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yuán



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源 yuán

源 means source or origin.

Used often with 开源, meaning 'Open Source'.



Interview: Bitcoin Mining Pioneer, Qi Hardware's Liu Xiangfu, on Open-Source History

By **Guest Author** - March 29, 2019

TL;DR: For the release of the **EHash Project**, the first completely open-source Bitcoin miner, we met with Liu Xiangfu. Member of **Qi Hardware** for a decade and founder of Canaan Creative, Xiangfu has been an active supporter and contributor to open-source projects long before Satoshi published his White Paper. In this interview, Xiangfu tells us how open-source has contributed to the Bitcoin mining industry in China, and his plans to reestablish the concept.

More Spice: [The Bitcoin White Paper Visualized](#)

From Suitcase to Warehouses, Liu Xiangfu's Bitcoin Mining Journey

The Wudaokou neighborhood in Northwest Beijing, affectionately nicknamed "the Wu," is the commercial and cultural hub linking the city's top universities and research institutes, attracting a

diverse body of students, researchers, and entrepreneurs. In 2012, in a small coffee shop on the upper floor of an office building near Tsinghua University, a dozen or so students and young software developers gathered for the first time around their common interest in Bitcoin.

Xiangfu Liu, founder of [Canaan Creative](#), a Bitcoin mining hardware company launched the following year, was at that meetup of Beijing-based cryptocurrency enthusiasts. “There was a very young student there, sitting in the corner,” Xiangfu recalls, being careful not to reveal any names. “Later, he founded the world’s number one Bitcoin mining pool.”

The student was pitching his online messaging group, where you could learn about Bitcoin in exchange for a 1 BTC entrance fee. “I never paid,” Xiangfu laughs, “because I could read the source code.” The meeting itself ended early when a birthday party took over the small coffee shop, turning these cryptocurrency pioneers out into the street. At the time no one in the room had any idea how far Bitcoin would go.

A Separate Place of the Internet

Fuzzy headlines have fueled the narrative of a mysterious China mining world, where data centers hide in remote mountains. While China is often considered as a separate place of the Internet, it has become one of the major centers of the blockchain world. Chinese miners especially have shaped what Bitcoin is today, by adding a whole new level of security to the chain.

Beijing, Tsinghua University, Main Building, China

These blurry pictures of journalists have failed to capture the whole story. During the last decade, the breathtaking pace of Bitcoin development relied on the capacity of Chinese hardware designers and manufacturers to organically grow and ship products.

Xiangfu, who has seen the whole Bitcoin story unfold, remembers it all started by its enthusiasm for open-source technologies. “I grew up in Northern China and when I arrived at the university in Beijing, I was very impressed by the big city,” Xiangfu explained. “I [studied] software development, but everything was about Windows. I wanted to find out more about how computers work; Windows was closed but then I found Linux. At that time, only two students in my class were interested in Linux. At the end of university, we all had to choose a direction. I realized that choosing Windows meant competing with everyone else in China, so decided to choose Linux because it was more of a specialty.”

Milkymist One

In China at that time, Linux was not so popular. “My first jobs were all under Windows but after a few years, I started working on Linux more and more,” recalls Xiangfu. “Around 2007-2008, I started to work on the Openmoko cell phone. It was before the iPhone. I worked for Openmoko for 1-2 years where I started contributing to open-source more. I wrote low level code for bootloader which talks to hardware directly. From when the power button is pushed to when the screen goes on, there is a delay. I had to wait for the hardware to power on! I was getting more interested in hardware AND software, not just hardware. You code on the platform, then the platform and the kernel, and others take care of the hardware.”

The Milkymist One (2011)

The Openmoko project faded, and Xiangfu moved on. He joined Qi Hardware and helped to build **Milkymist**, one of the first commercialized system-on-chip designs with free HDL source code. There, Xiangfu learned to program FPGA (field-programmable gate array), an advanced technology for reprogrammable CPUs. “With Openmoko, the CPU was fixed, can’t check the inside. The Milkymist had FPGA. It made more sense that software and hardware were combined,” he insisted.

In 2011, Xiangfu heard about a small group of people in Beijing building a miner. “When working on Milkymist, [I discovered] FPGA was the same one used for the first FPGA bitcoin miner. The people doing the FPGA mining were getting higher frequency on the chip, and we wondered how they were doing it. Then I tried to find out more about Bitcoin,” he remembers.

Icarus, Warm Apartment Walls

Xiangfu continued to play with FPGAs and explore Bitcoin mining. In 2012, he created the **Icarus**, an open-source FPGA miner. “No one used the blockchain at that time, only bitcoin. I decided to contribute the FPGA driver code to the open source lib CGminer. Back then, CGminer was the number one open source miner application in Bitcoin. Before the OpenWrt and CGminer, miners used a whole computer to control the FPGA miners and gpu miners,” Xiangfu detailed.

The first "baby mining farm" in a suitcase made of 20/30 stacked FPGAs

From there, he continued experimenting with mining technology. "One of my first miners fit in a suitcase. Then it was growing bigger and bigger, so I bought a much better power supply unit because I was worried about fires. The walls of my apartment were warm even in Beijing's cold winter!"

In 2012, a team started to come together in Beijing to ship a new ASIC miner, the first machine with an ASIC specifically designed for Bitcoin. "All the work was happening over the internet. There were no in-person meetings. I had to learn everything: how the hardware was made, all the factory details, etc.," explains Xiangfu.

From China to the World

Online, the war of pre-orders started. More and more people were beginning to use bitcoin, and mining machines were in demand. And back in 2012 companies, such as those in the United States, announced unrealistic shipping dates and ended up postponing deliveries for the first ASIC miners.

Avalon unboxing.

In Beijing, Canaan chose to put a big countdown on their website to announce shipment of their first product batch. On January 19, 2013, as the countdown displayed zero, and the first 300 **Avalon mining rigs** were sent out from China to the world.

“Most of my code was open-source so everyone in China start using it, often without changing it even a little,” continues Xiangfu. “I was really busy with the software so I stopped mining myself. Then, in the space of a few years, mining went from my suitcase to a basement, to entire warehouses.”

Time-to-Market and EHash

Indeed, the hashrate grew from roughly 20 transactions per second to several millions in the space of a few years. “I remember visiting one mining facility that was installed on a chicken farm. Also somewhere in the North of China, they had this huge transformer from a Russian brand. It was so hot that they had to build a small lake to put the transformer into and cool it,” Xiangfu said.

While most of the millions of machines have been shipped from companies based in Beijing, the other instrumental city in this story is Shenzhen. “The most important thing in Bitcoin manufacturing is the time-to-market. Every time BTC changes difficulty, profit changes so time becomes the critical thing to plan for. Shenzhen has such a gigantic component market that, as long as you are willing to pay for it, you can always get what you want tomorrow instead of next week. Their factory working style is super fast, plus the shipment to Beijing only takes one day,” he marveled.

The evolution of BTC Hashrate since January 2019

Factories in Beijing, on the other hand, are more inclined to work with governmental contractors. “In Beijing, you have the top two universities, and so there are lots of hi-tech people and professors. You can easily talk to them to ask for help and connections,” explained Xiangfu. “Mining farms are mostly located in Southern China because energy costs less. With all the rain in the summer, they have large excesses of hydro power so you can plug directly from dams to the mines. It usually takes a two or three-hours ride in the mountains to get there though.”

That wealth of experience and knowledge has prepared him for the next chapter. After years leading the expansion of the Bitcoin mining industry, Xiangfu announced **EHash**, a new 100% open-source miner. “I hope the contribution of an open-source design file can help the mining industry develop a standard of mining hardware for blockchain,” he explained, “so we can make mining more efficient and smooth, like a container standard for logistics.”

Clément Renaud, author. Special thanks to Qi Hardware for allowing CoinSpice to publish the interview.



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The second operating system hiding in every mobile phone

[Thom Holwerda](#) [2013-11-12](#) [Wireless](#) [42 Comments](#)

I've always known this, and I'm sure most of you do too, but we never really talk about it. Every smartphone or other device with mobile communications capability (e.g. 3G or LTE) actually runs not one, but *two* operating systems. Aside from the operating system that we as end-users see (Android, iOS, [PalmOS](#)), it also runs a small operating system that manages everything related to radio. Since this functionality is highly timing-dependent, a real-time operating system is required.

This operating system is stored in firmware, and runs on the baseband processor. As far as I know, this baseband RTOS is always entirely proprietary. For instance, [the RTOS inside Qualcomm baseband processors](#) (in this specific case, the MSM6280) is called AMSS, built upon their own proprietary REX kernel, and is made up of 69 concurrent tasks, handling everything from USB to GPS. It runs on an ARMv5 processor.

The problem here is clear: these baseband processors and the proprietary, closed software they run are poorly understood, as there's no proper peer review. This is actually kind of weird, considering just how important these little bits of software are to the functioning of a modern communication device. You may think these baseband RTOS' are safe and secure, but [that's not exactly the case](#). You may have the most secure mobile operating system in the world, but you're still running a second operating system that is poorly understood, poorly documented, proprietary, and all you have to go on are Qualcomm's Infineon's, and others' blue eyes.

The insecurity of baseband software is not by error; it's by design. The standards that govern how these baseband processors and radios work were designed in the '80s, ending up with a complicated codebase written in the '90s – complete with a '90s attitude towards security. For instance, there is barely any exploit mitigation, so exploits are free to run amok. What makes it even worse, is that every baseband processor inherently trusts whatever data it receives from a base station (e.g. in a cell tower). Nothing is checked, everything is automatically trusted. Lastly, the baseband processor is usually the master processor, whereas the application processor (which runs the mobile operating system) is the slave.

So, we have a complete operating system, running on an ARM processor, without any exploit mitigation (or only very little of it), which automatically trusts every instruction, piece of code, or data it receives from the base station you're connected to. What could possibly go wrong?

With this in mind, security researcher Ralf-Philipp Weinmann of the University of Luxembourg [set out to reverse engineer the baseband processor software](#) of both Qualcomm and Infineon, and he easily spotted loads and loads of bugs, scattered all over the place, each and every one of which could lead to exploits – crashing the device, and even allowing the attacker to remotely execute code. Remember: all over the air. One of the exploits he found required nothing more but a 73 byte message to get remote code execution. Over the air.

You can do some crazy things with these exploits. For instance, you can turn on auto-answer, using the [Hayes command set](#). This is a command language for modems designed in 1981, and it still works on modern baseband processors found in smartphones today (!). The auto-answer can be made silent and invisible, too.

While we can sort-of assume that the base stations in cell towers operated by large carriers are "safe", the fact of the matter is that base stations are becoming a lot cheaper, and are being sold on eBay – and there are even open source base station software packages. Such base stations can be used to target phones. Put a compromised base station in a crowded area – or even a financial district or some other sensitive area – and you can remotely turn on microphones, cameras, place rootkits, place calls/send SMS messages to expensive numbers, and so on. Yes, you can even brick phones permanently.

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TOPICS

This is a pretty serious issue, but one that you rarely hear about. This is such low-level, complex software that I would guess very few people in the world actually understand everything that's going on here.

