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Internet - Cryptoassets

US Equity Research
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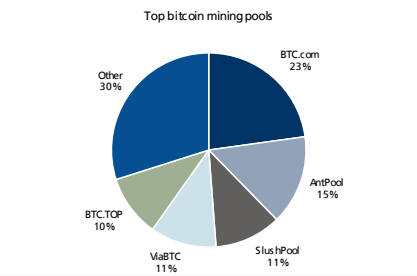

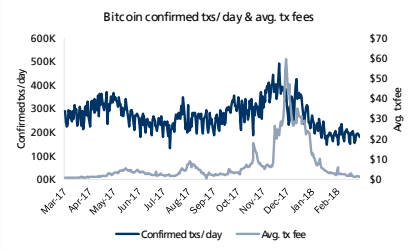

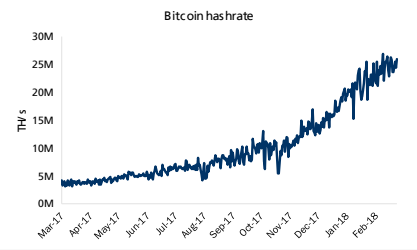

Industry Update

Digital 49'ers: A look into the state of cryptoasset mining

Summary: Just as the 1849 era saw waves of entrepreneurs and profit-seekers heading west in their covered wagons to pan the streams for gold, cryptoasset miners represent the vanguard of the digital asset movement. These pioneers are committing large amounts of capital and taking significant risk in pursuit of profits which also serve to facilitate the growth and security of blockchain networks, with bitcoin being by far the most-developed and best-known example. In this report we take a deeper look at the cryptoasset mining landscape, including:

Bitcoin mining fundamentals – We highlight several core concepts with regards to bitcoin mining:

- **Blockchain, proof-of-work and mining –** A blockchain is a series of blocks of cryptographically signed data that forms an immutable data of records. Bitcoin utilizes the proof-of-work (PoW) consensus algorithm, in which miners devote computational resources to verify a block of transactions.
- **Supply schedule, block rewards and transaction fees –** Bitcoin follows a fixed schedule in which a total of 21M BTC will be mined. Miners are currently rewarded with 12.5 BTC per block as well as transaction fees for the computational resources they provide to bitcoin's blockchain.
- **Hash rate & difficulty –** The notable increase in the number of miners has led to an increase in bitcoin's hash rate. Given that bitcoin's blockchain self-adjusts so that the average block confirmation time remains at 10 minutes/block, its difficulty has also continued to increase.

Five important considerations for miners today – From the perspective of a miner, we have identified several key considerations to keep in mind:

- **Which coins to mine? –** Bitcoin is by far the most heavily-mined cryptoasset, but there are a handful of other altcoins that can similarly be mined.
- **Settling on a hardware roadmap –** Led by the Chinese mining giant Bitmain, multiple chip manufacturers have developed ASICs at various prices, hash rates and efficiencies.
- **Navigating Ethereum's switch to proof-of-stake –** Ethereum currently represents a significant portion of mining power, but later in 2018 the need for this capacity may go away as it transitions from proof-of-work to proof-of-stake.
- **Managing implications surrounding power consumption** – Bitcoin would be the 45th-largest "country" as measured by its mining electricity consumption, representing a potential threat to its long-term sustainability.
- **Preparing for a future of compressed margins & moth-balled capacity** – As margins compress for mining companies, we may see a diversification into other business lines such as cryptoasset exchanges or ICO advisory services.

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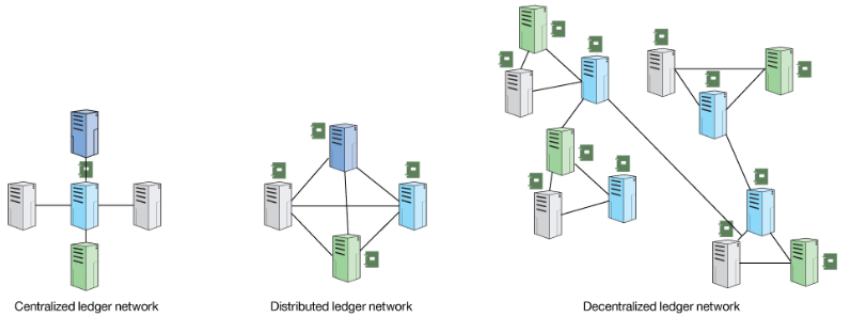
Bitcoin mining fundamentals

Overview of blockchain, proof-of-work and miners

Mining refers to a process that accomplishes two primary purposes: 1) creates an incentive to validate transactions on a network, thereby powering the underlying blockchain, and 2) creates a mechanism for distributing coins to a user population. There have been over 1,500 cryptoassets created to-date. The vast majority of these are not "mineable" but are instead distributed in various ways. There are, however, a handful of mineable coins, including bitcoin, ether and Litecoin, among others. The most well-known is bitcoin, and its mining process has created a very large profit pool that is being pursued by many players. Bitcoin mining provides a foundation for understanding the mining of other coins as well, so we therefore focus first on the fundamentals of mining the bitcoin blockchain.

A **blockchain** is a series of blocks of cryptographically signed data that forms an immutable and perpetual database of records. A blockchain can also be described as a distributed ledger, as trust is decentralized and therefore requires verification authority across multiple locations, or nodes, to confirm every transaction on the network. Furthermore, nodes serve a distinct purpose in making independent processing decisions without consulting with other nodes, which helps to maintain the integrity and accuracy of a blockchain.

Figure 1: Centralized vs. distributed vs. decentralized ledgers



Source: IBM

While a given blockchain can employ a variety of consensus mechanisms in order to verify the transactions on its network, **proof-of-work (PoW)** is the most well-recognized mechanism in the context of mining for bitcoin and other cryptoassets. In a proof-of-work system, **miners** dedicate computational resources to a blockchain network, with the purpose of solving a "puzzle" that verifies a set of transactions that make up a block. As a reward for verifying a given block of transactions, miners receive block rewards from the network. Miners can also earn transaction fees in exchange for verifying transactions and writing them into the blockchain.

