         | Pool Name         | Percent, last 1000 blocks | Daily \$M   | Monthly M\$   | Annualized M\$ | Host Country |
|--------------|-------------------|---------------------------|-------------|---------------|----------------|--------------|
| 1            | f2pool            | 16.7%                     | 0.76        | 22.71         | 276            | Global       |
| 2            | easytomine        | 16.2%                     | 0.73        | 22.03         | 268            | China        |
| 3            | litecoinpool      | 13.6%                     | 0.62        | 18.49         | 225            | Global       |
| 4            | viabtc            | 12.2%                     | 0.55        | 16.59         | 202            | Hong Kong    |
| 5            | poolin            | 11.7%                     | 0.53        | 15.91         | 194            | Global       |
| 6            | lrcbtctop         | 8.8%                      | 0.40        | 11.97         | 146            | Global       |
| 7            | antpool           | 7.6%                      | 0.34        | 10.33         | 126            | china        |
| 8            | btcdotcom         | 7.1%                      | 0.32        | 9.66          | 117            | global       |
|              |                   |                           |             |               |                |              |
| <b>Total</b> | <b>of network</b> | <b>93.9%</b>              | <b>4.26</b> | <b>127.69</b> | <b>1,554</b>   |              |

*Table 6. The top Dogecoin mining pools based on recent winning block distribution. We show the estimated daily, monthly, and annualized revenue and the host country.*

The three largest ETH pools are Sparkpool, Ethermine, and F2pool. The first two are ETH only, whereas F2pool also mines Bitcoin. Seven of the top 20 pools producing over \$100 M revenue per annum are in China, two in the US and two in Europe. Eight are global, but may have substantial hashing power in China as part of that. The top pools are responsible for \$18.3 billions of annual economic value, and represent 88% of the entire hash rate on the network.

There are 17 Bitcoin pools larger than \$100 M annual revenue, shown in Table 5. The largest are F2pool, Poolin, and Antpool. Of these six are in China including Hong Kong, and three are in the US. The global pools also likely include much Chinese mining as a portion of their total hash rate. For example, F2pool is the largest, originated in China, but calls itself global. The top 17 Bitcoin pools represent 95% of the network and are responsible for \$12.8 billions of annual economic value. There are 6 pools producing over \$1 billion per year.

There are eight large Dogecoin pools listed in Table 6, of which F2pool, Easy2mine, and Litecoinpool are the largest. One of the interesting things about Dogecoin is it can be mined simultaneously with other coins. The top 8 pools produce \$1.55 billions of annual economic value.

## Glossary

**Bitcoin** – The original cryptocurrency, blockchain and consensus algorithm was outlined in October 2008 in the Satoshi white paper. The Bitcoin blockchain began in January 2009. Bitcoin uses proof of work and has a disinflationary monetary policy based on Halvings.

**Blockchain** – A chain of transaction blocks with each block linked to the one prior and the one after by a hashing technique. Each block incorporates a hashed representation of the prior block along with its own transaction records. A specific type of database with timestamped and linked record blocks.

**Block reward** – The reward for being the winning miner of a block. It consists of a subsidy and any transaction fees collected by miners.

**BTC** – Abbreviation for the bitcoin cryptocurrency.

**Cryptocurrency** – A currency stored in a digital ledger that implements cryptographic security to prevent theft or counterfeiting. Cryptocurrencies may be created with different mechanisms and the ledgers are often decentralized to varying degrees.

**DeFi** –Decentralized Finance. DeFi implements automated financial methods by use of cryptocurrencies and blockchains.

**Dogecoin** – A cryptocurrency created from Litecoin, itself a clone of Bitcoin, in 2013, as a joke. It has a mildly disinflationary monetary policy.

**ETH** – the native cryptocurrency of the Ethereum network.

**Ethereum** – The second largest cryptocurrency by market value was created in 2015 by Vitalik Buterin, Joe Lubin and others. It was designed to implement smart contracts such as those used in DeFi. It presently mines ETH, its native cryptocurrency via proof of work, but will shift to proof of stake as Ethereum 2.0 rolls out.

**Halving** – The algorithmically enforced decrease in the block reward subsidy for Bitcoin miners. Originally this was 50 BTC for the winning block. Halvings occur roughly four years apart after each 210,000 block interval. The last halving dropped the subsidy from 12.5 to 6.25 bitcoins per block.

**Hash rate** – The rate at which a computer system (mining rig) can generate hash guesses to solve the cryptographic puzzle. A Terahash/s is a trillion hashes per second, a Petahash/s is a quadrillion, and an Exahash/s is a quintillion ( $10^{18}$ ) hashes per second.

**Miners** – The computer systems that solve the cryptographic puzzle for a proof of work cryptocurrency. Miners are characterized by hash rate, the amount of solution power. Custom ASICs or GPUs are employed, typically. The first computer that solves the puzzle commits the block of transactions and receives the block reward.

**Money** – A medium of exchange, store of value, and unit of account. Bitcoin and Ethereum represent monetary technology; they have not achieved full 'moneyness' but are on the path as their utility grows.

**Pools** – Pools consist of mining farms plus smaller miners that voluntarily contribute their hash power in order to gain a portion of the mining rewards. Pools are run by companies for profit.

**Sharding** – Sharding is a database technique of dividing the database into multiple sections for faster parallel access. Ethereum 2.0 is implementing 32 shards.

**Smart contract** – An automated contract for exchange of value implementing agreed upon rules between the parties for transfers.

**Zipf's law** – A relationship that says the rank order and value of some quantity (e.g. size of lakes) are inversely correlated to the first power.

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