That complexity is exactly one of the reasons why it's not easy to write your own baseband implementation. The list of standards that describe just GSM is [unimaginably long](#) – and that's *only* GSM. Now you need to add UMTS, HSDPA, and so on, and so forth. And, of course, everything is covered by a ridiculously complex set of patents. To top it all off, communication authorities require baseband software to be certified.

Add all this up, and it's easy to see why every cellphone manufacturer just opts for an off-the-shelf baseband processor and associated software. This does mean that each and every feature and smartphone has a piece of software that always runs (when the device is on), but that is essentially a black box. Whenever someone does dive into baseband software, many bugs and issues are found, which raises the question just how long this rather dubious situation can continue.

It's kind of a sobering thought that mobile communications, the cornerstone of the modern world in both developed and developing regions, pivots around software that is of dubious quality, poorly understood, entirely proprietary, and wholly insecure by design.

About The Author



Thom Holwerda

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42 Comments



2013-11-12 11:19 PM

andrewclunn

... at least now we know how SkyNet takes over 😊



2013-11-12 11:49 PM

tidux

In every phone I'm aware of except the OpenMoko Freerunner (which uses RS-232), the baseband speaks to the "main" SoC through DMA. That's what really makes most smartphones impossible to truly secure.



2013-11-12 11:55 PM

informatimago

It's by design of course. Just wait for another Snowden.



2013-11-13 1:12 AM

ddc_

I *hope* it is by design, but Hanlon's razor might be more adequate here: careful design would produce one small vulnerability to exploit, or several redundant vulnerabilities, but the vast number suggests carelessness and/or stupidity. Though one may easily fit on top of another...

Topics

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2013-11-13 12:52 AM

shmerl

So, basically that black box system has full access to the RAM of the device, while also being the main communication component? This is really nasty.



2013-11-13 1:23 AM

shmerl

Aren't there 3 operating systems on many phones then? SIM card contains kind of an OS too.

Edited 2013-11-13 01:24 UTC



2013-11-13 9:02 AM

Lobotomik

And Bluetooth, Wifi, GPS and touch chips have an internal processor too, running their internal software, which can be quite complex. They tend to use small ARM cores (M3, M0), and generally use an RTOS.

There are tons of RTOS for these applications, from tiny to titanic and from free to very expensive (and these axes are orthogonal): ThreadX, Nucleus, RTX, pSOS, eCOS, RTMS...

So yes, in your cellphone there are a lot more than three operating systems running at the same time.



2013-11-13 9:21 AM

pashar

Add to that storage, which runs its own firmware, usually with an RTOS. And, if smartphone has an SD card slot, SD card runs its own firmware, too.



2013-11-13 11:14 AM

Tractor

Indeed, SIM Card have their own OS too.

But they are more secure by design.

SIM Card don't accept "anything that comes from the air". Data must be properly encrypted, using industry standard algorithms (3DES or AES). Just this simple protection makes it immensely more secure than baseband OS.

Now, beyond that protection, these OS are software rubbish. They are safe mostly because they are extremely limited. Someone able to crack (or pass) the encryption layer protection would have no problem crashing the SIM card OS.

But stealing data from it ? nah, that's the hardest part. This is probably the only thing which has been properly designed in these OS.



2013-11-13 11:26 PM

fuckregistration

“ Indeed, SIM Card have their own OS too.

But they are more secure by design.

Oh yes? You might want to watch the talk of Karsten Nohl at OHM2013.



2013-11-13 4:52 PM

Carewolf

Beyond all those that run on their own chips for specific components there is also a low power operating system in most phones that run when the phone is powered off. Its main job is to react to power button key events.

edit: typos

Edited 2013-11-13 16:53 UTC



2013-11-13 1:38 AM

Berend de Boer

Very relevant warning. What kind of phone does RMS use?



2013-11-13 1:46 AM

Morgan

I would think even a modern "dumbphone" would have this nastiness in it. A modem is a modem, and even the most basic cellphone has baseband software, if I'm not mistaken. So much for going off the grid by abstaining from smartphones.

And this potentially affects much more than just cellphones. My wife's iPad and Kindle are both 3G versions, which means they have AT&T-connected modems in them. The iPad modem is "turned off" via iOS, but that doesn't necessarily mean it's off altogether. The Kindle's 3G is used every few days when she doesn't have a WiFi connection.

Beyond those devices, how many cars these days come equipped with onboard cellular connectivity? Here in the US it would be most if not all GM vehicles via OnStar, as well as Teslas. I wonder if every one of those devices have the same potential vulnerabilities as your average cellphone.



2013-11-13 1:46 AM

shmerl

May be no mobile phones at all?



2013-11-13 1:55 AM

Delgarde

Tin can and string?



2013-11-13 3:13 AM

Poseidon

He doesn't use one. He doesn't like being tracked.



2013-11-13 9:01 AM

glarepate

“ Very relevant warning. What kind of phone does RMS use?

So I googled it.

“ Cellular Phones

I see that cellular phones are very convenient. I would have got one, if not for certain reprehensible things about them.

Cell phones tracking and surveillance devices. They all enable the phone system to record where the user goes, and many (perhaps all) can be remotely converted into listening devices.

In addition, most of them are computers with nonfree software installed. Even if they don't allow the user to replace the software, someone else can replace it remotely. Since the software can be changed, we cannot regard it as equivalent to a circuit. A machine that allows installation of software is a computer, and computers should run free software.

Nearly every cell phone has a universal back door that allows remote conversion into a listening device. (See Murder in Samarkand, by Craig Murray, for an example.) This is as nasty as a device can get.

From the book Alone Together, by Sherry Turkle, I learned that portable phones make many people's lives oppressive, because they feel compelled to spend all day receiving and responding to text messages which interrupt everything else.

Perhaps my decision to reject this convenience for its deep injustice has turned

out best in terms of convenience as well.

When I need to call someone, I ask someone nearby to let me make a call. If I use someone else's cell phone, that doesn't give Big Brother any information about me.

He seems to know about this already. So he doesn't own one but he borrows them from others if he feels the need.

He doesn't seem to think that his voice can be matched by any listening system(s).
GLWT Richard.



2013-11-13 7:15 PM

theosib

What's ironic is that RMS really does have nothing to hide. He wants everything Free and out in the open, with the exception of personal things that SHOULD be private. He wants his personal privacy not because he's doing anything illegal (well, maybe he smokes a little pot, but only fascists care about that), but because he believes in the inalienable right of personal privacy.

Basically, as the leader of the "Free" world, RMS is the ideal counter-argument to "if you have nothing to hide."



2013-11-13 7:50 AM

Antartica_

But not that not all smartphone operating systems have this architecture; not Symbian, at least.

One of the differentiating points of Symbian is that it doesn't need a separate baseband processor, as the GSM stack runs on symbian; it runs on the application processor (it is mostly a cost-cutting measure, as it means the device doesn't need a separate processor for the baseband).



2013-11-13 3:33 PM

JAlexoid

Not true. Symbian requires a baseband processor. However a lot of Nokia dumbphones would not have two systems, just one.



2013-11-13 5:07 PM

Antartica_

AFAIK, Symbian 9 is shown in the official documentation as to be paired with a baseband processor, as in

http://developer.nokia.com/Community/Wiki/Symbian_OS_Internals/02_...

But Symbian 8 was single-chip capable (i.e. with no separate baseband processor); not sure if that capability was maintained in Symbian 9. See

http://www.theregister.co.uk/2006/02/14/symbian_news/



2013-11-13 11:36 PM

fuckregistration

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http://developer.nokia.com/Community/Wiki/Symbian_OS_Inter

But Symbian 8 was single-chip capable (i.e. with no separate baseband processor); not sure if that capability was maintained in Symbian 9. See

http://www.theregister.co.uk/2006/02/14/symbian_news/

It's of course the other way around.

Symbian phones lack a separate application processor, the UI runs on the baseband processor.

How can you do radio without a processor that runs it?

Think before you type.

But anyway, how does that matter? One processor or two, the baseband firmware is closed.



2013-11-14 12:16 AM
oiaohm

“ But anyway, how does that matter? One processor or two, the baseband firmware is closed.

How does it matter is in fact the critical question. If everything is in the one processor and their is a breach in any part the complete system could be breached.

Now some phones will be more safe than others.

Like baseband and gps can be sharing same processor/memory for their baseband operations. Great for emergency services and person tracking.

Symbian 8 loads the baseband firmware. So the baseband firmware is a driver under Symbian 8.

So the old Symbian 8 was a Application Processor with a Software-defined radio connected. Basically a PC does not cease to be a PC because you connect a Software defined radio or win-modem either.

What defines if it a baseband processor or an application processor is what starts first. Symbian 8 devices it is Symbian 8.

Yes this did disappear in Symbian 9. Also you would not get what was Symbian 8 style past FCC any more. You might be able to get single processor past using arm trusted extensions but the baseband would have to be starting first. Over all it simple to get past regulators with decanted baseband processor with decanted ram. There have been issues with phones sharing baseband and application space.

Yes there is a open source baseband firmware issue is legally using it. <http://bb.osmocom.org>

Yes FCC and other regulator approvals are required to transmit to your standard telephone carriers.

Of course this is not a issue when you are your own carrier out side the normal phone network. Understanding baseband to make sim cards is in fact critical to open source GSM stations like openbts.



2013-11-14 8:54 AM
fuckregistration

“ “ But anyway, how does that matter? One processor or two, the baseband firmware is closed.

How does it matter is in fact the critical question. If everything is in the one processor and their is a breach in any part the complete system could be breached.

Now some phones will be more safe than others.

The application part is completely irrelevant when it comes to the telephony functionality.

The microphone and speaker are connected to the BB processor.

A breached BB has the effect of somebody else listening to

your calls, reading your SMS.

Nobody cares about the application side.

The stuff on the application processor is just a PDA, if you have a modem in the same case does not matter.

“ Like baseband and gps can be sharing same processor/memory for their baseband operations. Great for emergency services and person tracking. Symbian 8 loads the baseband firmware. So the baseband firmware is a driver under Symbian 8.

That's just your definition, nothing accepted by the general public.

“ So the old Symbian 8 was a Application Processor with a Software-defined radio connected. Basically a PC does not cease to be a PC because you connect a Software defined radio or win-modem either.

Those phones do the demodulation in a DSP which is connected to the (BB-) processor.

The modulation is even done without the DSP involved.

Your definition of a SDR is different than the definition of the rest of the world.

“ What defines if it a baseband processor or an application processor is what starts first. Symbian 8 devices it is Symbian 8.

Again, just your gentleman definition.



2013-11-13 9:51 AM

OsQar

I'm not a security expert at all, but I've been working on mobile radio access technologies for several years, so I feel quite confident to say that some of your claims are wrong. E.g:

“The standards that govern how these baseband processors and radios work were designed in the '80s, ending up with a complicated codebase written in the '90s – complete with a '90s attitude towards security.”

Well, GSM's baseband was developed from late 80's to early 90's, UMTS' from late 90's to early 00's, and LTE's can be now be considered almost finished. I know that GSM is not secure at all now (it was when it was released, but now it has been cracked), but I'm not so sure about UMTS (CDMA is very hard to demodulate, so cracking is even worse) and LTE (OFDMA is quite a headache).

“What makes it even worse, is that every baseband processor inherently trusts whatever data it receives from a base station (e.g. in a cell tower). Nothing is checked, everything is automatically trusted.”