Figure 2: Bitcoin nodes distribution

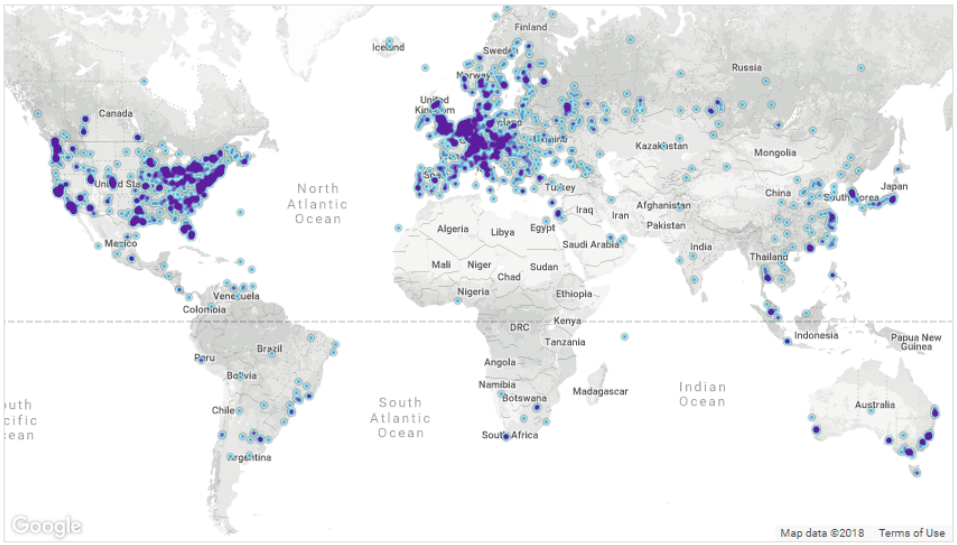
Rank	Country	Nodes	%
1	United States	2,720	22.5%
2	China	2,003	16.6%
3	Germany	1,928	16.0%
4	France	706	5.9%
5	Netherlands	512	4.2%

Source: Earn.com, Canaccord

Miners vs. nodes

There are multiple variables to consider with regards to the critical process that drives bitcoin's blockchain. First and foremost, it is important to note that miners represent a subset of **nodes**, a powerful computer in bitcoin's network that maintains a complete copy of the blockchain. As of 3/24/18, there were 12,077 nodes in the bitcoin network, distributed globally as can be seen in Figures 2 and 3:

Figure 3: Bitcoin nodes distribution

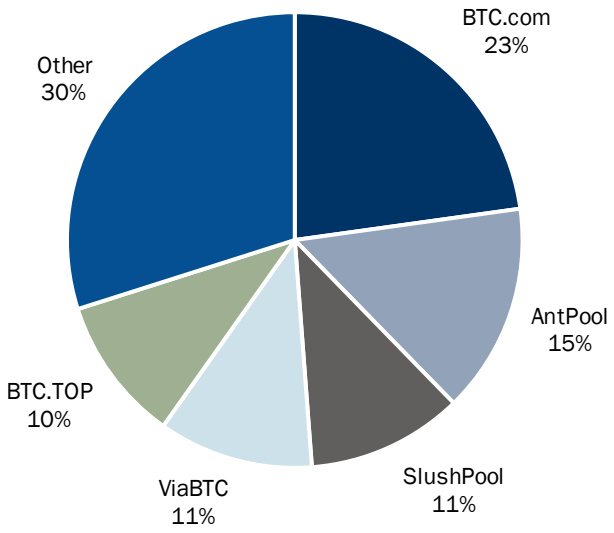


Source: Earn.com

Mining pools

While there exists a very large number of miners globally, they typically will participate in one of the top mining pools that dominate bitcoin's hashrate. **Mining pools** refer to groups of individual miners that aggregate their processing power to collectively earn bitcoin's next block, as opposed to attempting the same thing independently. This "smooths out" the stream of block rewards because the mining pool with a large amount of processing power has a much higher chance of earning the next block reward than does any small independent miner. When a mining pool earns a block reward, it is split in proportion to the amount of hashpower each individual contributed to the solving of the block. Currently, the top five mining pools control 70% of bitcoin's entire hashrate distribution, as can be seen in Figure 4:

Figure 4: Top bitcoin mining pools (as of 3/24/18)



Source: Blockchain.info, Canaccord

As indicated in Figure 5 below, mining pools employ various approaches to rewarding the individual miners who contribute hashpower towards mining a block; below is an overview of some of the major payment methods:

- **PPS (Pay Per Share):** Under the PPS method, miners receive a standard, fixed payout rate for each share completed, regardless of whether or not the pool has solved a given block. Given that the PPS approach eliminates the "luck" component of a miner's payout, miners are subject to higher fees than those for other payment methods. FPPS (Full Pay Per Share), or PPS+, is a variation of PPS, in which miners are also allocated a portion of the transaction fees in addition to the fixed payout.
- **PPLNS (Pay Per Last N Shares):** Meanwhile, payment under the PPLNS method is dependent on whether the overall mining pool has found a given block, as well as the individual miners' proportion of hashrate contributed to the mining pool. Although miners pointing their hashrate do not benefit from the fixed payout received by miners under PPS, they are subject to more favorable payouts over the long term. In addition, PPLNS allocates transaction fees to miners, like FPPS/PPS+ but unlike the standard PPS.
- **SOLO:** According to ViaBTC, which supports PPS+, PPLNS and the less common SOLO payout method, a SOLO approach means that the entire block reward is allocated to the single miner responsible for the block.
- **Score:** Lastly, the Score payment method utilized by SlushPool considers not only the proportion of the total hashrate contributed by a given miner, but also the time in relation to the start of the current round when the hashrate was provided. Under the Score method, older shares have lower weighting than more recent shares, thus reducing the motivation to switch between pools within a given round.

Figure 5: Top bitcoin mining pools (as of 3/24/18)

	BTC.com	AntPool	SlushPool	ViaBTC	BTC.TOP
% of hashrate distribution	22.8%	14.9%	11.1%	11.0%	10.3%
Location	China	China	China	Czech Republic	China
Public / private	Public	Public	Public	Public	Private
Payment method	FPPS	PPLNS	PPS+, PPLNS, SOLO	Score	NA

Source: Canaccord

Figure 6: Bitcoin halving

Date reached	BTC/block	# days between halving
1/3/09	50.00	
11/28/12	25.00	1,425
7/9/16	12.50	1,319
5/31/20*	6.25	1,422

