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FILECOIN'S INITIAL COIN OFFERING: USING BLOCKCHAIN TO DECENTRALISE STORAGE

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> *This sale was a wild ride for us, and likely for you too. We pulled things off mostly smoothly, but there were some issues and lots of lessons learned.*[1]
>
> Filecoin Team

In August 2017, Filecoin, a blockchain-based cloud storage startup, was preparing to raise funds through a novel funding mechanism called the initial coin offering (ICO). An ICO typically offered to-be-released tokens (i.e., "coins") associated with a new business venture, as opposed to the case of an initial public offering (IPO) where investors were offered a stake in the private company. Even before its ICO, Filecoin had already garnered considerable interest by raising US$52 million from its pre-sale to a select group of institutional investors.[2] In the absence of an actual product or service, the fledgling startup still managed to gather a sizeable war chest to realise its vision of decentralised storage network.

What was Filecoin? How did it work? Was it another virtual currency that followed the long trail of others, such as Flooz before the dot.com bust at the turn of the millennium, and the more recently Bitcoin and Ethereum? How did Filecoin relate to cryptocurrencies and other tokens, such as Bitcoin and Ethereum, and more broadly, blockchain technology? How did it raise capital through an ICO? What were the promises and perils behind its endeavour? Ultimately, would you invest in it?

Associate Professor Low Buen Sin and Research Fellow Wee-Kiat Lim prepared this case based on published sources. This case is intended for class discussion and learning, and not intended as source of research material or as illustration of effective or ineffective management.

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GENESIS AND ANATOMY OF FILECOIN

Since 2010, Filecoin Founder Juan Benet had been active in the tech entrepreneurial scene even before he graduated with a Masters in Computer Science from Stanford University. In 2014, Juan founded Protocol Labs with the aim to create more open source network protocols that would help make the Internet more open and accessible to everyone. (See **Exhibit 1** for significant events and milestones in Filecoin's development.)

Among the several projects that Protocol Labs embarked on was Filecoin. Juan and his associates were proponents of a decentralised Internet, believing firmly that the emerging blockchain technology could be the vehicle to support their cause. (See **Appendix 1** for brief biographies of Juan Benet and his team.)

> *We believe it is incredibly important to improve the properties of the Internet with the ideas of decentralisation and peer-to-peer knowledge.*[3]
>
> Juan Benet, Founder and CEO, Protocol Labs

Specific to Filecoin, Juan and his associates surmised that the time had come to tap into the "hundreds of exabytes" of unused latent storage worldwide and possibly create the largest distributed and decentralised cloud storage network.[4] Otherwise, they argued, such storage was simply "getting depreciated and wasted, and a lot of people are losing money every second…. [This] could be put online and actually provide a valuable service to the world, and it could drop the price of storage significantly."[5]

One exabyte was equivalent to one billion gigabytes. Filecoin as a storage network would behave like a market in a manner of Airbnb, where unused storage of individual owners could be offered and rented using Filecoin as the token for all transactions.

Filecoin's ecosystem, as conceived by Juan and his team at Protocol Labs, comprised clients (i.e., users), miners, and partners.[6] The boundaries across the three groups were porous, meaning to say, an individual or an organisation may assume multiple roles.

Clients, for example, could be a company that both required storage and partnered with Protocol Labs to strengthen the Filecoin protocol at the same time. Other clients would include users of cloud storage, consumers of data, web companies and developers, and even organisations storing or serving significant volumes of data (e.g., research institutes, Big Data firms). Miners covered existing cryptominers who were already invested in other cryptocurrencies (e.g., Bitcoin), cloud storage companies, data warehouses, and individuals with spare storage. Partners, according to Filecoin, would be storage hardware manufacturers, Internet service providers (ISPs), data centres, developers, and investors.[7]

Not surprising, a lot of work had to be done to develop the ecosystem. Protocol Labs had to develop components, such as the mining software, the client software, user interfaces and apps, network infrastructure and monitoring, and third-party wallets and exchanges that could support Filecoin. Developers would also need tools that would help Filecoin integrate with other data storage software and for web applications. There were other tasks, including deploying the network, scaling Filecoin's growth in a sustainable way, and to market to miners, clients, and partners, bringing them into the ecosystem.

Juan and his associates planned to organise Filecoin transactions into storage and retrieval markets. The storage market would allow clients to pay storage miners to store data, while the retrieval market would, in turn, pay retrieval miners to deliver data to clients. In both cases, clients and miners could either set their offer and demand prices or accept current offers.