This is NOT TRUE. At all. Even from GSM times. Handheld devices run a bunchload of ID checks to know what basestation is sending data; and basestations also carefully allocate and check mobile ID's. This is especially true in UMTS (where you have to discriminate interfering users by using pseudorandom codes) and LTE (where you even need angle-of-arrival information to reach more users).

So, I'm not claiming that mobile basebands are inherently secure, but they're definitively not based on 80's security technology.

On the other hand, I agree with your viewpoint that the closed implementations and the huge standards are not the best way to allow the community to check for security bugs. But manufacturers are the main supporters of actual standardization bodies, so it's quite complicated to fight against it.



2013-11-13 11:25 PM

fuckregistration

“ So, I'm not claiming that mobile basebands are inherently secure, but they're definitively not based on 80's security technology.

No? Where does that claim come from?

GSM is a set of standards written in the 80s. Go to the ETSI website and look it up.

UMTS and LTE are newer, but that's a different topic.



2013-11-14 7:31 PM

benyocamela

Uh? He gave a concise reason regarding some of the newer basebands.



2013-11-13 9:55 AM

twitterfire

I'd recommend HackRF if you want to easily mess with baseband.

<http://www.kickstarter.com/projects/mossmann/hackrf-an-open-source-...>



2013-11-13 11:31 PM

fuckregistration

“ I'd recommend HackRF if you want to easily mess with baseband.

<http://www.kickstarter.com/projects/mossmann/hackrf-an-open-source-...>

It's amazing how many people here in the comments claim to have a clue about GSM basebands.

Nobody, even the author of the original article mentioned osmocombb. You may want to look it up.

What you need is a 15\$ phone, not a fucking expensive SDR. Just because you know some random piece of hardware does not put you in the position to recommend anything to anybody. If the people reading the comments here are as dumb as you they will waste hundreds of \$.



2013-11-14 7:53 AM

twitterfire

“ It's amazing how many people here in the comments claim to have a clue about GSM basebands.

Nobody, even the author of the original article mentioned osmocombb. You may want to look it up.

What you need is a 15\$ phone, not a f–king expensive SDR. Just because you know some random piece of hardware does not put you in the position to recommend anything to anybody. If the people reading the comments here are as dumb as you they will waste hundreds of \$.

That thing is only usable for GSM. With a SDR you can mess with CDMA, UMTS and LTE. Not only that, but you can do much, much more beside hacking phone networks.

Also, that piece of software is only usable as a baseband software for your own stupid phone. You can't impersonate a base station with it with ease.

Better think before posting stupid comments and embarrass yourself.

Edited 2013-11-14 07:54 UTC



2013-11-14 8:35 AM

fuckregistration

“That thing is only usable for GSM. With a SDR you can mess with CDMA, UMTS and LTE. Not only that, but you can do much, much more beside hacking phone networks.

There is no usable code released for anything other than GSM. Implementing a stack for UMTS takes man years (given a programmer who is experienced in that field already). This is unrealistic, only a purely theoretical possibility.

“Also, that piece of software is only usable as a baseband software for your own stupid phone.

Not true. There are quite a lot of applications for osmocombb, not only ‘mobile’, which is the normal MS functionality. Of course a general purpose SDR has more possibilities, but that’s well out of scope of this discussion.

“You can’t impersonate a base station with it with ease.

Yes you can.

<http://bb.osmocom.org/trac/wiki/Software/Transceiver>

That’s not any more complicated than running ‘mobile’.



2013-11-13 10:49 AM

przpgntx

“As far as I know, this baseband RTOS is always entirely proprietary.”

Not “entirely” proprietary. Qualcomm’s AMSS is based on OKL4, whose source code is available: <http://wiki.ok-labs.com/>

I remember being able to download the sourcecode from the same OKL4 version on which the AMSS of a phone of mine was based.

The OS is only a small portion of the code that runs in the baseband, though.



2013-11-13 1:56 PM

fatjoe

No, OKL4 is closed source. The old “academic” open source version on their site is nothing like the current “commercial” version running on phones.

Also, OKL4 is just a tiny tiny part of the baseband software, the rest was/is/will be closed as always.



2013-11-13 11:32 PM

fuckregistration

“As far as I know, this baseband RTOS is always entirely proprietary.”

Not “entirely” proprietary. Qualcomm’s AMSS is based on OKL4, whose source code is available: <http://wiki.ok-labs.com/>

I remember being able to download the sourcecode from the same OKL4 version on which the AMSS of a phone of mine was based.

The OS is only a small portion of the code that runs in the baseband, though.

Great. That’s the same relationship as with Darwin and Apple iOS. That gets you absolutely nothing, it’s just a microkernel.



2013-11-13 12:04 PM

gerwitz

Anyone reading this comment thread might find what's known about the iDevices interesting:

http://theiphonewiki.com/wiki/Baseband_Device

2013-11-13 1:04 PM

dsmogor

It's an RTOS and is perfectly capable of running basband and radio on the same SOC.

BlackBerry could possibly design a cheapest smartphone ever if they exploited their gem fully.



2013-11-19 11:25 PM

zima

Some Symbian devices already had that architecture, it didn't really result in major enough cost savings.



2013-11-13 3:37 PM

vrypan*[...] "While we can sort-of assume that the base stations in cell towers operated by large carriers are "safe" [...]"*

Well... If things are as described, I wouldn't trust base stations, in every country I visit.



2013-11-14 3:04 AM

robbrowsing

Perhaps this is tangential, but I just read this article on the decline of Real-Time Linux.

<https://lwn.net/Articles/572740/>

It would be nice if you could have "one kernel to rule them all" – i.e. nearly all functions in a phone handled using the Linux kernel. But I don't think that will ever happen or would be desirable/feasible in any case?

I don't think RT Linux would ever be a good fit for Mobile Phones but it's still a great project for other uses, so its loss would be sad. Maybe somebody more knowledgeable would like to disagree with me?



2013-11-14 11:29 AM

DeepThoughtdid run ENEA OSE (www.enea.com) besides the Ericsson OS.

But this was in the past.

But I am pretty sure, the iPhone 5s has at least 3 OSES:

iOS, the baseband-OS and the OS running inside the Cortex-M3 (motion controller).



2013-11-14 7:34 PM

benyocamela

I think the term OS may be a bit overextended when applied to systems which are basically rudimentary executives.



2013-11-15 7:08 AM

DeepThought

“ I think the term OS may be a bit overextended when applied to systems which are basically rudimentary executives.

What makes an OS and OS? Can we call DOS and OS? Or does an OS needs at least virtual memory? Or even a (G)UI?

Granted, the average woman/man on the street will use the term OS for Windows (and maybe Linux).

Nowadays even iOS or Android come to mind. But to me these a GP(general purpose)OS'es.

For example, QNX. This is the OS even claims to be an RTOS. But the

executive is Neutrino, the $\hat{\mu}$ kernel.
So to me, any SW which handle resource management, offers some kind of IPC and supports multiple tasks is an OS.

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FROM THE ARCHIVES

From the Archives:

The Global Economy's Shifting Centre of Gravity

Danny Quah

*Economics Department, London School of Economics
and Political Science and LSE Global Governance*

Research Article (special section)

Abstract

This article describes the dynamics of the global economy's centre of gravity, the average location of economic activity across geographies on Earth. The calculations here take into account all the GDP produced on this planet. The article finds that in 1980 the global economy's centre of gravity was mid-Atlantic. By 2008, from the continuing rise of China and the rest of East Asia, that centre of gravity had drifted to a location east of Helsinki and Bucharest. Extrapolating growth in almost 700 locations across Earth, this article projects the world's economic centre of gravity to locate by 2050 literally between India and China. Observed from Earth's surface, that economic centre of gravity will shift from its 1980 location 9,300 km or 1.5 times the radius of the planet.

Policy Implications

- If soft power mirrors but lags economic power, then the source for global and political influence will be similarly gradually shifting east over the next 50–100 years.
- Policy formulation for the entire global economy, and global governance more generally, will no longer be the domain of the last century's rich countries but instead will require more inclusive engagement of the east.
- Many global policy questions will remain the same, e.g. promoting growth in the world economy, but others might change in character, e.g. appropriate political and military intervention.

This article presents the dynamics of the global economy's centre of gravity. Studying such dynamics forms part of more general ongoing research on the world's shifting distribution of economic activity (Quah, 2010). By economic centre of gravity, I mean the average location of the planet's economic activity measured by GDP generated across nearly 700 identifiable locations on the Earth's surface. The calculations in this article take into account the entirety of GDP produced on this planet.

Grether and Mathys (2009) have previously estimated this same concept of the world economic centre of gravity, focusing on large urban agglomerations. Brinkhoff (2009) has presented related data on the planet's urban areas. The work here builds on Grether and Mathys' important contribution in two ways. First, I extend the observations to cover GDP in all of the world's economies, constructing in each national economy a spatial conditional average to stand in for the economic activity located outside the large urban agglomerations. Second, I formulate a cylindrical projection method to represent

the dynamics of the global economy's centre of gravity, taking into account that that centre of gravity is typically located in the interior of the planet.

I report below that the world's economic centre of gravity (WECG) located in 1980 at a point in the middle of the Atlantic Ocean. By 2008, however, that centre of gravity had drifted to a location at about the same longitude as Izmir and Minsk, and thus east of Helsinki and Bucharest. Of course, this change occurred not due to the emergence of Turkey or Belarus, but instead from the continuing rise of China and the rest of East Asia.

Extrapolating growth in the 700 locations across Earth, the world's economic centre of gravity is projected by 2050 to locate, literally, between India and China. Observed from Earth's surface, that economic centre of gravity will shift away from its 1980 location a distance of 9,300 km or 1.5 times the radius of the planet.

Beyond this substantive conclusion, this article contributes a methodological innovation. The study of earth projections by geographers (e.g. Snyder, 1993) has,

historically, dealt with the problem of accurately representing on a two-dimensional map locations and shapes that rest on the surface of a curved three-dimensional sphere. The subject matter is extensive but the critical result is that no perfect representation exists (Gauss's Theorema Egregium). No one representation can be necessarily more accurate than all the others in every characteristic of interest. This study seeks to represent on to the same two-dimensional map not just the usual points on the Earth's surface but locations and trajectories that penetrate the surface of that three-dimensional sphere and tunnel into the sphere's interior. Therefore, the mathematical problem is at least as intricate as that for the standard Earth projection, and the same impossibility result implies that no representation can be ideal in every possible way. Instead, what this article does is propose and apply a projection (or distance-minimising) technique to describe on a two-dimensional map the world's economic centre of gravity.

Aside from the representation problem, the equations for calculating a spatial weighted average – as for calculating any weighted average – are of course invariant and unique, and thus in this article are necessarily the same equations exactly as appear in Grether and Mathys (2009). In this direction, the current article only furthers that line of analysis initiated in Grether and Mathys (2009) by adding a set of observations to pick up the global economy located *outside* urban agglomerations: the Grether and Mathys study considered only that part of the global economy within urban agglomerations. I follow Grether and Mathys in ascribing a constant per capita income across urban agglomerations within a national economy. However, I also hypothesise a positive but lower per capita income in the areas outside those urban agglomerations. Grether and Mathys, by contrast, impute zero incomes for those (rural) areas.