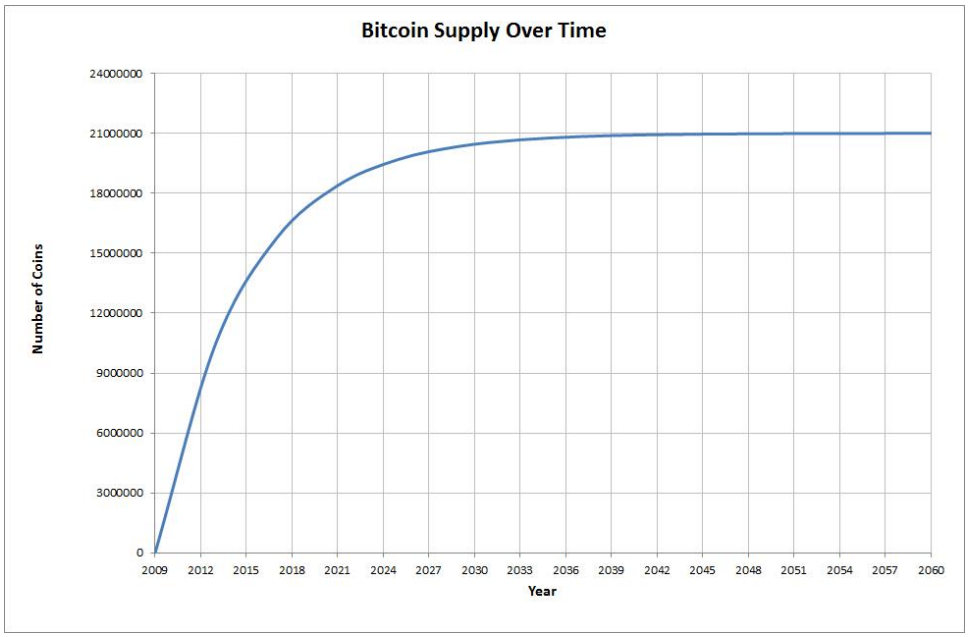
*Estimated date of next halving

Source: bitcoinblockhalf.com, bitcoinwiki, Canaccord

Supply schedule, block rewards, & transaction fees

Yet another variable to keep in mind with regard to bitcoin mining is BTC's supply schedule. There are currently 16.9M BTC in circulation, with a maximum total supply of 21M to be reached around the year 2140. Importantly, bitcoin undergoes what is known as **halving**, a process in which the block reward is cut in half every 210,000 blocks, or approximately every four years. As can be seen in Figure 6, the current block reward is 12.5 BTC as of 7/9/16, and it is expected that this reward will be cut in half in late-May 2020.

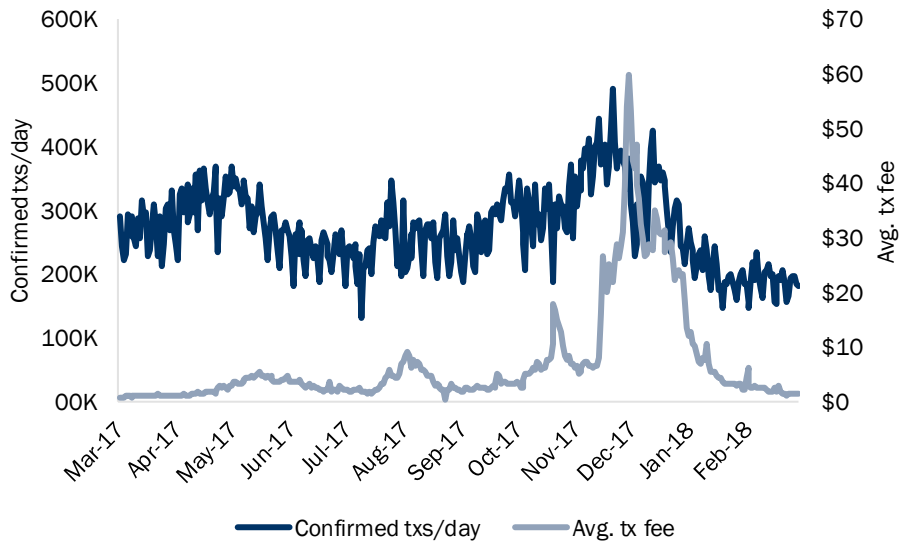
Figure 7: Bitcoin supply schedule



Source: https://dealingwithdisruption.com/2014/04/16/myth001/

In addition to the block reward as determined by bitcoin's halving schedule, miners also receive transaction fees for confirming transactions and adding blocks onto bitcoin's network. The fee for a given transaction is calculated dynamically at the time of the transaction, based on the amount of volume on the network at the time. As can be seen in Figure 8, bitcoin's peak average transaction fee coincided closely with an increase in the number of confirmed transactions per day in late-2017. At the peak achieved on 12/22/17, the average transaction fee was ~$60, after sitting below $5 for the majority of 2017. However, BTC's transaction fee has come down drastically since December 2017 and currently stands at ~$1.25.

Figure 8: Bitcoin confirmed transactions/day & avg. transaction fee

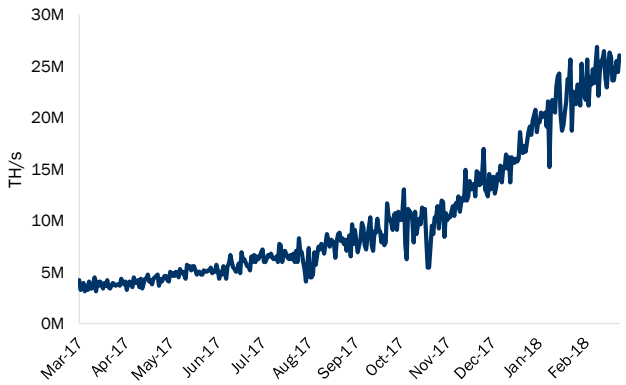


Source: Blockchain.info, Canaccord

Hashrate & difficulty

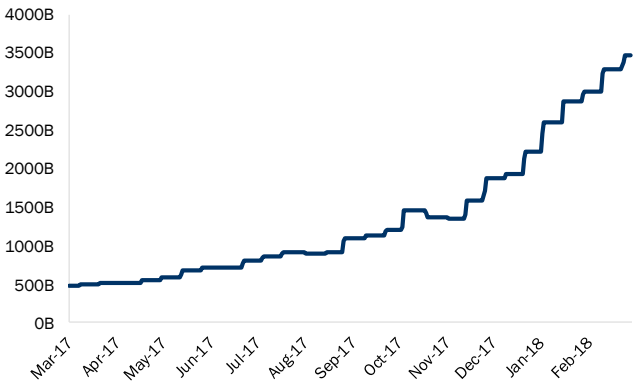
To understand how bitcoin is able to strictly follow its supply schedule outlined above, it is important to understand two key concepts, hashrate and difficulty. **Hashrate**, measured in tera hashes per second (TH/s) in Figure 9 below, measures the amount of power consumed by the bitcoin network. As can be seen in Figure 9, bitcoin's hashrate steadily increased throughout 2017, as more and more miners joined the network seeking the 12.5 BTC reward per block. However, while BTC's hashrate (or hashpower) increased in 2017, bitcoin's rate of awarding new blocks did not accelerate meaningfully for its supply schedule to meaningfully deviate from its original timetable, because of the corresponding increase in the **difficulty** to mine each subsequent block. Specifically, bitcoin's difficulty adjusts every 2,016 blocks, or around every two weeks, to account for the changes in its network's hashrate, so that one block continues to be mined approximately every 10 minutes.