Filecoin miners would have to compete with one another to mine blocks with sizable rewards. At the same time, Filecoin mining power would be proportional to active storage, meaning that miners with more storage could mine more tokens. This feature would be a more attractive incentive for miners to accumulate as much storage as they could for rental. According to Juan, compared to Bitcoin which was designed to be a form of currency and nothing else, Filecoin with its attendant storage capability would be a far more useful service to clients.[8]

Juan and his team also envisioned that, in due time, Filecoin tokens could also be exchanged for cryptocurrencies, such as Bitcoin and Ethereum, as well as existing fiat currencies, such as US dollars, Japanese yen, and euros. They believed their initiative had the potential to improve the livelihoods of people who had the entrepreneurial flair to rack up as many hard drives as they could find, so as to earn more Filecoin tokens. They had ambitious dreams for Filecoin, envisioning that this initiative could develop into something that would be adopted universally across various domains.

> *[Filecoin tokens] can have other uses too, for example, using it as collateral for data storage contracts, or for different international entities to pool resources in order to back up critically important data. We have big plans to store major infrastructure data on the Filecoin network, things like Wikipedia, Open Access scientific journals, large datasets, government records, and more. Other entities we've been speaking to are very excited to store their massive datasets – some public, some private – in the Filecoin network, to ensure the data is stored and served resiliently and cheaply.*[9]
>
> Juan Benet, Founder and CEO, Protocol Labs

Filecoin captured the attention of several investors, including established venture capital players, such as Sequoia Capital, Andreessen Horowitz, and Union Square Ventures.

> *The web is consolidating at the applications layer around a small number of data monopolies and we're really big believers in the re-decentralisation of that wonderful resource, and when we first met Juan, we realised that what he was doing is one of the real keys to making that possible.*[10]
>
> Brad Burnham, Partner, Union Square Ventures

"Hard Drives Instead of Hashers": IPFS and Blockchain Technology as the Backbone of Filecoin

Juan Benet once quipped that Filecoin was like Bitcoin, albeit "with hard drives instead of hashers".[11] "Hashers" referred to miners who earned value by tapping into blockchain technology when they built new blocks and verify transactions. It was tempting to compare Filecoin with Bitcoin, which like several other cryptocurrencies and token networks, relied upon blockchain technology to function. (See **Appendix 2** for a brief introduction to blockchain technology and Filecoin.) It was the "hard drives" feature that distinguished Filecoin from other initiatives which used blockchain technology, including Bitcoin. Efficient, distributed, and strongly secured storage would be its key feature.

How Filecoin stored and distributed data depended on the IPFS, which stood for Inter-Planetary File System. It was a peer-to-peer protocol that Juan and his team built at Protocol Labs to store and move content, which included but was not limited to files, data, and hypermedia, with content addressing and cryptographic verification. IPFS was expected to be a protocol controlled by no central body.

Juan founded Protocol Labs precisely to establish an environment that would be conducive for developing a system like IPFS, simply because he could not find it anywhere else.[12] Its namesake, Protocol Labs, also belied his mission: IPFS would be among the first among many open source protocols Juan and his team would be developing in years ahead.[13] He believed that the independence of the organisation from the influence and pressures that were apparent in academia or the private sector was paramount:

> *[Founding Protocol Labs] was born out of a personal frustration where when I was starting an IPFS project, I didn't have such an organisation that I could go to and go and build a project there. Really, I think the only option was either [a] university or Google. In the university case, it would have been killed in the publish-or-perish world where like, hey, this is way too ambitious. …Then the flip side, I think this kind of tech is stuff that Google might be interested in funding from the perspective of Google funds a lot of protocols and funds a lot of research. But it also kinda runs counter to basic Google positions around data, control of data, and how the Internet, how information flows and all that kinda stuff. It's like in direct opposition, so it's stuff that probably shouldn't have been funded or in direct control by Google. It's the kind of stuff that has the potential to really rebalance power on the Internet. I figured I would start an organisation that's separate. Protocol Labs is really a group that is trying to create a number of these projects and protocols around things that we think are broken on the Internet.*[14]
>
> Juan Benet, Founder and CEO, Protocol Labs

In a nutshell, IPFS was designed to achieve a more secure and private Internet by distributing storage and becoming less reliant on servers. The current arrangements meant that original content resting in servers would likely be lost should servers go offline for any reason, such as due to technical failure or being seized by governments.[15] The cryptographic features in IPFS would also better safeguard privacy and would make the worldwide web more censorship-resistant.[16]

Juan and his team developed IPFS before creating Filecoin. Filecoin as a token would be the layer built upon IPFS to incentivise people to store and to send stored content. Put simply, Filecoin was IPFS attached with a financial incentive feature. (See **Exhibit 2** on how Filecoin tokens and IPFS were supposed to work together.)