While it might be tempting as a result to say that what I do here improves or makes more precise the estimation of the world's economic centre of gravity, I think it would be more useful to consider my estimates as simply being different, in substance, from those in Grether and Mathys. Since what we seek to estimate is unknown and unmodelled it is not possible to say which of our estimates is more precise or more reasonable. Comparing their table 1 and their figure 1 with Figure 2 and its table in this article cannot determine whose estimates should be preferred. Reassuringly, however, our substantive conclusions remain the same although of course the details will differ.

Finally, the world's economic centre of gravity should not be confused with a concept of *clustering* of world economic activity. To see this difference, suppose for instance that the world only had two locations, say Beijing and New York, and these two places shared equal amounts of economic activity. Then the world's

economic centre of gravity would be exactly halfway between Beijing and New York. And that centre would show exactly zero economic activity. In this example, there are two clusters – one in Beijing, the other in New York – but only one centre, precisely midway between them. Indeed, in general, as the centre is the average, there can only ever be one centre. Each of the different concepts contains useful information. Therefore, the WECG given here holds interest because it shows tendencies – the sharp eastward drift of economic activity as Beijing grows faster than New York – not because that central location is where everyone should seek their economic fortunes. For the latter, the appropriate concept is clustering, not the centre of gravity. Indeed, in the example I have just given, as long as Beijing and New York remain equal, a business would wish to locate as far as possible from the centre of gravity.

1. Motivation

Typical cross-country studies of income dynamics deduce parameters from the cross-sectional variation to help assess the causes of economic growth. Such analyses hypothesise a representative or average economy in whose properties the researcher is interested. This study, by contrast, takes its principal concern to be the dynamic behaviour of the entire spatial distribution of economic activity. The mean of that spatial distribution of income across the planet is the global economy's centre of gravity. I focus on that mean because it is a convenient and tractable representation of that distribution, not because of any inherent interest in the representative or average economy.

Why do this? There are two large sets of reasons, both concerning the dynamics of the distribution of incomes across economies. A first is that understanding the changing income distribution across economies gives insight into the future evolution of global inequality more generally (e.g. Held and Kaya, 2006; Milanovic, 2005; Quah, 2003) and thus of global justice and the state of humanity.

A second set of reasons is that such understanding provides critical input into another wide-ranging group of questions across the social sciences. Among these are questions surrounding the rise of the BRICs (Goldman Sachs Global Economics Group, 2007); the emergence of Asia (Mahbubani, 2008); the relative decline of the world's established global powers (Cox, 2007); the evolution of the world's reserve currency and, more broadly, change in the global monetary system (Chinn and Frankel, 2008); and the evolving global distribution of soft power (Nye, 2004). Such issues can be addressed only by modelling the entire cross-country distribution of economic and political activity, not by analysing a hypothetical representative economy.

2. Calculations

I took, to begin, national GDP figures adjusted for purchasing power parity (World Bank, 2010) augmented with data for Taipei China (Asian Development Bank, 2008). This provided 210 data points per year. Then I used Google Earth to determine the geographical locations of every urban agglomeration on the planet having 2009 populations exceeding 1 million (Brinkhoff, 2009 and Grether and Mathys, 2009 have previously also discussed and presented data on those locations). This gave 483 urban agglomerations on Earth. Some nation economies have no such agglomeration, others many: for example, China had 79; India, 48; the US, 54.

To add to this collection, using Google Earth again but now together with uniform spatial averaging, I located the point average across geographical extent in each of the 210 nation economies. This gave for each nation economy a single point proxying for the rural (non-urban) geography. Altogether, these 483 urban agglomerations and 210 rural proxies provided 693 identifiable locations on Earth.

Following Grether and Mathys (2009) I allocated national income across locations so that all urban agglomerations within a nation economy had equal per capita income. I assigned per capita income in the remainder of the nation economy to be 10 per cent lower than in the urban agglomerations. This last step diverges from Grether and Mathys (2009), who omitted all geographies outside urban agglomerations. Put another way, Grether and Mathys (2009) applied a rural discount of 100 per cent. I experimented with varying this rural discount between 0 per cent and 40 per cent with almost imperceptible change in the end results.

A more extensive study might attempt to model rural–urban income dynamics more carefully, and analyse changes in spatial locations as cities emerge or vanish. I do not pursue such extensions here.

To summarise, I took 693 locations to represent the spatial distribution of all the economic activity on Earth. Tracking incomes in these locations over time gives a representation of the spatial distribution dynamics of global economic activity. At any given point in time, calculating the three-dimensional weighted average across the 693 locations yields the WECG. Take the approximation that Earth ε is exactly spherical with radius R and that a location for economic activity is a point on the three-dimensional Earth's surface. Written in Cartesian coordinates,

$$\zeta = (\zeta_x, \zeta_y, \zeta_z) \text{ with } |\zeta| = (\zeta_x^2 + \zeta_y^2 + \zeta_z^2)^{1/2} = R.$$

(In future, with ongoing scientific progress, locations for economic activity might be off the Earth's surface – whether above or below – so that the last equality

would then no longer hold. However, nothing essential changes in the calculations.) Denote the collection of all urban agglomerations and rural proxies:

$$\{\zeta^{(i)} : i = 1, 2, \dots, N\}.$$

For W the measure of economic activity of interest, here income, the world's economic centre of gravity is that point $\bar{\zeta} \in \varepsilon$ such that

$$\bar{\zeta} = \sum_{i=1}^N W^{(i)} \zeta^{(i)} / \sum_{i=1}^N W^{(i)}$$

Typically, $|\bar{\zeta}| < R$, that is, this centre of gravity lies within the Earth's volume, not on its surface.

When $\zeta = (\zeta_x, \zeta_y, \zeta_z)$ is an urban agglomeration that rests on the planet's surface and has latitude φ and longitude λ measured in radians, the Cartesian coordinates relate to latitude and longitude by:

$$\zeta_x = R \cos \varphi \cos \lambda$$

$$\zeta_y = R \cos \varphi \sin \lambda$$

$$\zeta_z = R \sin \varphi.$$

The easiest way to understand this calculation is to project a point ζ on to the equatorial plane and then to decompose that projection along x and y coordinates in that plane.

The latitude and longitude of any $\zeta = (\zeta_x, \zeta_y, \zeta_z)$, not necessarily on the planet's surface, can be recovered as:

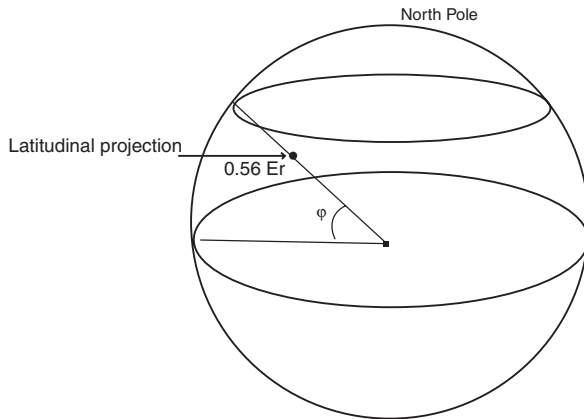
$$\varphi = \sin^{-1}(\zeta_z/|\zeta|) \text{ and } \lambda = \tan^{-1}(\zeta_y/\zeta_x) \quad (1)$$

with its distance from the physical centre of the planet given by $|\zeta| = (\zeta_x^2 + \zeta_y^2 + \zeta_z^2)^{1/2}$.

Given the data used in this article, the resulting WECG turns out to be well beneath the surface of the planet. Tracking the dynamics of such subterranean locations is not straightforward.

On a two-dimensional map any point on the Earth's surface bears a unique configuration relative to the usual landmarks of coastlines, cities and mountains. That property fails, however, for points beneath the surface of the three-dimensional planet. To see this, suppose that some sequence of points inside the planetary sphere has an east-to-west trajectory when viewed from one perspective. But when viewed from the other side of the planet that same sequence will instead traverse west to east. Since any given perspective is arbitrary in three-dimensional space, without further justification for fixing a viewing position, no discussion of the centre of gravity moving east (or west) can draw a compelling conclusion.

Figure 1. Calculating the cylindrical projection.



Note: When the WECG is 0.56 Earth's radius from the physical centre, its latitude ϕ makes it appear much further north than it actually is. The cylindrical projection realigns perspective appropriately and, by virtue of being a (distance-minimising) projection, locates the closest point on the planet's surface to the WECG.

Related to this ambiguity, latitudinal and longitudinal information for subterranean points can be visually misleading. For instance, a point close to the Earth's physical centre but only a little distance north will have a relatively large latitudinal measure. This last will make that location appear much closer to the North Pole when it is compared with other locations the same distance north of the equatorial plane but which themselves rest on the planet's surface (Figure 1). These anomalies arise from deeper technical difficulties in projecting the three-dimensional Earth on to a two-dimensional flat map. In contrast, previous mapping analyses (Snyder, 1993) have only ever considered projecting points on the Earth's surface, not locations deep underground.

To minimise this visual misperception and ambiguity, the maps I present will depict, when indicated, a WECG mapped on to the Earth's surface by projecting from the planet's north-south axis to the cylindrical surface tangent at the planet's equator. Again, see Figure 1. It might seem that such cylindrical projection necessarily exaggerates movement in the WECG. A counterexample, however, confirms it does not. Suppose the shifting distribution of global economic activity pulls the WECG further into the planet's interior but directly toward the north-south axis: then the WECG's cylindrical projection registers zero variation whereas, in reality, the physical movement can be considerable.

3. Results

In 1980 the WECG located 24 degrees West and 66 degrees North, but 2,800 kilometres (almost half Earth's

radius) beneath the surface of the Atlantic Ocean. Along the east-west axis, this location is between Iceland and Brazil. Intuitively, the 1980 WECG sat between North America and Western Europe because most of the world's economic activity then occurred in just those two geographies.

At 66 degrees North relative to the equatorial plane, the WECG might seem to be as far north as Iceland. However, measured along the north-south axis, the WECG – because it is so deep beneath the planet's surface – turns out to be only 3,200 kilometres north of the equator, approximately the same distance north as Austin, Texas, Tel Aviv or Shanghai.

This account just given suggests a way to describe the dynamics of the WECG while preserving visual intuition, as described briefly at the end of the previous section. Project the WECG onto the Earth's surface by locating both the WECG and its surface projection on the straight line that minimises the distance between Earth's north-south axis and a cylinder tangent to the equator. Roughly speaking, the projection is that point on the Earth's surface that someone would be looking at when they fix their eyes on the north-south axis while encircling Earth on the equatorial-tangent cylinder, and the WECG just comes into view. (And that observer is hypothesised to be able to look only orthogonally from the surface of the cylinder.)

Figure 2 shows the shifting WECG at three-year intervals between 1980 and 2007 in the historical sample, and then extrapolated forwards to 2049. I calculated the WECG beyond 2008 by fitting exponential trends individually for each of the nearly 700 geographical locations, and then re-estimating the WECG each year between 2009 and 2049. Along with Figure 2, I also provide a table containing longitude, latitude and radial distance of each of these WECGs, as well as the latitude of the cylindrical projection on to the planet's surface: these are the numbers used in the figure.