Figure 9: Bitcoin hashrate



Source: Blockchain.info, Canaccord

Figure 10: Bitcoin difficulty



Source: Blockchain.info, Canaccord

Hashing algorithms

Taking a step back, bitcoin's network undergoes the mining process to mint new BTC because it employs what is known as **proof-of-work**, a consensus mechanism to validate transactions on bitcoin's blockchain. In essence, proof-of-work functions as miners around the world compete to find a valid hash that is less than or equal to the target hash. A **hash** is a 64-digit hexadecimal number, i.e., a string of 64 digits made up of numbers between 0-9 and letters a-f. Below is an example of a hash:

000000000000000057fcc708cf0130d95e27c5819203e9f967ac56e4df598ee

Beginning with the **block header** (the main way of identifying a given block in a blockchain) of the previous block, miners proceed by applying a **nonce** ("number used once") to discover a valid hash. Given the overwhelmingly large number of permutations possible for a hash, this discovery process is repeated via the computationally intensive mining process, until a valid hash is found to be broadcast to the network to claim the block reward. Accounting for the difficulty of discovering the correct hash, a miner must perform approximately 10^{21} computations, taking ~10 minutes, to find the right fixed-length hash.

Meanwhile, there are multiple different consensus algorithms that fall under the broader proof-of-work umbrella; several of the top algorithms are described below:

- **SHA-256:** A subset of the SHA-2 cryptographic hash function initially designed by the NSA, the SHA-256 algorithm is most notably used to mine bitcoin, as well as several other cryptoassets (e.g., Bitcoin Cash, Steem). While SHA-256 mining was initially performed with CPUs in bitcoin's earliest days, miners have since transitioned to GPUs and more recently ASICs to support the significant amount of energy required by SHA-256. While SHA-256 is considered to be among the most energy-intensive hashing algorithms, it is also considered to be one of the most secure and free of errors.
- **Scrypt:** In contrast to SHA-256, Scrypt is considered a faster and easier algorithm for mining purposes, as it is less energy-intensive and therefore can be run on CPUs as opposed to GPUs or ASICs. Given this advantage, many newer coins have opted for the Scrypt hashing algorithm, such as Litecoin, Dogecoin and Verge. There are currently hundreds of altcoins that employ Scrypt.
- **Ethash:** Ethash is the proof-of-work function specific to Ethereum and Ethereum Classic. While it is nearly impossible to mine for Ethash-based cryptoassets, Ethash has been designed to work with GPUs and is also considered to be ASIC-resistant because of the large amount of memory it requires.

Cloud mining

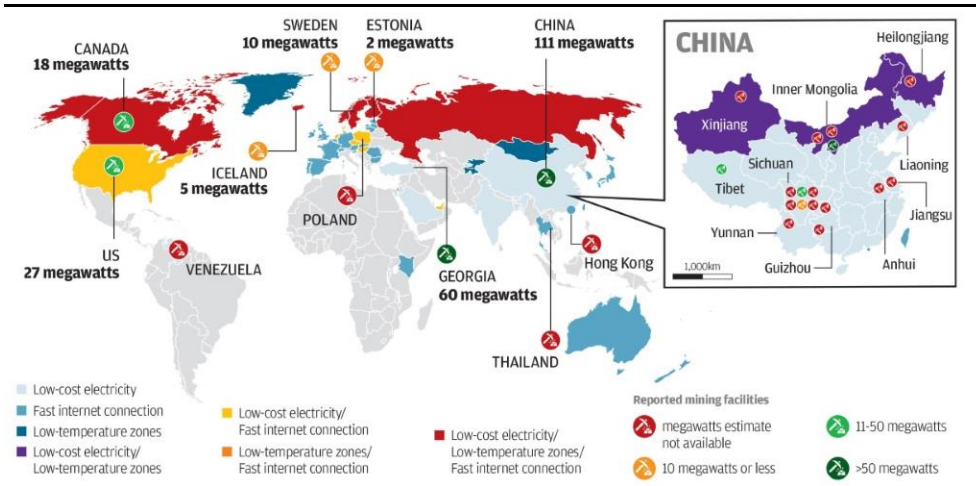
While many miners have opted to purchase their own hardware and set up large-scale operations, cloud mining has allowed for smaller players in the ecosystem to participate in the verification process for various cryptoassets. Under cloud mining, companies house and maintain entire facilities of mining rigs in various datacenters around the world, then distribute their processing power among customers that register and purchase mining contracts or shares. These contracts are often structured with favorable terms for the mining entities, as they take on the responsibility of maintaining the hardware and other fixed costs inherent to the mining process. Meanwhile, individual miners benefit from minimizing the upfront costs

required to set up mining operations, although in return they receive less favorable economics in terms of block rewards and transaction fees for each mined block.

Top countries for bitcoin mining

As mining operations require a combination of low electricity rates, a cool environment and a favorable regulatory landscape, miners have historically congregated in a select number of countries, most notably China. Until recently, it has been believed that China mines roughly three-quarters of the world's bitcoin, as it also benefits from the added advantage of being located in close proximity to the bitcoin mining chip manufacturers. However, 2018 has brought about increased talks about mining operations moving away from China, as the country's government has stepped up its efforts to eliminate mining owing to excessive electricity consumption and financial risk. While Chinese mining companies have long been considered to have benefited from electricity rates below $0.10/kWh, more recent reports indicate that miners now face China's highest-ever regulated electricity price of $0.13/kWh.

Figure 11: Top countries by cryptoasset mining electricity consumption



Source: University of Cambridge

Given China's shifting attitude towards bitcoin mining, the last several months have brought about a meaningful relocation of miners from China to other countries such as Canada, Iceland, Eastern Europe and Russia. In particular, Canada may have received the biggest influx of mining companies setting up operations within its borders, in part due to the country's favorable regulatory environment and electricity prices. For example, electric utility company Hydro Quebec has been reported to be offering rates as low as $ 0.0394/kWh for mining companies to relocate to Quebec, while other regions such as Newfoundland and Alberta are believed to be offering rates of $0.03 and $0.06, respectively. However, the rapid growth of the bitcoin mining industry in Canada has also brought about its own set of concerns regarding the sheer amount of power required by these companies; while the Montreal Canadiens' hockey arena is estimated to require five megawatts of electricity, the top mining operations have requested upwards of 200 to 300 megawatts from Hydro Quebec to run their facilities.

Five important considerations for miners today

1. Which coins to mine?

Notably, a significant number of today's top cryptoassets do not employ any mining process at all, as many were pre-mined at launch. In fact, out of the top 10 cryptoassets today, only four (bitcoin, ether, Bitcoin Cash, Litecoin) are mineable (see Figure 12 below).