Juan explored building Filecoin on an existing blockchain and cryptocurrency platform, Ethereum. There were plans and ongoing work to interface with Ethereum, specifically on "Filecoin-in-Ethereum interface contracts and protocols".[17] The intent from Juan and his team was to enable Filecoin to capitalise on Ethereum's "smart contract" feature. Simply put, smart contracts were computer programs which could activate automatic transfer of content (be it data, property or any other assets deemed valuable) between parties based upon pre-specified conditions. In the case of applying smart contracts to Ethereum or other cryptocurrencies, the transfers would be governed by a set of code or protocols and not be controlled by one single or central entity.

In addition to ongoing work on the Filecoin–Ethereum interface, Filecoin also needed to complete several tasks that it laid out for itself as the startup marched toward ICO. Among those tasks included formal verification of the various concepts that were critical to Filecoin operations, such as mathematical proofs of its verification processes and new consensus algorithm.

Limitations of Filecoin

While Juan and his associates asserted that storage costs would significantly fall with the advent Filecoin, there was considerable scepticism about the efficacy of this novel system.[18] This was because a blockchain-driven approach toward creating a secure and decentralised transactional system still contained significant drawbacks.[19]

Some pointed out that relying only on individual private key to encrypt one's digital assets would not be sufficiently secure. They needed to be complemented by other means, such as two-factor authorisation, and in an emergency, be able to disconnect the system from the Internet. Others also argued that lower storage cost alone was not a sufficiently compelling value proposition to switch from existing online storage or cloud providers to Filecoin. This is because existing service providers had already included other features,

such as file-sharing and being able to work on the documents on multiple devices on-the-go. Such features were critical for collaboration in the work and learning environments.

Regardless, Juan and his team believed in Filecoin and strove to bring it to fruition. An ICO would be the means to do so.

(NOT) ALL ROADS LEAD TO ROME: THE PROMISE AND PERILS OF ICOS

The public took note of ICOs, which arrived in 2017. ICOs offered a new way for blockchain-based initiatives—startups and established companies alike—to raise cash without turning to traditional venture investors or capital markets. Instead of buying a stake in a private company, investors were given tokens. Many projects had solicited funds directly from their websites even though they might not deliver a tangible product to market any time soon.

This notion of using the term "token" in lieu of "cryptocurrency" in recent years and "virtual currency" even further back marked an evolution of how such units of exchange backed by blockchain technology had evolved over time. Stepping away from claims that blockchain would replace fiat currencies (i.e., "token" and not "cryptocurrency" or "virtual currency") in part allayed concerns from investors and regulators.

> *I like the metaphor of a token because it makes it very clear that it's like an arcade…. You go to the arcade, and in the arcade you can use these tokens. But we're not trying to replace the US government. It's not meant to be a real currency; it's meant to be a pseudo-currency inside this world.*[20]
>
> Chris Dixon, General Partner, Andressen Horowitz

Protocol Labs worked with AngelList to create a CoinList in May 2017, an ICO platform that would connect investors and new tokens or cryptocurrencies.[21] AngelList Chief Executive and Co-Founder Naval Ravikant was a Protocol Labs investor. In fact, CoinList might eventually become a spun-off joint venture between the two companies that hosted future ICOs from other projects.[22]

> *ICOs are obviously a new and interesting form of funding for blockchain-based protocols…. But it's not clear that all of them comply with US securities laws or that all of them are companies that have good native use cases for new coins. …So, we wanted to use a high-quality coin and team to trailblaze a legal and compliant ICO.*[23]
>
> Naval Ravikant, CEO and Co-Founder, AngelList

CoinList anticipated that the US Securities and Exchange Commission (SEC) would warn about ICOs.[24] In fact, it was designed to be a platform for SEC-complaint ICOs.[25] Filecoin would be CoinList's first ICO, by using a new framework created by Protocol Labs called a Simple Agreement for Future Tokens (or SAFT).

A SAFT was to be a promise for future tokens at a fixed price. It was structured such that investors could receive tokens when the Filecoin network would eventually launch or come with inbuilt vesting features so that they would be incentivised to continue support the enterprise. It was to also offer some protection to investors should Filecoin's ICO project fail. A critical difference between Filecoin's ICO and other ICOs was that the former was limited to only US-accredited investors.[26] This meant that ordinary retail investors were not eligible to participate.[27]

To be clear, investors were not buying tokens immediately; they were in reality signing a contract to receive them in the future.[28] This was because the Filecoin network would not launch for at least six months from September 2017. (See expected delivery timeline in **Exhibit 1**.) By creating this novel SAFT instrument, Juan and his team took a gamble to secure the trust and confidence of regulators, signalling to the financial

establishment that they would play ball even though Filecoin was then the latest kid on the block (chain). They wanted to portray Filecoin as a compliant and contributing member of the financial community.