To emphasise again, in this construction, Figure 2 shows the sequence of WECGs not from a single fixed perspective. Instead each point in Figure 2 is from one element in a sequence of perspectives that track the WECGs as the latter traverse their trajectory.

By 2008 the WECG had drifted to a location 27 degrees East and 74 degrees North (surface projected, 31 degrees North). Viewed from the tangent cylinder, 2008's WECG appeared just south of Izmir, Turkey, on the same longitude as Minsk and Johannesburg. Over the quarter of a century since 1980, the WECG has travelled 1,135 km (18 per cent of Earth's radius) through three-dimensional space. Its surface projection – that distance perceived in Figure 2 – moved 4,800 km or 75 per cent of Earth's radius across the surface of the planet from its 1980 location in the middle of the Atlantic Ocean.

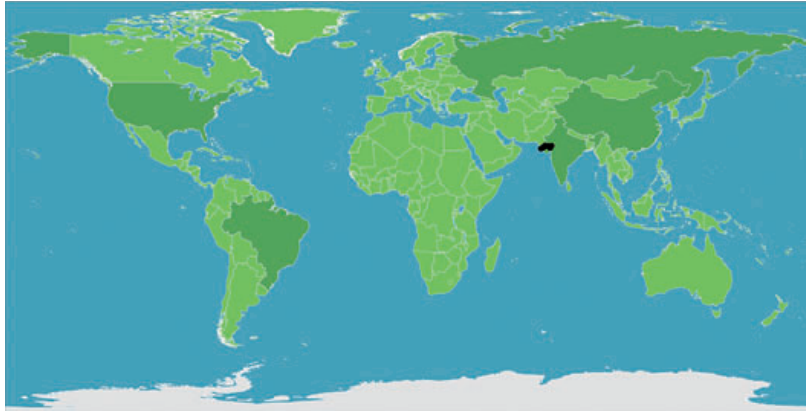
Figure 2. The world's economic centre of gravity, 1980–2007 (black) and extrapolated (in red, reduced size, italicised in table), at three-year intervals.



Year	Latitude (degrees)	Projected Latitude (degrees)	Longitude (degrees)	Radial Distance (Earth's radius)
1980	66	31	-24	0.56
1983	68	31	-21	0.56
1986	69	31	-21	0.55
1989	72	33	-6	0.57
1992	73	32	0	0.56
1995	73	32	3	0.55
1998	73	32	1	0.55
2001	74	32	6	0.55
2004	74	32	16	0.55
2007	73	31	27	0.54
2010	73	<i>31</i>	<i>35</i>	<i>0.54</i>
2013	72	<i>31</i>	<i>44</i>	<i>0.54</i>
2016	71	<i>31</i>	<i>53</i>	<i>0.54</i>
2019	69	<i>31</i>	<i>62</i>	<i>0.55</i>
2022	66	<i>31</i>	<i>69</i>	<i>0.56</i>
2025	64	<i>31</i>	<i>75</i>	<i>0.57</i>
2028	61	<i>31</i>	<i>79</i>	<i>0.58</i>
2031	58	<i>31</i>	<i>83</i>	<i>0.60</i>
2034	55	<i>31</i>	<i>86</i>	<i>0.62</i>
2037	52	<i>31</i>	<i>88</i>	<i>0.64</i>
2040	50	<i>31</i>	<i>90</i>	<i>0.66</i>
2043	48	<i>30</i>	<i>91</i>	<i>0.69</i>
2046	46	<i>30</i>	<i>92</i>	<i>0.71</i>
2049	44	<i>30</i>	<i>92</i>	<i>0.72</i>

Source: Author's calculations.

Figure 3. Flat world's economic centre of gravity, 1980–2007.



Source: Author's calculations.

Note: Karachi is the nearest large city to either 2007's or 1980's WECG.

Some readers have suggested that the WECG's eastward movement is simply an artefact of a Euro-Asia-centric perspective. Had we viewed this same sequence of points from the Pacific Ocean instead, the traversal would be westward. However, locating the map's perspective in the Pacific Ocean would not trace out the cylindrical projection – which, recall, is defined to be a distance-minimising mapping.

Another striking feature of Figure 2 is how the WECG seems to move so rigidly along a given latitude, that is, visually horizontally in the map. Does this imply that the north–south divide will remain invariant, so that even as the south grows, so too does the north?

To address this point, look at the table following Figure 2. That shows the actual latitude of the WECG in its second column. Notice that that latitude declines from 66 degrees North to 44 degrees North by 2049. This might seem to imply that the south, like the east, is actually gaining considerable relative economic strength.

However, at the same time, the radial distance of the WECG from the centre of the earth has risen, from 0.56 to 0.72 of the planet's radius. Therefore, the WECG is percolating up to the surface of the planet. These two tendencies imply that when viewed from the surface of the planet, there is little north–south movement.

To visualise this, consider drawing a circle around the Earth at about 30 degrees North on the planet's surface. Then slice that circle right into the interior of the planet. What Figure 2 shows is that the WECG remains on that slice even though drifting toward the planet's surface. I interpret this to mean that the north–south divide remains constant, and thus Figure 2 correctly illustrates the reality.

By 2049 the surface-projected WECG is forecast to approach a limit point around 92 degrees East and

30 degrees North. That location is no large city precisely but surrounding it are Urumqi, China, Kolkata, India, Dacca and Chittagong, Bangladesh and Mandalay, Myanmar. In this extrapolation, by 2050 the WECG will shift in three-dimensional space 4,250 km, or two-thirds of the Earth's radius. Its surface projection will move 9,300 km, or 1.5 times Earth's radius eastward across the surface of the planet.

The forecast limit point is close to what the WECG would be if the world were flat, that is, when per capita incomes equalise everywhere. (This uses the same evocative phrasing but is obviously a drastic simplification of themes developed in Friedman (2006).) Such a flat-world centre of gravity is arithmetically identical to a spatial average using population rather than income as weights for each location: Grether and Mathys (2009) presented exactly the same calculation and referred to it as the demographic centre of gravity. While the calculation is, obviously, the same, their and my interpretations differ for this location. In my description, I consider this flat-world centre of gravity to hold interest because it describes a possible future when per capita incomes equalise. For Grether and Mathys (2009) the interest lies in how this location is the geographical centre of the world's population. Figure 3 shows the flat world's WECG in 2009 located 68 degrees East and 38 degrees North (surface projected, 23 degrees North), close by Karachi. The WECG under this definition obviously does evolve through time but the variation – whether historical or extrapolated (not shown) – is minimal relative to that in Figure 2.

Conclusions

This article has documented the dynamics of the world's economic centre of gravity. The results show that such a

centre of gravity began in the mid-Atlantic in 1980, reflecting how most of the world's economic activity then occurred in either North America or Western Europe.

Since 1980, however, the historical evidence has implied a profound eastward shift in economic activity. In 2008 the world's economic centre of gravity had moved close to Izmir, thus having been pulled 4,800 km (75 per cent of the Earth's radius) eastward across the surface of the planet. Extrapolating to 2050, the global economy's centre of gravity will continue to shift east to lie between India and China. Measured on the planet's surface this will be a shift since 1980 of 9,300 km, or 1.5 times the radius of the Earth.

Note

I thank Michael Cox, Jean-Marie Grether, David Held, Nicole Mathys, Stryker McGuire, Eva-Maria Nag and Alastair Newton for discussions leading to this article. Two anonymous referees provided extremely helpful comments.

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Apr 7, 2019 • Jon Phillips



Matt Hope Wearing Cooling Suit 0, Photo by [Christopher Adams](#)

Hello world! This is Jon Phillips making a recap of Breakerspace HK in a way I have not done in ages, writing a review. I am going to put everything on my mind here, and continue the precedent set with the first Breakerspace, to make a recap. I begin.



Matt Hope Wearing Cooling Suit 0 Shaking Hands

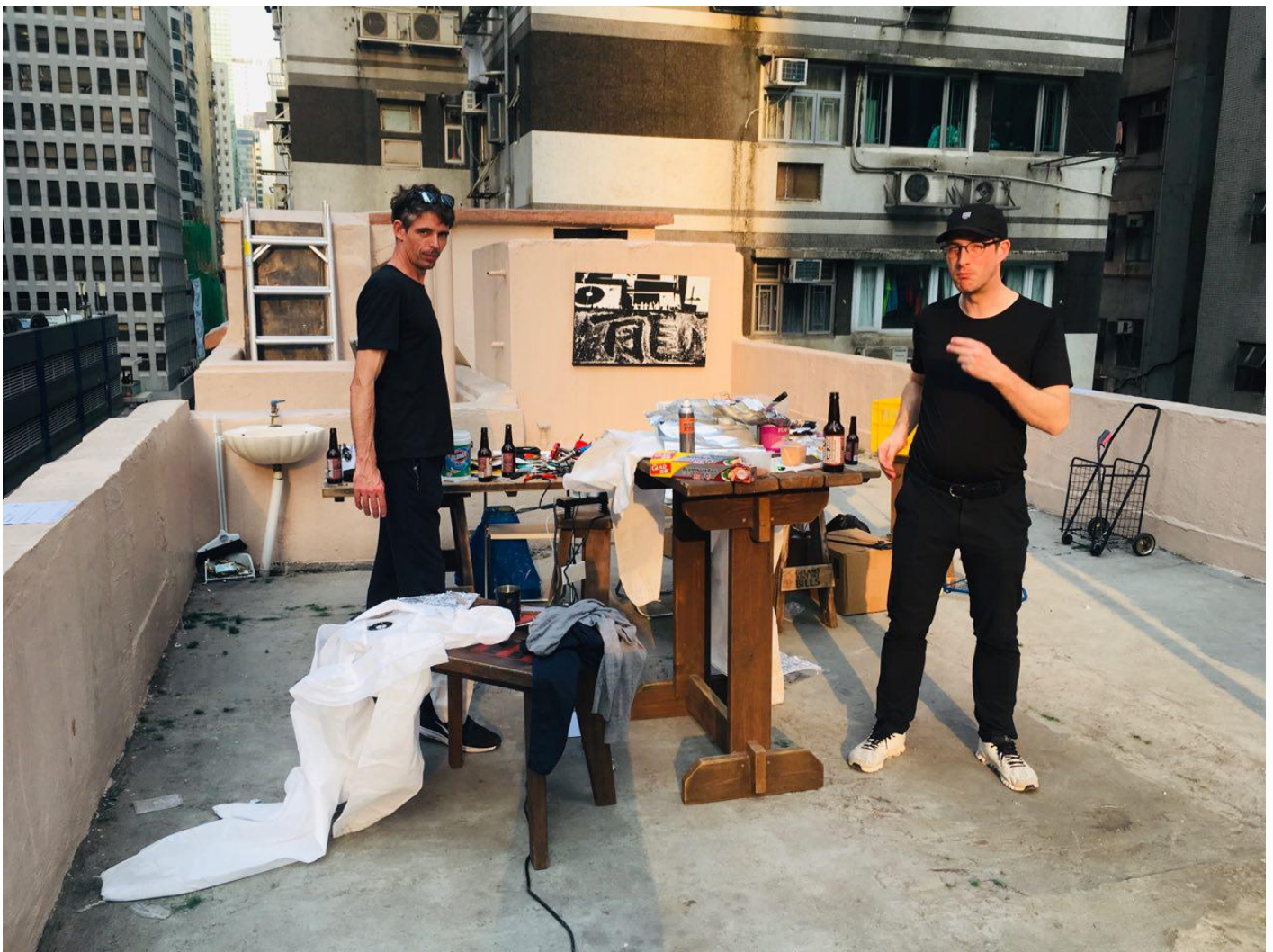
I need 10 photos, why 10 photos, because that is the max that Instagram can post and we live in that realtime world now! In this day and age, it is quite difficult to find time to review what happened. We just keep going with what we learned or dumped. However, we do have

memories.



