



Bitcoin

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OCT 2017 | NORTH AMERICAN | [SPECTRUM.IEEE.ORG](http://SPECTRUM.IEEE.ORG)

# The Bitcoin Mines of China

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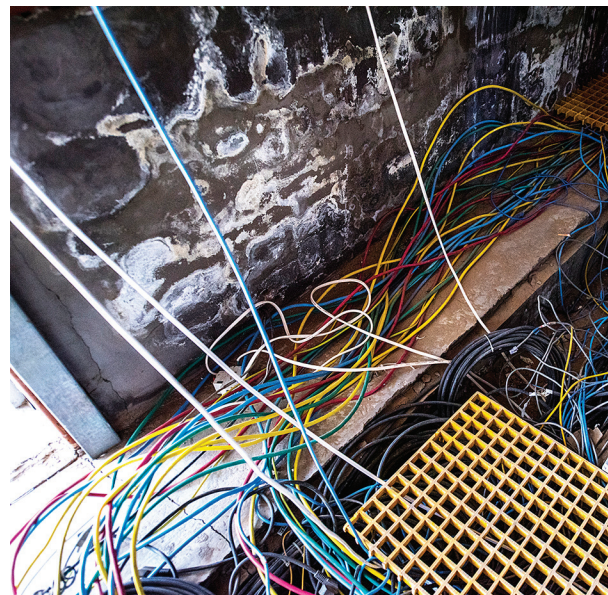






**I**N THE DUSTY, SUNBAKED land surrounding Ordos, a city in China's Inner Mongolia, sits one of the world's largest bitcoin mines. Encircled by coal-fired power plants, rare earth mineral extraction sites, and the skeletal remains of abandoned, half-constructed housing complexes, the Bitmain Technologies bitcoin mine is evidence of a new economic boom in the area. ■ Every 10 minutes, a new block of data is added to the Bitcoin blockchain,

the accounting ledger that records every transaction made with the currency. And every 10 minutes, a shiny new cache of bitcoins is deposited into the digital pocket of the person whose computer added the most recent block. Miners compete for the right to add new blocks by running a single calculation, the SHA-256 hash function, over and over as fast as they can. This essentially enters them into a lottery with all other miners on the network. The rewards of this lottery now amount to over US \$8 million worth of bitcoins every day. ■ Half of this goes to miners in China, who own a majority of the hashing power on the Bitcoin network, according to a new study by University of Cambridge researchers. Their proximity to manufacturers of specialized hardware and their access to cheap land and cheap electricity make Chinese miners the natural beneficiaries of the Bitcoin system, which rewards efficiency and hustle above all else. ■ In addition to its huge mining assets, Bitmain also happens to be the world's largest supplier of bitcoin-mining ASICs—integrated circuits that are specifically customized for the task of unearthing new bitcoins. With 21,000 machines, collectively computing approximately 250,000 trillion hashes per second, Bitmain controls nearly 4 percent of the computing power on the Bitcoin network from the Ordos mine alone. ■ Photographer Stefen Chow and I visited the mine on 12 July. For a deeper dive into what makes these mines work, see <http://spectrum.ieee.org/bitcoinmine1017>.







## Speedy Installation

**THE FASTER THE** machines are plugged in, the sooner they can begin gulping down electricity and turning it into money. Racks of bitcoin mining rigs run the length of seven warehouses at Bitmain's Ordos facility, which is in a constant state of upgrade.



## Compact Power

**AT ORDOS, BITMAIN** has installed its most sophisticated mining rigs, Antminer S9s [left]. Each houses 189 ASICs customized to run the SHA-256 hashing algorithm. A single machine can compute between 11.5 trillion and 14 trillion hashes every second, according to company estimates.

## Haste Makes Money

**A TANGLE OF** networking cables is evidence that the building was constructed and the equipment installed at breakneck speeds [far left].



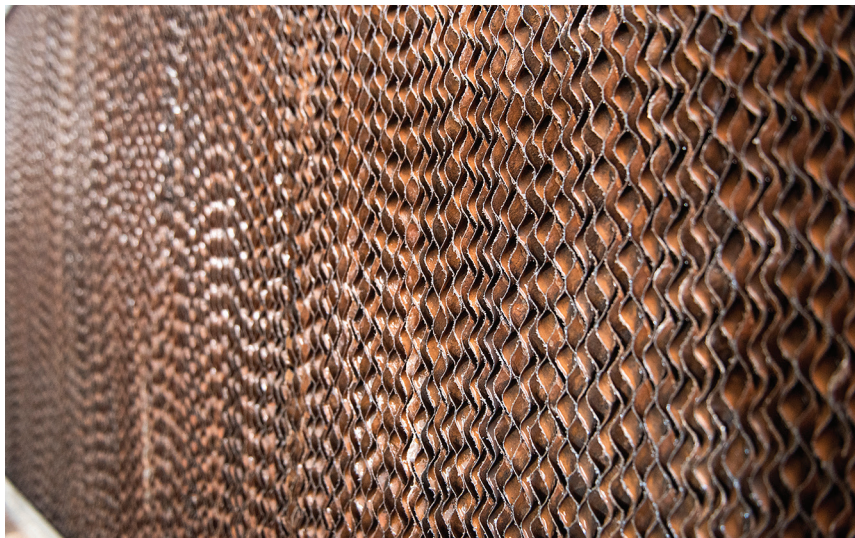
# Harsh Conditions

## INNER MONGOLIA HAS

some of the cheapest electricity prices in the world (4 U.S. cents per kilowatt-hour, a government-reduced rate), which is the primary reason miners are setting up shop here. But it comes with a trade-off: The climate outside Bitmain's warehouses can be brutal, especially in the summer.