Figure 12: Top 10 cryptoassets (as of 3/24/18)

Symbol	Name	Market cap	Price	Circulating supply	Max supply	Mineable?
BTC	Bitcoin	$151.5B	$8,944.55	16.9M	21.0M	Yes; Proof-of-Work (SHA-256)
ETH	Ether	$52.9B	$537.33	98.4M	NA	Yes; Proof-of-Work (Ethash)
XRP	Ripple	$25.6B	$0.65	39.1M	100,000.0M	No
BCH	Bitcoin Cash	$17.3B	$1,015.30	17.0M	21.0M	Yes; Proof-of-Work (SHA-256)
LTC	Litecoin	$9.2B	$165.33	55.8M	84.0M	Yes; Proof-of-Work (Scrypt)
EOS	EOS	$5.2B	$6.90	748.6M	1,000.0M	No
ADA	Cardano	$5.0B	$0.19	25.9M	45,000.0M	No
XLM	Stellar	$4.5B	$0.24	18.5M	103,689.1M	No
NEO	NEO	$4.4B	$68.24	65.0M	100.0M	No
MIOTA	IOTA	$3.8B	$1.38	2,779.5M	2,779.5M	No

Source: CoinMarketCap, Canaccord

Aside from bitcoin, its most well-known forks (Bitcoin Cash and Litecoin) and ether, a handful of other cryptoassets, also known as altcoins, can be mined. Like bitcoin, Dash is mined using ASICs, such as the Antminer D3. Meanwhile, security tokens Monero and Zcash can also be mined, but importantly do not use ASICs but rather rely on GPUs. In some ways, this has allowed Monero and Zcash to remain relatively more decentralized than Dash, which also sports its own security features but is considered to be much more centralized due to its masternodes and its use of ASICs (as they are significantly more expensive than GPUs and therefore can often only be mined by larger entities with significant resources). Other notable tokens that can be mined include Ethereum Classic, Bitcoin Gold and Siacoin (for which Bitmain is reported to be creating an ASIC). In Figure 13 below, we highlight some of the top altcoins (alongside bitcoin) that can be mined and relevant metrics:

Figure 13: Selected mineable cryptoassets (as of 3/24/18)

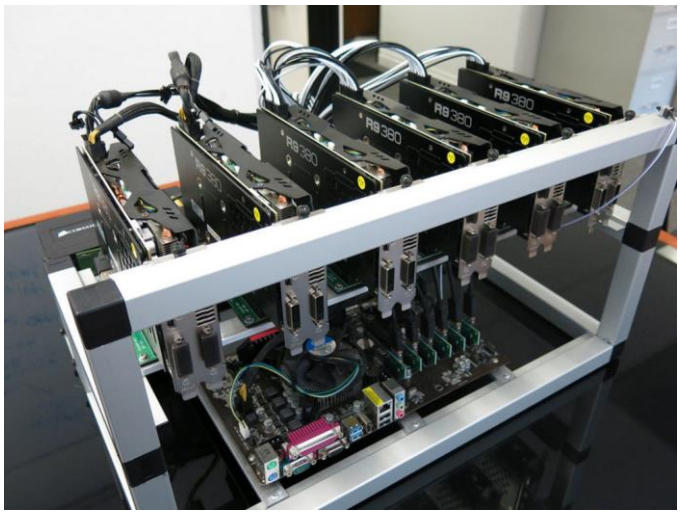
	Bitcoin (BTC)	Ether (ETH)	Bitcoin Cash (BCH)	Litecoin (LTC)	Dash (DASH)	Monero (XMR)	Zcash (ZEC)
Price	$8,944.55	$537.33	$1,015.30	$165.33	$439.69	$215.29	$252.02
Market cap	$151.5B	$52.9B	$17.3B	$9.2B	$3.5B	$3.4B	$894.9B
Circulating supply	16.9M	98.4M	17.0M	55.8M	8.0M	15.9M	3.6M
Max supply	21.0M	NA	21.0M	84.0M	18.9M	18.4M	21.0M
Avg. # of blocks/hour	2	249	6	27	23	30	24
Reward/block	$112,763.53	$1,857.32	$12,720.45	$4,144.76	$1,483.54	$1,078.74	$3,157.74
24-hour reward	$4,961,595.48	$11,097,458.62	$1,819,024.85	$2,636,064.44	$812,470.13	$782,608.93	$1,787,283.02
Hashrate	22.755 Ehash/s	260.218 Thash/s	2.802 Ehash/s	184.303 Thash/s	2.061 Phash/s	1.003 Ghash/s	515.664 Mhash/s
Mining profitability	0.218 USD/Day for 1 THash/s	0.0426 USD/Day for 1 MHash/s	0.6492 USD/Day for 1 THash/s	0.0143 USD/Day for 1 MHash/s	0.198 USD/Day for 1 GHash/s	0.7804 USD/Day for 1 KHash/s	3.466 USD/Day for 1 KHash/s

Source: BitInfoCharts, CoinMarketCap, Canaccord

2. Settling on a hardware roadmap

Not to be lost in the discussion around mining is the hardware that allows for the computationally-intensive hashing process to occur. In its early days, bitcoin could be mined using standard multi-core **central processing units (CPUs)**, which could be found on nearly any computer. However, CPUs gave way to **graphics processing units (GPUs)** less than two years later, when the first code for mining BTC using GPUs was released to the public in October 2010. This transition marked the beginning of more dedicated hardware to combat the growing mining difficulty on bitcoin's network, as more and more cryptoasset enthusiasts and early adopters/investors began to catch on to the lucrative business of mining bitcoin. In addition, November 2010 brought about the concept of pooled mining, in which large numbers of miners would "pool" their computational resources to mine a block and share the block reward and transaction fees pro rata.

Figure 14: GPU mining rig



Source: ToughNickel

Figure 15: Antminer S5 ASIC

Source: Amazon

By June 2011, **field-programmable gate arrays (FPGAs)** became the focus of bitcoin miners, as they notably utilized ~3x less power than GPUs to achieve the same task. Nonetheless, the adoption of FPGAs proved short-lived, as they came with the disadvantage of having to be modified after purchase for mining purposes, compared to the **application-specific integrated circuits (ASICs)** that arrived onto the scene in 2013 to modernize bitcoin mining hardware as it stands currently. Today, ASICs have become the only viable hardware solution to handle bitcoin mining operations, and companies such as Bitmain and BitFury have emerged as the leading manufacturers of these chips. In addition, incumbent chipmakers NVDA and AMD have stated in recent quarterly earnings that they have seen an uptick in their chip products for mining purposes, while Samsung announced earlier this year that they would begin building bitcoin mining chips.

Currently, the most popular ASICs for bitcoin mining include Bitmain's Antminer S7 and Antminer S9 as well as Canaan's Avalon6. Antminer S7, released in 2015, remains a favored option today, given its relatively strong hashrate and efficiency metrics considering its $1,300 price tag (see Figure 16 below). Since 2015, Bitmain has also released the Antminer S9, a more powerful and energy-efficient alternative, although the S9 is currently priced at more than two times the S7. Meanwhile, Canaan's Avalon6 is geared towards bitcoin hobbyists looking to mine for the first time, as its relatively weak hashrate low efficiency makes it an unsuitable option for dedicated mining companies.