Myself Wearing Early Cooling Suit 1, Friend & Matt Hope Wearing Cooling Suit 0

What can I say? My life was much different before I met Matt Hope! There was a time before, and now only a time after. We met at UCSD, in art grad school. I remember the first year grad art intro presentations. Everyone else described what they created and I never forget, well, I hope people forgot the funny projects I presented, but everyone was showing their amazing creations. Come time for Matt to speak, he did something no other person did: while at Winchester, he REMOVED some structural wires on the wall of the grad studio that were not necessary. While everyone else was ADDING, he was REMOVING.



Matt Hope and Barry Threw Working on Cooling Suits at #ROOFZERO, The Clubhouse HK

Zoom forwards to a few weeks ago. Matt and his family, 2 year old son were in Hong Kong doing a very un-Matt-like thing, relaxing during Chinese New Year and enjoying a family vacation. I was super proud of my friend. Now in his early 40's, we both battled our way through Beijing, both independently arriving in 2007/2008, with our own struggles. And, we both emerged. The big news, other than Matt's renewed focus on health and family, he had a show in Los Angeles in a few days of his large "guided drawings" setup by supporter Stefan Simchowicz at the Newsstand, a new project space in Beverly Hills. I of course flew to the opening and had a grand rendezvous with my friends. What a breakthrough time nearly 15 years since UCSD (and a story for in-person or another writing :).



Takes two people to put on one suit as seen with Matt Hope, Photo by [Christopher Adams](#)

Matt and I spent time together and we decided we should do something in the mold of old from when we were in UCSD, a digital happening. Matt previously came up with the idea of what one could do with all these big almost-free spaces found in St. Louis, convert them into breakerspaces. This is counter to the trend of makerspaces and co-working spaces (which by the way, we have nearly hit peak co-working). Breakerspaces are spaces where people can break down physical items into component parts and use those components to build something else. So we began on Matt's birthday, Tuesday February 18 with the idea: make a breakerspace

in HK during Hong Kong Art Week...

At this point. I will stop. Is this interesting at all? Should I continue this writing? This first part will go into the journal Scale Journal Week 13. Feedback is welcome and I will write more if this is found interesting, ok?

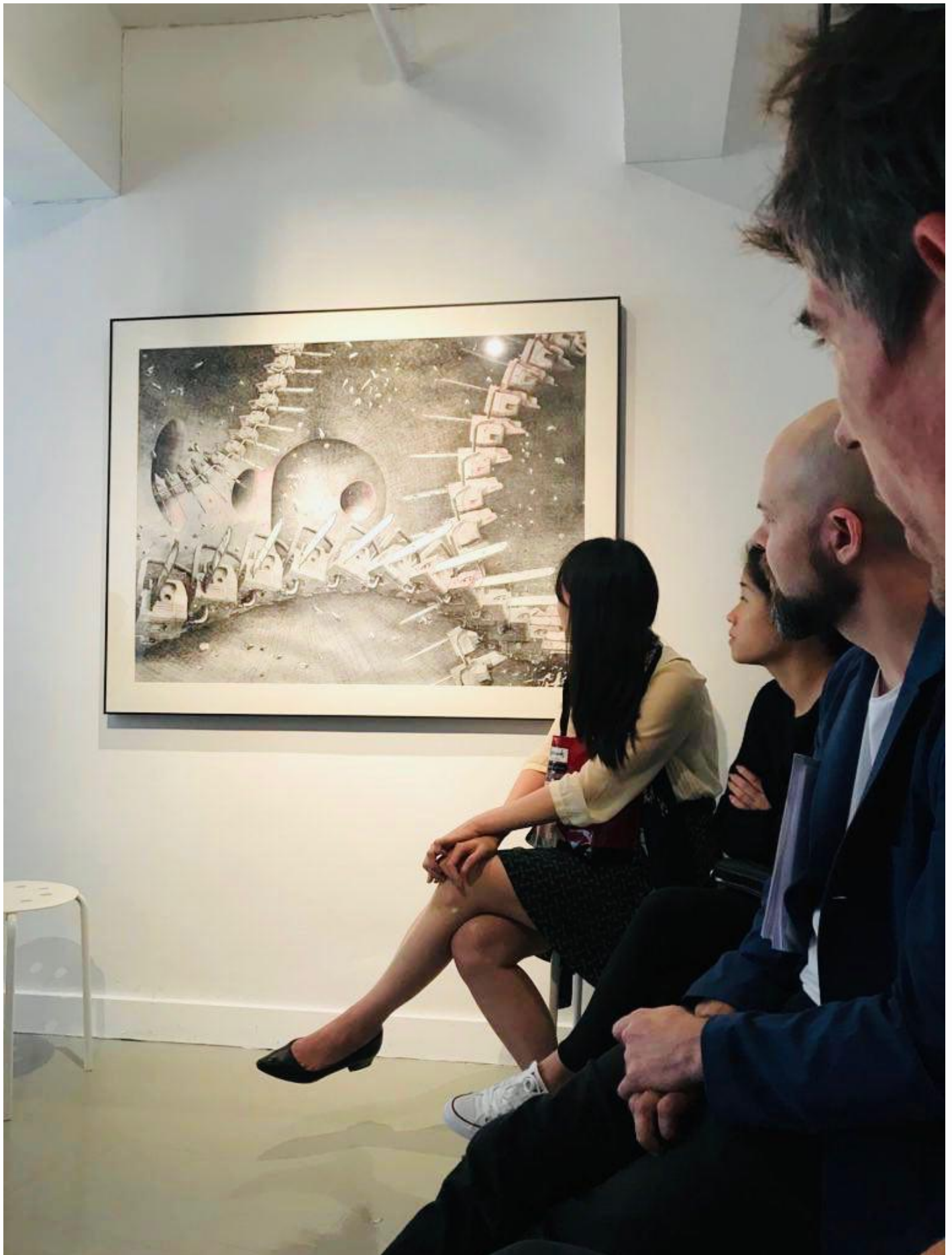


Stack of several prepared Cooling Suits for Transformation

For everyone else, here is the TL;DR recap:

[Matt Hope](#) and the [Fabricatorz](#) project to collect e-waste and transform it into #zerowaste cooling suits worked. While not easy to do, and much less easy than anticipated, 8 suits were made just

in time for a large rain storm on #roofzero, HKWalls The Clubhouse HK. Matt Hope and other breakerspacers then headed to Oui.Gallery for an opening of his guided drawings, cooling suits were worn, and more as part of the [Oui.Gallery](#) group show, [Cantoco.re](#).



Oui.Gallery's Oui.Talk Artist Talk Series with Matt Hope discussing his piece, Food Chain

Breakerspace HK Facts:

- 34 Days of Discussion and Planning from Feb 18 until March 30, 2019
- 6 Days of Execution or “Breaking”
- 40 Days in Total of Breaking :)
- 3-7 Active Collaborators Each Day of Breaking
- 8 Cooling Suits Produced
- 1 Wechat Group with 50 People and growing made
- 1 Wechat Communication System Explored with Gif Animations
- 1 Art Gallery Opened, Oui.Gallery HK
- 1 Initial Art Show Created in Service of that Gallery, “GONG HEI”
- 1 Group Show, Revival of Cantoco.re Brand and Name
- 1 New Breakerspace, aka Breakerspace HK or BSHK
- 3 Parties, #ZEROWASTE #STREET #ART #PARTY, #roofzero happy hour & Cantoco.re Opening
- 2 E-waste Collection Points: Oui.Gallery and The Clubhouse HK
- 1 New Cryptocurrency, Hope Coins or “Hopes”
- 25,920 “Hopes”
- 2 Venues in one HK: #wastezero at Pedder & Hollywood and #roofzero at The Clubhouse HK
- 1 Artist Talk, Oui.Talk with 3 Artists Present, Matt Hope, Kingson Chan, and Gianluca Crudele
- 1 Zerowaste Hike
- 10 Bags of E-waste Collected and Converted to #zerowaste
- 7 Partners and Sponsors



Matt Hope's Entropic Bodies Cooling Suit 0 laid out on the ground

For more information

- [Oui.Gallery Cantocore Exhibition Open Until Friday, April 12 in HK](#)
- [Matt Hope Website](#)
- [Jon Phillips Website](#)

About Matt Matt Hope

Matt Hope (born 1976, London, U.K.) lives and works in Beijing, China. Hope received his M.F.A. from the University of California, San Diego in 2004. Selected recent solo exhibitions include Art Lights up Life: People's Power Station – Lighting Up Project, Guangzhou, China, 2016; Sun Dragon Hardware, Ace Gallery, Los Angeles, 2015; and Spectrum Divide, Saamlung Gallery, Hong Kong, China, 2012. Selected recent group exhibitions include Desert Island -

Epicenter Projects, Coachella Valley Art Center Indio, California, 2017; Shenzhen Biennale of Contemporary Art, Shenzhen, China, 2017; BI-City Biennale of Urbanism\Architecture, Shenzhen, China, 2016; BOOSTER: Art Sound Machine, MARTA Herford Contemporary Art Museum, Herford, Germany, 2016; The Solutions, International Design Exhibition, Chengdu Biennale, Chengdu, China, 2011; and What if, Beijing International Design Triennial, China National Museum, Beijing, China, 2011. <https://matthope.org>

About Jon Phillips

Jon Phillips is Co-Founder of Oui.Gallery and Fabricatorz, a global art technology studio. His projects have been exhibited at the Venice Biennale, SFMoMa, ICA London, OCAT Shenzhen, and featured in Wired, the Washington Post, BBC, Al Jazeera, CNN and the Guardian. He lives in Saint Louis and Hong Kong, and is currently working daily on blockchain projects.

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A real Linux distribution for phones

and other mobile devices.



Alpha version. Calls don't work, etc. Only suitable for hackers.

ABOUT

We are sick of not receiving updates shortly after buying new phones. Sick of the walled gardens deeply integrated into Android and iOS. That's why we are developing a sustainable, privacy and security focused free software mobile OS that is modeled after traditional Linux distributions. With privilege separation in mind. Let's keep our devices useful and safe until they physically break!