## Engineered for Endurance

**BITMAIN'S MINING MACHINES** have been engineered to tolerate extreme temperatures and fluctuating environmental conditions. "Our miners are operating in both hot and cold climates and sometimes in cheap data centers without temperature control," says Peter Holm, director of integrated circuit design at Bitmain. "One of the important jobs of the controller is to manage the fan speed, voltage, and frequency of each ASIC during startup and in the presence of ambient temperature variation. The firmware algorithms for this are very carefully tuned." Still, the machines must be protected as much as possible from Ordos's heat and dust.

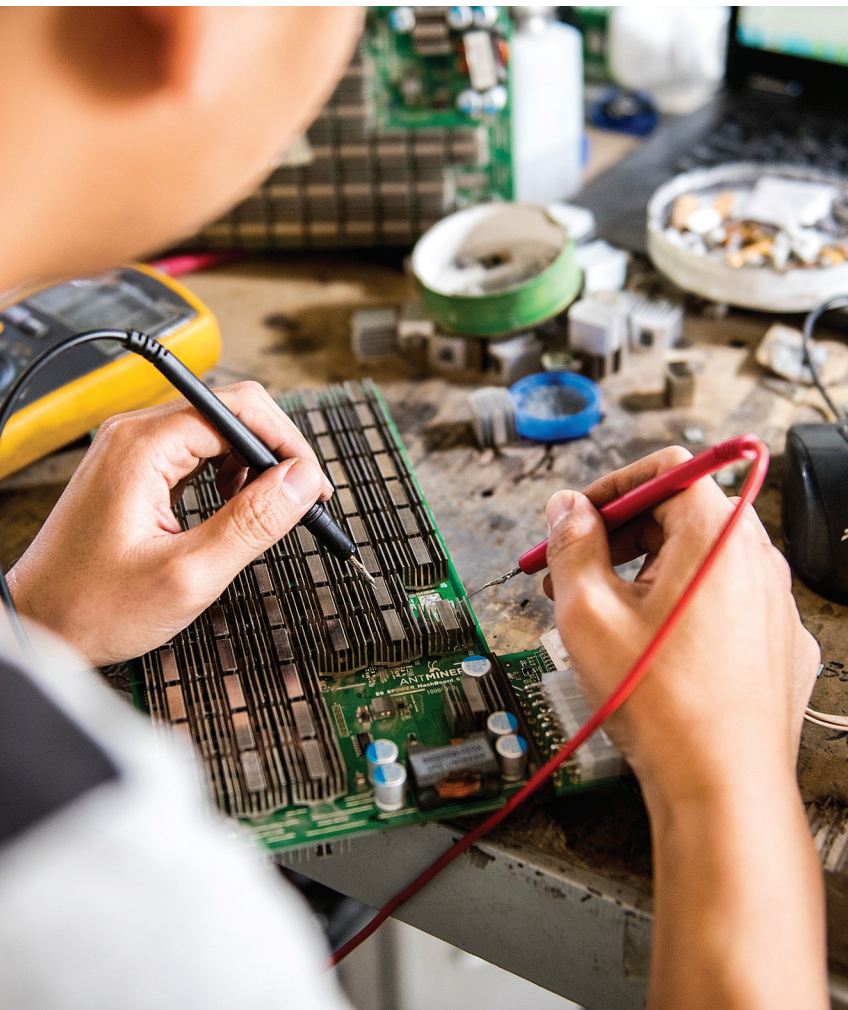
## Breathe In

**EACH WAREHOUSE IS** swathed in a fine netting [above, top] to keep pollen and dust from getting inside. Windows have been removed from one full side of the warehouse and replaced with desert fans—panels of twisted metal [above, bottom] that get doused with water from a pipe running along the top. As air enters the warehouse through these desert fans, the water evaporates and cools the interior.

## Heat Shields

**THE LAYOUT OF** the mining racks [left] is being reconfigured to maintain a cool side and a hot side. The machines are set up on a single rack that traverses the entire length of the warehouse. The fans are aligned to shoot hot air out behind the machines into the hot side of the warehouse, and a barrier is set up to keep the air from circulating back. On the hot side of the warehouse, industrial fans [far left] blow air back out into the courtyard. Temperatures on this side exceed 40 °C (104 °F).





## The Cost of Downtime

**DESPITE THE EFFORT** put into protecting the ASICs from dust and heat, rigs inevitably break down while they're churning out their digital lucre. With the current price of the bitcoin (it was trading for about US \$4,600 as this article went to print), each Antminer S9 rig earns the owners around \$18 per day. When the full fleet is up and running and bitcoin prices are above \$4,000, the Ordos mine makes at least \$300,000 per day. But every time a machine fails, that number falls slightly.

## Something's Wrong

**SOFTWARE MONITORS THE** operating status [far right] of the thousands of mining rigs and alerts workers when one has failed. The machines themselves also report when they're failing with a red indicator light. Once the rig is extracted, workers test the ASICs that perform the critical hash calculations, searching for duds [above].

## Fix It

**IN THE REPAIR** shop [right], workers manually tend to broken rigs, fixing fans and replacing chips. At each workstation, scavenged jar caps are filled with new ASICs ready to be glued into place. Workers remove heat sinks from circuit boards and replace any failed chips.







## Home Sweet Repair Shop

**ONE BUILDING** ON the grounds houses a lunchroom, operational center, repair shop, and dormitory. A few dozen employees run the entire facility. Their jobs include scanning the racks for malfunctioning machines, cleaning the cooling fans, fixing broken rigs, and installing upgraded machines. Many of the employees are recent engineering graduates from the local university.

