distributed hash research

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Re-Orienting Antminer S19s for Improved Performance and Power Density.

distributed hash research is dedicated to studying the mining ecosystem and producing content that empowers miners of all sizes and experience levels. For project consultation, hosting, or general inquiries, please email hosting@distributedha.sh

There are as many mining setups as there are miners in the Bitcoin ecosystem. It is often said by Alex at Kaboomracks that, "There are no experts in Bitcoin mining." We agree with this statement. The age of our industry, combined with the interdisciplinary skills of IT, contracting, procurement, construction, wiring, and HVAC (to name a few), means we are still in the early days of generating best practices in our space.

The following research brief aims to introduce early data on the effects of mounting 42 Antminer S19j Pro machines of various terahash ratings, either vertically or horizontally, in a commercial mining facility and the consequences on power density and performance while running both stock and aftermarket firmware (Braiins).

Our early data suggests that running Antminer S19j Pros vertically, case to case, is sub-optimal due to insufficient cooling of the power supply unit. Optimal spacing of S19s, using a hot cold barrier, is ~4in between units. At this spacing, turning machines horizontal increases power density per rack by 60% and may increase nominal hash produced in lower rated machines (sub 100T) by up to 15.02% while running Braiins firmware.

Our immediate recommendation is that you review both the physical arrangement of your machines, and the utilization of aftermarket firmware as a way to optimize the nominal hash of your facility, given your physical constraints.

Notes on Miner Data:

The following data were collected in a dry, Western environment at an altitude over 4,000ft, but below the manufacturer recommended maximum operating altitude of 6,561ft (2000m) for most new generation miners. Data was collected via a mounted weather station and API query in a single air-cooled datacenter across multiple weeks in early September. Temperature conditions varied between a high of 104.2F (40.1C) midday and 39.2F (4C) in the evenings. Precipitation was 56.8mm over the period of data collection with humidity between 100% and 10% (average 50%) and wind conditions between 0 mph and 31.1 mph.

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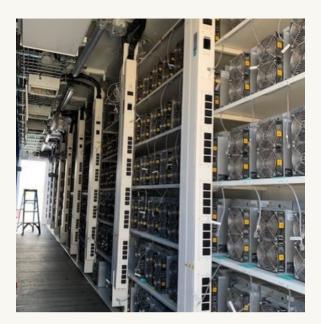
Airflow Issues in Vertically Mounted S19s.

It is extremely common to see containerized or warehouse mining setups featuring long rows of S19s racked shell to shell. Note the first image to the right of a containerized solution using this technique.

It would seem obvious that this is the optimal way to arrange ASICs to maximize the number of machines you can fit into a facility, however, this mounting style poses problems for airflow through the power supply unit (PSU) and can artificially throttle your hashrate or lead to unexpected machine shutdowns due to high heat.

Note the second image on the right of an Antminer S19. The PSU intake is highlighted in red. When rows of S19s are racked shell to shell, the PSU intake fans are set back a number of inches from the main intake fans (the two large black fans in the right image). The main intake fans of the S19 are substantially more powerful than the three smaller PSU fans.

The combined effects of the PSU fan setback and the powerful main fans, is that during times of high heat and heavy fan load most air will flow through the chips at the expense of the PSU. This causes machine shutdowns due to PSU overheating, not chip overheating.

We found via facility experimentation, that spacing S19s approximately 4inches apart (on an 8ft rack) allowed us to operate nearest to the stated nominal hash without a substantial throttling effect occuring.

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Horizontal Mounting: Density & Performance

To determine the effects of mounting S19s horizontally versus vertically, we arranged a set of machines in both orientations on 8ft lengths of rack. Note, to give the vertically racked machines the greatest advantage possible we arranged them predominantly on the far right side of the racks to avoid the above stated fan issues with shell to shell mounting. Machines were either running stock firmware or Braiins.

Before exploring the aggregated data, it is also worth noting that given our previous discussion of 4in spacing between vertically mounted machines, 8 machines fit on a single 8ft length of rack. By mounting S19s horizontally and shell to shell, you are able to decrease shelf height from 16in to 10in and subsequently increase rack density by 60%.

This is because with tighter vertical rack spacing on an 8ft rack, you are able to add 2 additional rows of 8 machines on a full rack setup and bring (at least in our case with our racks and rack manufacturers) the total count of machines on a full rack to 64 from 48. This adjustment maintains benefits discussed below in our data exploration and is worth considering in your mining setup.

Provisional Data on Machine Performance

Model	Firmware	Vertical	Horizontal	Variance in Th
J Pro 95Th	Braiins	88.95	102.31	15.02%
J Pro 100Th	Braiins	105.63	107.7	1.96%
J Pro 100Th	Stock	101.98	101.98	0.00%
J Pro 104Th	Braiins	107.9	110.1	2.03%

The above data are 30 day average hash rates from individual S19 machines, as a representative sample of the mine. Our early data suggests that there is some efficiency gain in Antminer S19s while mounted horizontally, **and** running aftermarket firmware (Braiins in our case).

This data is a small sample set (<50 machines) and additional data is being collected to determine stock performance or degradation in the highest and lowest rated machines throughout the year.

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Conclusions and Next Steps:

This provisional research brief is intended to help establish core principles and best practices in the physical mounting, arrangement, and operation of bitcoin ASICs. In this case we review the often used case to case vertical arrangement of Antminer S19s in containerized and warehouse solutions and the subsequent overpowering of PSU fans during times of heavy fan load.

We do not recommend mounting S19s vertically and case to case if you can avoid it. If you choose to mount your S19s vertically, we suggest experimenting with 4in gaps between machines to allow sufficient airflow to access the PSU. Your particular situation will be unique, so take our suggestions as a starting point for your own experimentation and not a hard and fast rule for facility setup and operation.

We conducted a provisional experiment with 42 S19s mounted both vertically and horizontally running both stock and aftermarket firmware, with special attention paid to avoiding any issues around PSU airflow in vertically mounted machines.

Our provisional data suggests no negative performance, and a potential increase in hashpower in Antminer units running aftermarket firmware (we would need more data to clearly determine effects of firmware vs. mounting condition). This provisional data, combined with our prior research on Whatsminer PSUs, suggests that there are potential performance gains that can be made in lower Th rated machines (for both MicroBT and Bitmain) that are physically arranged in an advantageous manner and managed properly.

These findings should pique the interest of large operators seeking to build out the most cost effective operation. Lower Th rated machines often cost substantially less than the state of the art, so any potential increases in running efficiency or nominal Th output must be considered from a modeling perspective when setting up an operation.

The rough and tumble early days of bitcoin mining are over. Increases in machine efficiency will no longer jump 200%-300% in a five year period as ever smaller nm chip technologies improve drastically. Our belief is that as chip efficiency converges on the physical limits of silicon, the winners will be those who play the game of incremental gains in energy acquisition, contracting, business arrangement, physical setup and machine management and optimization.

Knowledge is power.

-distributed hash team

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