Figure 16: Top bitcoin ASICs

	Antminer S7	Antminer S9	Avalon6
			
Manufacturer	Bitmain	Bitmain	Canaan
Price	$1,300	$3,200	NA
Hash rate	4.73 Th/s	14 Th/s	3.5 Th/s
Efficiency	0.25 W/Gh	0.098 W/Gh	0.29 W/Gh
Weight	8.8 lbs	8.1 lbs	9.5 lbs

Source: Amazon, bitcoinmining.com, Canaccord

Figure 17: Ethereum nodes distribution

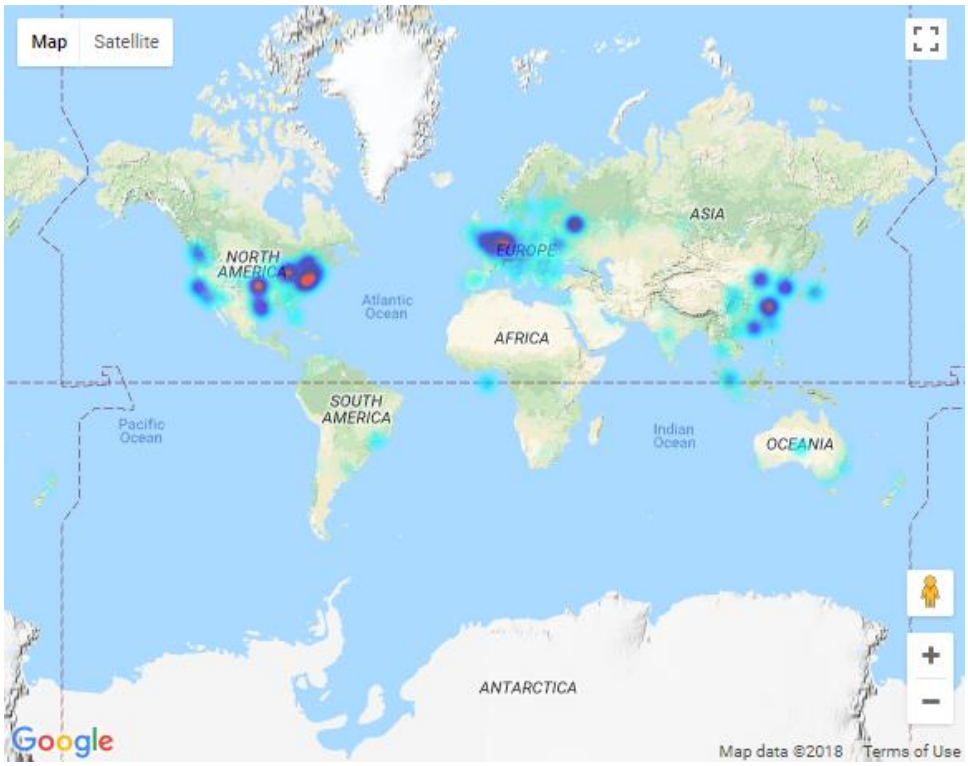
Rank	Country	Nodes	%
1	United States	5,395	34.5%
2	China	1,794	11.5%
3	Russia	924	5.9%
4	Germany	862	5.5%
5	Canada	861	5.5%

Source: ethernodes.org, Canaccord

3. Navigating Ethereum's transition to proof-of-stake

As mentioned above, Ethereum's planned transition from a proof-of-work to a proof-of-stake consensus mechanism will be one of the most significant events to monitor in the entire cryptoassets industry in 2018, and the implications for ether mining specifically stand to be particularly large. Currently, there are 15,633 Ethereum nodes worldwide that make up entire ether mining rig operations in countries such as the U.S., China, Germany and Russia (see Figure 17), and it is possible that their businesses may not be viable over the long-run if Ethereum is successfully able to transition from PoW to PoS, which will obviate the need for mining. That being said, despite meaningful progress already being made to move Ethereum from proof-of-work to proof-of-stake, mining equipment manufacturers such as Bitmain may have reason to believe that mining will remain a part of Ethereum, as reports indicate that they will release ether-specific ASICs later in 2018. Currently, ether is mined primarily using GPUs (e.g., Radeon Rx 480, Radeon HD 7990, Radeon R9 295 X2), as Ethereum was initially designed to be "ASIC-resistant."

Figure 18: Ethereum nodes distribution



Source: ethernodes.org

Figure 19: Bitcoin mining electricity consumption

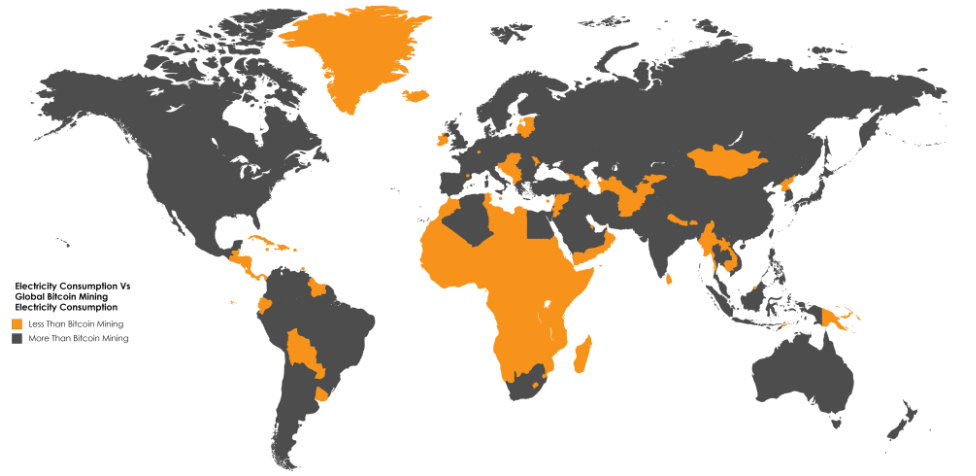
Rank	Country	TWh/year
1	China	5,920
2	United States	3,913
3	Russia	1,065
43	Israel	60
44	Switzerland	58
–	**Bitcoin**	57
45	Kuwait	54
46	Greece	53

Source: Digiconomist, Power Compare, Canaccord

4. Managing implications surrounding power consumption

Meanwhile, perhaps bitcoin mining's biggest drawback has been and will continue to be its sheer amount of electricity consumption, currently estimated to be ~57 TWh/year. By this metric, this would make bitcoin the 45th-largest "country" by energy consumption, just behind Israel and Switzerland (see Figure 19). Furthermore, this figure is only expected to grow in the coming years, with some estimates predicting that bitcoin mining will require more electricity than the entire U.S. by July 2019. Looking ahead, while #2 cryptoasset Ethereum is seeking to transition to a proof-of-stake (PoS) model by the end of 2018 (see our note from 12/12/17 for more info) and thereby removing the mining process entirely from its network, there are no plans to enact such measures on bitcoin. Therefore, given the continued run-up in bitcoin's price and thus an increased demand to mine for incremental bitcoin, electricity consumption will continue to be a key variable to monitor in the years ahead.