[Sounds good, tell me more about the vision >](#)

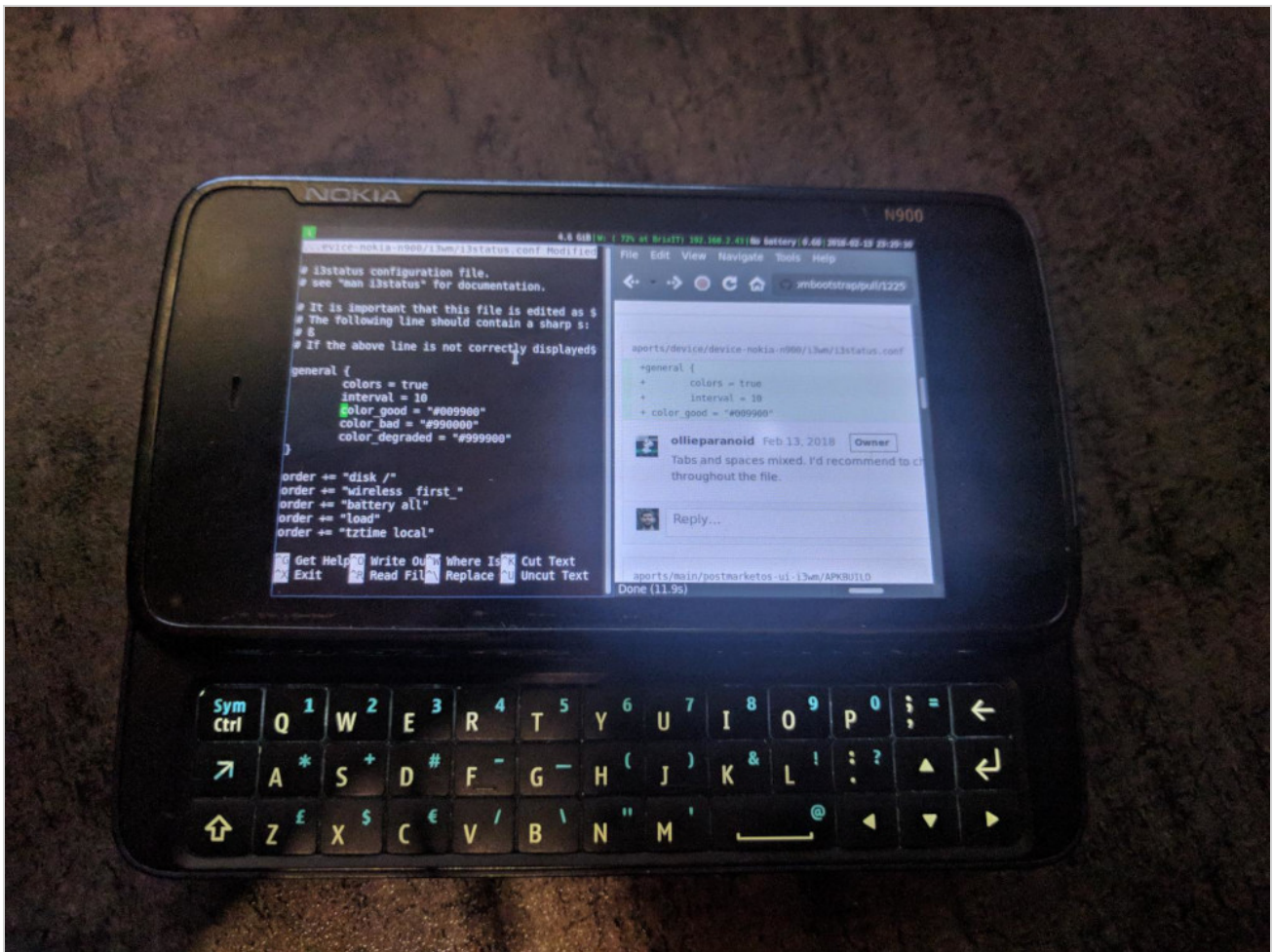
[Don't forget to worry about proprietary firmware >](#)

OVER 100 BOOTING DEVICES



GOOGLE NEXUS 5

We've replaced the end-of-life Linux kernel fork from Android with a kernel running close to mainline. Proprietary userspace blobs from Android are not necessary to make use of the GPU or connecting to the modem anymore, instead the free software components freedreno and oFono can be used. This allows running Plasma Mobile (in the picture) and other sophisticated UIs with decent performance.



NOKIA N900

The N900 has been upgraded to use the mainline kernel as well. While its RAM size and CPU power is surely limited, the attached hardware keyboard still makes it a great minimal hacking device. After all, keyboard-optimized interfaces (such as [i3](#), in the picture) and terminal applications are known to be lightweight. [XFCE4](#) is another UI that works fine with it.

[Show me all devices >](#)

[Give me that battle tested porting guide >](#)

[Tell me how to spin it up in a VM on my PC >](#)

WHAT OTHERS SAY

"postmarketOS, Plasma Mobile's favorite platform, is now 1 year old! In one year, development has been astounding, and pmOS is shaping up to be THE through and through Free mobile distro of the future."

KDE Community, 2018-06-11

ARCHITECTURE

We avoid Android's build system entirely. Instead of building a monolithic system image for each and every device, the whole OS is divided into small packages. These same package binaries can be installed on all devices that share the same CPU architecture. Device specific parts are kept as minimal as possible, ideally there is only one device package. In practice there is often the downstream Linux kernel too, but we are trying to replace those with the mainline kernel wherever possible. In the spirit of most other Linux distributions, multiple user interfaces from upstream projects are packaged for postmarketOS, such as Plasma Mobile and Hildon from Maemo Leste.

postmarketOS is based on Alpine Linux, which is so tiny (less than 10 MB in size) that development of pmOS can be done quickly on *any* Linux distribution. We install Alpine in multiple chroots to cross compile packages, build and flash postmarketOS, run it in a VM with QEMU or interactively port new hardware. All with our lightweight Python script pmbootstrap, without installing anything on the host system. Writing packages is easy, by the way: as long as you know how to write shell scripts, you are good to go. We have continuous integration in place that makes sure everything builds that gets submitted to our packages repository, among other sanity checks.

The above design decisions make it feasible to keep the system up-to-date, for all devices at once! Compared to Android, it makes development more efficient and democratic: you don't need to afford a powerful and expensive PC to rebuild the entire OS. Just build the tiny part that you are interested in modifying.

Speaking of modifying, due to the free software nature of the project, you can change pretty much everything. We don't even require running proprietary Android userspace drivers. In fact all proprietary components (even the WLAN, cellular modem and bluetooth firmware) are optional and you are asked whether you want to include them in your installation. The plan is to binary patch security issues in proprietary firmware with programs like nexmon one day, or even straight liberation with free software.



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Linzhi Ltd

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Canaan Creative

From Wikipedia, the free encyclopedia
Jump to navigation Jump to search

Canaan Creative, known simply as **Canaan**, is a computer hardware manufacturer based in Beijing, China. It produces application-specific integrated circuits (ASICs) for use in bitcoin mining.

Founded by N.G. Zhang in 2013,^[1] Canaan invented the first Bitcoin-specific ASICs.^[2] Canaan is known for using open source software in its products.^[3]

As of September 2018 Canaan was the world's second-largest mining hardware manufacturer.^[4] On May 15, 2018, Canaan filed for an IPO on the Hong Kong Stock Exchange, seeking to raise US\$1 billion.^[5]

As of September 2018 Canaan's chip architect and former CTO, Chen Min, launched a new company called Linzhi to create a new line of Ethereum miners with a code name of Lavasnow which mine Ethereum at 1,400 million hashes per second.^{[6][7]}

As of October 2018 In October 2018, Canaan announced its newest miner, the 911 which reportedly has performance of 18 Terahash per second and the power consumption of 1440 Watts.^[8] This is the second miner in the 9 series behind the 921 which is also powered by Canaan's 7 nm process ASIC chips says Canaan representatives.

As of November 2018 In November 2018, Canaan allowed its Hong Kong Stock Exchange filing for \$1 Billion USD to lapse and expire.^[9]


As of December 2018 In December 2018, Canaan reportedly raised 'hundreds of millions of dollars'.^[10]

As of January 2019 In January 2019, reports surfaced that Canaan is currently considering an IPO in the United States.^{[11][12]}

As of February 2019 In February 2019, according to documents filed, Canaan Co-founder and board member since 2013, Xiangfu Liu is no longer a board member of Canaan Creative and stepped away from his day-to-day role at the company due to "disagreements" over the companies strategy.^[13]

As of March 2019 In March 2019, Canaan Co-founder, Xiangfu Liu released "open source" plans for the Bitcoin Miner Canaan A851 and earliest miner the FPGA Miner, Icarus, along with other design files.^{[14][15]}

Canaan Creative CO., LTD

	
Type	Private company
Industry	Consumer electronics Computer hardware
Founded	2013
Founder	N.G. Zhang, Chen Min
Headquarters	Haidian District, Beijing, China
Area served	Selected markets List: China Hong Kong Taiwan Singapore Malaysia Philippines India Indonesia Israel Brazil United States United Kingdom France Germany Turkey Nepal
Key people	N.G. Zhang, Chen Min
Products	Computer Processors Computer Hardware
Number of employees	Approximately 100
Website	Canaan Global (http://canaan.io/en/)

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- 2 Pre-Canaan Pre-Avalon FPGA Miners
- 3 Avalon Product Line History
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-



Pre-Canaan History

In 2010, while still pursuing a Ph.D. degree in electrical engineering, Ngzhang discovered Bitcoin. In November 2011, Ngzhang announced on Bitcointalk the world's first dedicated bitcoin mining hardware named "Icarus" using FPGA technology.^[16]

The follow-up product came in May 2012 with the second FPGA-based design, the Lancelot.^[17]

In 2012, upon the release of Icarus, the Bitcoin community and industry gave much attention to the project. Then Ngzhang founded the Avalon Project as the brand to launch bitcoin mining hardware and Avalon ASIC semiconductors. And, because the software around the chips is open source, many engineers joined the project.^[18]

Pre-Canaan Pre-Avalon FPGA Miners

Name	Release Date	H/s	Watt	Voltage	Connection	Pictures
Icarus ^[16]	2011-11	360M	19.2	12	USB	
Lancelot ^[17]	2012-5	400M	26	12	USB	

Avalon Product Line History

Avalon is a Canaan Creative brand and product line offering both bitcoin mining machines and semiconductor chips under the same name. The project was originally created by Zhang Ng, known also as "ngzhang".

By January 2013, the Avalon Project successfully developed the world's first dedicated bitcoin mining ASIC chip, the Avalon1 A3256. A month later, Avalon announced a product, the Avalon1 3module which used the Avalon1 A3256 chip. The Avalon1 had the equivalent SHA-256 algorithm calculating power as the most powerful graphics card at the time, AMD's HD5970^[19] Test's performed showed that the chip was 110 times more powerful than the previous FPGA calculating power. This also meant that use of graphics card "GPU" bitcoin mining had also been surpassed with the Avalon1.

In August 2013, the Avalon Project launched its second generation of dedicated bitcoin mining ASIC chips, the Avalon2 A3255. Soon after, the "Avalon2 Single" hardware product using a single Avalon2 A3255 chip, was released. Unlike past machines, the Avalon2 does not operate in standalone mode. During the design of the Avalon2, a bottleneck in mining performance was realized with a standalone-only design. Therefore, the Avalon2 also is operated with an external controller so multiple Avalon2 Single units can be operated in parallel to reduce peripheral costs. The mining power in Bitcoin shifted from a single user's running individual mining machines to running Bitcoin mining farms.