Figure 20: Map of bitcoin mining electricity consumption vs. country electricity consumption



Source: Power Compare
Note: Countries in orange are those that consume less electricity than current bitcoin mining operations

5. Preparing for a world of compressed margins and moth-balled capacity

Regarding the future outlook of bitcoin miners generally speaking, our analyses above and conversations with multiple mining-focused companies indicate that as miners continue to enter the market and raise competition levels for block rewards and transaction fees, margins will as a result compress for all participants in the mining ecosystem. While this will allow the most efficient miners in bitcoin's network to continue to operate at relatively healthy profitability levels, less efficient mining companies are likely to face considerable pressure in this future setting of higher mining difficulty and hashrates. As a result, our expectation is that we will see the less-efficient mining companies begin to diversify their businesses sooner rather than later in one of several ways. In particular, we expect that some miners will diversify their portfolio of cryptoassets that they mine to altcoins beyond bitcoin, while others will pursue different lines of businesses altogether, e.g., cryptoasset exchanges or advisory services.

Mining profitability framework

In the following section, we lay out a series of matrices aimed at demonstrating the impact of a number of variables that determine profitability for bitcoin miners. In each of our three matrices, we assume that our miner is using a Bitmain Antminer S9 (currently the most popular bitcoin ASIC) and that it sports a hashrate of 14 Th/s at 1375 W. Meanwhile, we consider bitcoin at various prices between $5,000 and $50,000 in each of our below matrices, then adjust one of three variables – power cost, difficulty and pool fees – while holding the other two constant to arrive at various "gross margins" calculated as:

(bitcoin earned in USD – power cost – pool fees) / bitcoin earned in USD

Importantly, we note that the margins displayed in the below matrices do not factor other key costs such as hardware costs and other important fixed costs that would decrease profitability margins for bitcoin miners as displayed below.

BTC price vs. power cost

In our first matrix, we analyze the impact of bitcoin's price and a miner's power cost, as measured in $/kWh, on profitability. Holding difficulty at ~3.0T (BTC's current difficulty) and a pool fee of 2% as constants, we consider power costs between $0.05 and $0.10 kWh, as this represents the broad range of available power costs in Canada, perhaps now the #1 preferred location for bitcoin miners. Meanwhile, we consider bitcoin at various prices between $5,000 and $50,000, which yields gross margins in the range of 42% to 95%.

Figure 21: Miner gross margin at various levels for BTC price and mining power cost

		Power cost ($/kWh)					
		$0.10	$0.09	$0.08	$0.07	$0.06	$0.05
BTC price	$5,000	42%	50%	54%	58%	67%	71%
	$7,500	59%	62%	68%	70%	76%	78%
	$10,000	69%	71%	76%	78%	82%	84%
	$15,000	79%	81%	84%	85%	86%	89%
	$20,000	84%	85%	87%	88%	89%	91%
	$30,000	89%	90%	90%	92%	92%	94%
	$40,000	91%	92%	92%	93%	94%	94%
	$50,000	92%	93%	93%	94%	95%	95%

Source: CoinWarz, Canaccord

Notably, we highlight that gross margin (again, measured as: (bitcoin earned in USD – power cost – pool fees) / bitcoin earned in USD) peaks at an astounding 95% as shown in the bottom-right corner of Figure 21. While we acknowledge that this level of "profitability" is reached only when assuming a price of $50,000 per bitcoin and miners are mining at a relatively low $0.05 kWh power cost (and at today's difficulty at a 2% pool fee), the overarching takeaway appears to be that mining has the potential to be highly profitable over the long-run for the most efficient miners if bitcoin reaches the prices that some in the crypto community believe to be inevitable.

BTC price vs. difficulty

Meanwhile, our second matrix accounts for various levels of difficulty for bitcoin's network and bitcoin prices, while keeping constant the power cost at $0.075/kWh and the pool fee again at 2%. To calculate the range of difficulty to be used, we took the current difficulty of ~3.0T as the minimum difficulty, and projected forward to the potential difficulty at the end of 2018, assuming that the difficulty would increase by 10.1% every two weeks (the current rate of increase in bitcoin mining difficulty so far in 2018).

Figure 22: Miner gross margin at various levels for BTC price and difficulty

BTC price	Difficulty 25.7T	21.2T	16.6T	12.1T	7.5T	3.0T
$5,000	Neg.	Neg.	Neg.	Neg.	Neg.	54%
$7,500	Neg.	Neg.	Neg.	Neg.	20%	68%
$10,000	Neg.	Neg.	Neg.	8%	42%	76%
$15,000	Neg.	Neg.	15%	39%	62%	84%
$20,000	Neg.	21%	39%	54%	69%	87%
$30,000	35%	43%	58%	69%	79%	90%
$40,000	48%	57%	69%	76%	83%	92%
$50,000	59%	66%	73%	79%	87%	92%

Source: CoinWarz, Canaccord

Unlike the first matrix, which showed high "profitability" for all levels of BTC price and power cost, Figure 22 demonstrates generally speaking that if the increase in difficulty on bitcoin's network continues to persist at the current rate, less efficient miners will not be able to meet its variable costs of mining, let alone its significant fixed costs stemming from capital investments in its hardware, facilities, etc. In other words, as bitcoin mining difficulty inevitably increases as more and more miners dedicate more hashpower to BTC's network, miners will become increasingly dependent on 1) a higher BTC price and/or 2) lower power costs to remain profitable.

BTC price vs. pool fees

Lastly, we consider various pool fee structures by altering the pool fee percentage that a given miner may need to forgo to reap the benefits of participating in a mining pool. Based on our understanding of the fees collected by the top mining pools, we consider pool fees between 0-5%, and again solve for BTC price between $5,000 and $50,000. Meanwhile, we hold the difficulty constant at the current difficulty of ~3.0T, and the power cost constant at $0.075/kWh.

Figure 23: Miner gross margin at various levels for BTC price and pool fees

BTC price	Pool fees 5.0%	4.0%	3.0%	2.0%	1.0%	0.0%
$5,000	50%	50%	54%	54%	54%	54%
$7,500	65%	65%	65%	68%	68%	70%
$10,000	71%	73%	73%	76%	76%	78%
$15,000	81%	81%	82%	84%	84%	85%
$20,000	84%	85%	86%	87%	88%	89%
$30,000	88%	88%	90%	90%	92%	92%
$40,000	89%	90%	91%	92%	93%	94%
$50,000	91%	91%	93%	93%	94%	96%

Source: CoinWarz, Canaccord

Based on Figure 23 above, we surmise that the pool fee may be the least important among the three variables (power cost, difficulty, pool fee) considered alongside the price of bitcoin in determining a bitcoin miner's profitability, as "profit" margins remain healthy even at the highest pool fee of 5% and the lowest BTC price of $5,000. Furthermore, the following matrix would echo what various mining companies we have spoken to have communicated to us, namely that they are less concerned with which pools they point their hashrate at and instead focus on acquiring the most efficient bitcoin ASICs and positioning themselves in power cost-friendly regions.