In April 2014, the Avalon Project launched the third generation dedicated bitcoin mining chip the Avalon3 A3233 after 1 year and 3 months from its predecessor. In that time, the Bitcoin industry grew around the world. The Avalon Project also launched the Bitcoin hardware product, the Avalon3 using the Avalon3 A3233 ASIC chip and an open source Web-based management software called AMS (Avalon Management System).^[2]


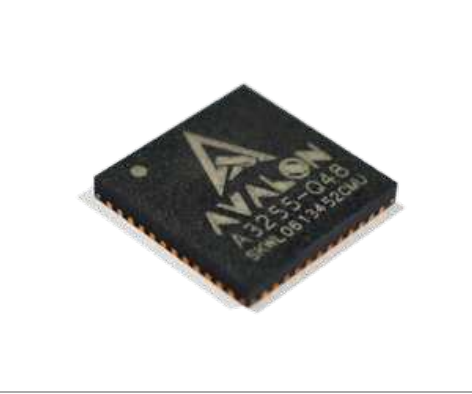
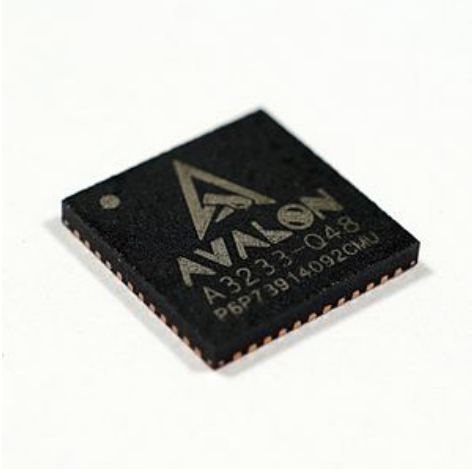

In August 2014, Avalon released the Avalon nano with a single A3233 chip on a small unit one can simply plug into a USB port for power and mining.

By September 2014, the Avalon Project entered advanced IC (ntegrated circuit) design by releasing the Avalon3 A3222 chip using a 28 nm ASIC chip manufacturing process.

In October 2014, the Avalon4.0 mining hardware was released using 40 Avalon A3222 chips to bring 1T or 1 Terahashes per second SHA-256 Hashing power.

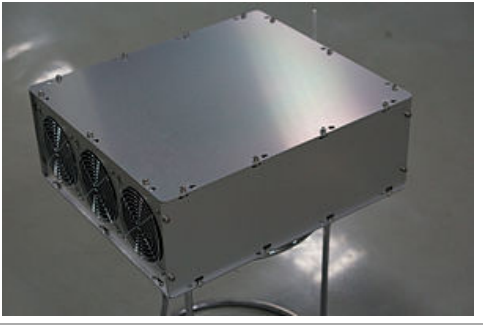

The latest hardware release came in October 2015 is the Avalon6 which uses 80 updated A3218 Avalon ASIC chips to achieve a 3.5T hash rate.

ASIC Processors







ASIC	Release Date	Process	HS	Voltage	Watt/GHs	Packing	Pictures
A3256 ^[20]	2013-1	110 nm	295MH@375 MHz	1.15V	6.6	QFN48 - 7X7, 0.5mm pitch	
A3255 ^{[21][22]}	2013-8	55 nm	1.5GH@750 MHz	0.8V-1.0V	1.6 - 2.45	QFN48 - 7X7, 0.5mm pitch	
A3233 ^{[2][23]}	2014-4	40 nm	7.08GH@600 MHz	0.55-0.85V	0.75 - 0.99	QFN48 - 7X7, 0.5mm pitch	
A3222 ^{[24][25][26][27]}	2014-9	28 nm	25GH@400 MHz	0.65V-0.8V	0.4 - 0.6	QFN56 - 8X8, 0.5mm pitch	



A3218	2015-9	28 nm	47.5GH@500 MHz	0.6V-0.7V	0.28 - 0.29	FCLGA - 8X8		
A3212	2016-9	16 nm	83GH@Auto MHz	0.4V-0.5V	0.12 - 0.13	FCLGA - 8X8		
A3210HP		16nm			0.095			
A3210M		16nm			0.090 - 0.100			
A3206	2018-8	7nm			0.089			
A3205	2019-3	16nm			0.056			

Avalon Miners

Name	Release Date	ASIC	ASIC Amount	H/s	Watt	Voltage	Connection	Pictures
Avalon1 3module ^{[28][29][30]}	2013-1	A3256		72G	600	100 - 240Vac	USB	
Avalon1 4module ^{[31][32]}	2013-6	A3256		90G - 110G	750	100 - 240Vac	USB	
Avalon1 mini ^{[33][34][35]}	2013-7	A3256		60G	595	100 - 240Vac	USB	

Avalon2 single ^[36]	2013-10	A3255		105G - 115G	340 - 385	12Vdc	USB	
Avalon3 single ^{[37][38]}	2014-5	A3233		295G - 325G	342 - 410	12Vdc	IIC	
Avalon3 3module	2014-6	A3233		710G - 970G	668 - 1235	12Vdc	IIC	
Avalon nano ^{[39][40]}	2014-8	A3233		1G - 3.6G	1 - 6	5Vdc	USB	
Avalon4.0 - 1T ^{[41][42][43][44]}	2014-10	A3222		800G - 1T	419 - 600	12Vdc	IIC	

Avalon4.1 - 1.3T ^{[45][46]}	2015-1	A3222		800G - 1.3T	419 - 990	12Vdc	IIC	
Avalon4 mini ^[47]	2015-7	A3222		30G - 78G	12 - 32.4	12Vdc	USB	
Avalon nano2 ^[47]	2015-8	A3233		1G - 4G	1 - 6	5Vdc	USB	
Avalon6 V6.0	2015-10	A3218		3.5T±5%	1050	12Vdc	IIC	
AvalonMiner 721	2016-10	A3212		6T -5% ~ +10%	900 - 5% ~ +15%	12Vdc	IIC	
AvalonMiner 741 ^[3]	2016-12	A3212		7.3T - 5% ~ + 15%	1150 +0% ~ +15%	12Vdc	IIC	
AvalonMiner 821	2017-12	A3210		11T -5% ~ + 15%	1200 +0% ~ +15%	12Vdc	IIC	

								
AvalonMiner 841	2018-3	A3210HP	104	13.6T	1290	12Vdc	IIC	
AvalonMiner 851		A3210M	104	14.5T	1450W	12Vdc	IIC	
AvalonMiner 911		A3210M	204	19.5T	1750W	12Vdc	IIC	
AvalonMiner 921	2018-8	A3206	104	20T	1800W	12Vdc	IIC	
AvalonMiner 10	2019-3	A3205	240	31T	1736W	176 ~ 264Vac (PSU included)	IIC	

Other products

In August 2018, Canaan announced a TV set that supposedly called "AvalonMiner Inside" which is a TV set with processing power of 2.8 trillion hashes per second.^[48]

In October 2018, Canaan announced the creation of a KPU or knowledge processing unit with an official title of Kendryte.^[8] Other products Canaan is working on include a "cloud computing heater" and a mobile mining farm called an "Avalon Box".

As of October 2018 As of October 2018, from Canaan's official website, it is unknown if these products were actually released or exist.^[49]

Acquisition history

The company attempted a reverse acquisition for \$466 Millions USD by Shandong Luyitong (LYT), publicly traded company on the Shenzhen stock market.^{[50][51]} After the acquisition, Canaan Creative would have been a wholly owned subsidiary at that point.^{[52][53]}

Public reports stated that, "Luyitong [would have] paid roughly ¥1bn (approximately \$152m) in cash, and issued 81 million shares at an average price per share of ¥24.57 (\$3.74), representing an additional ¥1.99bn (roughly \$303m)."^{[53][54][55][56]} Reports say that Canaan's "strong sales projections fueled the valuation, and that it anticipated a net profit of \$27m for 2016, with expectations of \$39m and \$53m in 2017 and 2018, respectively."^[54]

The attempted deal was an investment in Canaan's future as noted by founder, N.G. Zhang's statement, "This acquisition and investment provides us the necessary resources and autonomy to make even better products and innovations that our customers expect."^{[55][57]}

However, in the end, the deal did not happen as noted by Coindesk. "While Canaan spent time and resources pulling together this deal, those efforts are not wasted. They are contributions to our future. Internally Canaan strengthened its management structure, refreshed our public image, and have our product pipelines flowing to deliver solid reliable and efficient bitcoin technology solutions worldwide," said N.G. Zhang, Canaan's CEO.^[58]

See also

- Blockchain
- Bitcoin
- Qi Hardware
- Open Hardware

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External links

- Official Website (<https://canaan.io/>)
- Official Github Account (<https://github.com/Canaan-Creative>)
- Canaan Creative on Crunchbase (<https://www.crunchbase.com/organization/canaan-creative>)

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Qi hardware

From Wikipedia, the free encyclopedia

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Qi hardware is a project which produces copyleft hardware, in an attempt to apply the Free Software Foundation's GNU GPL concept of copylefting software to the hardware layer. The project is both a community of popular open hardware websites and a company, co-founded by Wolfgang Spraul and Yi Zhang, that makes hardware products. Formed from the now defunct Openmoko project,^[1] key members went on to form Qi Hardware Inc. and Sharism At Work Ltd. Thus far, the project has released the Ben Nanonote,^{[2][3][4][5]} the Milkymist One,^[6] and the Ben WPAN wireless project^{[7][8][9][10][11]} to create a copyleft wireless platform.

Copyleft hardware is essentially requiring that all plans for hardware design (i.e. schematics, bill of materials and PCB layout data) are released under the Creative Commons license Attribution-ShareAlike (CC BY-SA) and that the software needed to both manufacture the device and at least some software, including device drivers, necessary to use the hardware is released under the GNU General Public License. Technology for copyleft hardware are to be patent-free, and hence, all hardware which is Qi hardware is to be released early, often and publicly on the Internet.

The primary examples of Qi hardware projects are the Ben NanoNote pocket computer, Elphel 353 video camera and Milkymist One video synthesizer.

Contents

- 1 Products
- 2 See also
- 3 References
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Products

- Ben Nanonote, a Linux/OpenWrt based pocket computer
- Milkymist, a device for interactive visual effects for video performance artists (VJ)

See also

Qi Hardware Inc.



Type	Public
Industry	Computer hardware Computer software Consumer electronics Digital distribution
Headquarters	San Francisco, California, U.S.
Number of locations	Beijing, Hong Kong, San Francisco, Taipei
Area served	Worldwide
Products	Products list Ben Nanonote Milkymist

- List of open source hardware projects
- Amateur radio and Amateur television
- Do it yourself (DIY)
- Electronic design automation
- Engineers Without Borders
- FreeCAD (software)
- Free content
- Free software
- Homebrew Computer Club
- Graphics hardware and FOSS
- Open CASCADE - software development platform freely available in open source.
- Open content
- Open design - Open-source physical design with a wider focus
- Open source
- Open-source software
- Open-source robotics
- Open Hardware and Design Alliance (OHANDA)

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External links

- Official website (<http://qi-hardware.com/>)
- Nanonote (<https://web.archive.org/web/20121212152804/http://nanonote.cc/>)
- Milkymist One VJ workstation (http://en.qi-hardware.com/wiki/Milkymist_One)
- Ben WPAN (http://en.qi-hardware.com/wiki/Ben_WPAN)
- Identi.ca (<https://web.archive.org/web/20110727102957/http://identi.ca/qihardware>)

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