Mining company profiles

- BITMAIN

Bitmain: Beijing-based Bitmain has established itself as the leader in the bitcoin mining chip manufacturing market, with an estimated 70-80% share of bitcoin miners and ASIC chips. Currently, Bitmain's most demanded ASIC is the Antminer S9, which sports a hashrate of 14 Th/s and an efficiency of 0.0.98 W/Gh. While superior to its predecessor product, the Antminer S7 (see Figure 16 above), the S9 is currently being sold at over $3,000 with estimates for secondary market prices believed to exceed $5,000. Beyond its current suite of ASICs, it is widely expected that Bitmain will release its next generation bitcoin mining chip later in 2018, as well as introduce ASICs for other popular mineable altcoins.

- BitFury

BitFury: Considered the main competitor to Bitmain, BitFury offers a more diverse product set for bitcoin mining purposes, such as various software offerings as well as hardware solutions. While software products range from Digital Assets Platform-as-a-Service (PaaS) to Data Analytics, BitFury's primary hardware products consist of its 16nm ASIC and the BlockBox, BitFury's mobile bitcoin mining unit. According to investor documents, BitFury has 172 megawatts of data centers around the world and 2017annual revenue of $350M. Meanwhile, BitFury is also set to own a 49% stake in Hut 8 Mining, a new stock that will debut on the TSX Venture Exchange in early-2018 and plans to acquire 60 megawatts of mining farms in Canada by the middle of this year.

- ATLAS CLOUD

Atlas Cloud: Headquartered in Vancouver, Atlas Cloud is a company traditionally focused on the business of providing co-location and backup/redundancy IT, telecom equipment and cloud computing. Alongside its existing business, Atlas Cloud aims to become a low-cost producer of cryptoassets mining and blockchain infrastructure, and is in the process of transitioning a currently-owned facility for mining purposes in Electric City, WA, which benefits from a dedicated low-cost energy source of 3 MW. This past January, Atlas Cloud purchased 1,000 Antminer S9's from Bitmain, which are available for immediate mining deployment.

- 

CryptoGlobal: has quickly established itself as one of the largest and most diversified mining companies in Canada, with plans to expand to over 400 MW in capacity by the end of 2018 to mine a number of cryptoassets, including bitcoin, ether, Litecoin and Dash. Unlike several of its competitors, CryptoGlobal has pursued a fully diversified approach to mining cryptoassets beyond bitcoin, as it will flexibly allocate its resources based on each altcoin's profitability from a mining perspective. As part of its expansion strategy, CryptoGlobal plans to re-invest 50% of its earnings into new machines, and it expects to order 2,000 units monthly by the end of 2018.

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DMG Blockchain Solutions: As a full-service, diversified blockchain and cryptocurrency company, DMG Blockchain operates a more varied business model than some of its mining-focused counterparts. DMG's services include Mining as a Service (MaaS), bitcoin mining, forensics and diversified blockchain platform management in a variety of industries such as agriculture, pharmaceuticals and energy, among others. Regarding its mining business, DMG provides MaaS, which manages mining operations on behalf of third parties globally, and also mines bitcoin on its own, positioning it to benefit from the price appreciation of BTC.

- 

ePIC Blockchain Technologies: Located in Toronto, ePIC Blockchain is focused on the manufacturing of superior mining ASICs compared to those currently available in the market today. Regarding its product roadmap, ePIC is working towards the first bitcoin mining ASIC that will deliver up to 2x the efficiency of conventional ASIC chips. ePIC plans to launch this chip in beta in 2Q18, followed by a general release in 4Q18. Notably, ePIC received a $100K investment this past January to pursue the development of its ASIC from 360 Blockchain.

- 

Fortress Blockchain: Fortress Blockchain is a technology-oriented mining company with a particular focus on becoming one of the most operationally efficient miners in the industry. Beyond its flagship facility in Washington state, which has been in continuous operation since 2014, Fortress is in the

process of strategically acquiring additional facilities to build out its mining operations. Powered by renewable hydroelectric energy, Fortress utilizes one of the lowest power costs in all of North America, at around $0.03/kWh.

- HASHCHAIN TECHNOLOGY INC

HashChain Technology: HashChain is a cryptoasset mining company focused on the Dash cryptocurrency. HashChain currently has 100 Dash rigs deployed, with plans to roll out 13,400, 26,600 and 46,600 rigs by 2018, 2019 and 2020, respectively. Given its aggressive growth strategy, HashChain aims to achieve 40MW in mining capacity by 2019, which would make it one of the largest mining operations globally. While HashChain's current focus remains on mining the Dash cryptoasset (it currently operates a Dash masternode, which requires ownership of 1,000 DASH), HashChain will pursue a diversified mining strategy that will allow it to quickly shift to the most profitable cryptoassets as well as the most power-efficient regions.

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HIVE Blockchain Technologies: As the first publicly-listed cryptoasset mining company, HIVE has been one of the pioneers in the rapidly growing mining industry. HIVE's mining operations include state-of-the-art GPU-based facilities in Iceland and Sweden, which mint cryptoassets such as ether and other altcoins. Importantly, HIVE counts Genesis Mining, the world's leading cryptoasset mining hashpower provider and owner of the world's largest ether mining facility, as its exclusive partner and investor in the company, via Genesis' C$7M equity investment in HIVE announced in October 2017. HIVE trades on the TSX Venture Exchange.

- 

Hyperblock Technologies: Hyperblock is a Toronto-headquartered mining company aggressively pursuing a rapid growth strategy. Currently, Hyperblock is operational and generating revenue through 10 PH/s of bitcoin ASICs within its Sector 14 mine, and is planning to add an additional 10 PH/s in early 2018. Meanwhile, Hyperblock has signed a definitive agreement to acquire its co-location partner "Project Northwest," currently one of the largest mining facilities in North America with nearly 20 MW of capacity and scalable to 80 MW. In addition to its own mining operations, Project Northwest's business includes hashrate sales, server hosting and server hardware sales, and is powered using hydro-electric energy that provides industry-leading power costs of under $0.04/kWh.

- **Riot Blockchain:** NASDAQ-listed Riot Blockchain is developing into one of the largest cryptoasset mining companies globally, with ~3,000 ASICs currently deployed and an additional ~5,000 ASICs to be deployed by May 2018. Riot's mining facility, located in Oklahoma, is expected to have over 110 PH of hashpower for bitcoin mining once fully deployed, as well as 252 GH allocated for Litecoin mining. In addition to its mining business, Riot plans to launch a cryptoassets exchange in 2018 and has already signed a letter of intent to acquire Logical Brokerage, a registered member of the CFTC and the National Futures Association, to pursue its new business line. Riot's strategic investments include Coinsquare, TESS and Verady.

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Date and time of first dissemination: March 26, 2018, 05:22 ET

Date and time of production: March 26, 2018, 04:30 ET

Distribution of Ratings:

Global Stock Ratings (as of 03/26/18)

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Hold	243	26.19%	26.34%
Sell	19	2.05%	10.53%
Speculative Buy	100	10.78%	60.00%
	928*	100.0%	

*Total includes stocks that are Under Review

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