Filecoin planned to release 200 million tokens through their ICO and pre-sale to institutional investors. That would be 10% of the total supply of tokens it planned to release over decades. One billion tokens were expected to be released around the fourth year. In terms of allocation, apart from the sale at the ICO, Protocol Labs would hold 300 million tokens (15%) and miners could extract up to 1.4 billion (70%). The remaining 100 million tokens (5%) would go to Filecoin Foundation, an entity that was yet to exist but expected to play a critical role in providing long-term network governance, partner support and academic grants, and in building the Filecoin community (see **Exhibit 3**).

Establishing the Filecoin Foundation as an independent governance entity was something Juan and his team learnt from observing how other open source projects, such as Apache Software Foundation, the Mozilla Foundation, and the Linux Foundation, developed and grew the ecosystem.[29] (Details about investing in Filecoin are in **Appendix 2**.) They were also cognisant that the US SEC and the regulators around the world were monitoring ICOs closely. The public had found it difficult to differentiate ICOs from other fundraising efforts, including IPOs and crowdfunding platforms, such as Kickstarter. Some regarded ICOs as the latest incarnation of crowdfunding. Others quipped that they were "IPOs with digital coins".[30]

The confusion and potential for mischief and misconduct proved too much for some countries. Just after the Filecoin ICO closed, China and South Korea banned ICOs.[31] In fact, China planned to intensify its control over cryptocurrencies by even banning access to overseas cryptocurrency trading websites.[32] The US SEC also took action against fraudulent claims made by ICOs.[33]

In late 2017, the US financial regulator persecuted businessman Maksim Zaslavskiy who was planning to offer two cryptocurrencies through ICOs. One of the cryptocurrencies, REcoin, was supposed to be backed by real estate. According to the US SEC, however, Maksim's company REcoin Group Foundation had not even employed a single lawyer, accountant, or broker it had promised to hire or consult. Similarly, the other cryptocurrency, Diamond, was supposed to be backed by investments in diamonds.[34] The US SEC alleged that Maksim and his other company Diamond Reserve Club had, in fact, neither purchased diamonds nor engaged in any related business operations. According to the US SEC, Maksim and his companies had been selling "unregistered securities, and the digital tokens or coins being peddled don't really exist."[35]

Financial regulators around the world worked hard to make sense of the issues concerning cryptocurrencies and ICOs. While the US, together with other governments—such as China and South Korea—viewed ICOs with marked suspicion, other countries decided to follow a relatively more moderate and experimental approach.

For example, Singapore's Monetary Authority of Singapore, the national financial regulator, clarified in late 2017 when and how ICOs would be governed under its existing regulations, particularly when they would or would not be considered securities.[36] Moving toward the more open end of the regulatory spectrum, Switzerland, with its regulatory environment, was friendliest toward ICOs. Of the 15 largest ICOs that took place in 2017, four were hosted in Switzerland.[37] The amount raised by Swiss-based ICOs comprised 14% of the international ICO market in the same year.[38] Several blockchain and cryptocurrencies startups and organisations, including the Ethereum Foundation, were also based in the country. The Swiss government proudly declared its support for such financial technology or fintech initiatives.[39]

> *Switzerland has positioned itself as a hub for blockchain related activities. This success will be maintained if Switzerland welcomes innovative and serious projects…. Our work consists in distinguishing the innovations that deserve to have a chance for success from the ones that are fraudulent.*[40]
>
> Mark Branson, CEO, Swiss Financial Market Supervisory Authority (FINMA)

CONCLUSION

When Filecoin's ICO finally closed in early September 2017, the startup had raised US$233 million, including its pre-sale. In fact, buoyed by the value of ether (a unit of Ethereum cryptocurrency) and bitcoin, the final amount raised by one point would even hit US$253 million.[41] By late 2017, Juan and his team saw that one of Filecoin's most pressing tasks was to gather a critical mass of developers and users. In other words, it needed to quickly establish a Filecoin community. With "tens of thousands" of early storage users and miners already signed up for its early user and early miner programmes,[42] the startup shifted its focus to hiring more staff, from software engineers and research scientists, to finance managers and a legal counsel.[43,44]

Filecoin imagined itself as the Airbnb for online storage. It was an interesting proposition, albeit an idea that continued to be a work-in-progress, given that it was still in the pre-product stage. Should it be successful in launching its services, it would face competitors. The distributed storage landscape was also heating up.[45,46]

For example, Ethereum-based storage provider Storj had been in operation, but it faced limitations in payouts which were still conducted manually on a monthly basis. Sia, another blockchain-based storage project, was also already operational; but unlike Filecoin, it relied upon bitcoins as its token of exchange. There was also MaidSafe whose inception went as far back as 2006, but had yet to officially launch. In fact, when defined more broadly as online storage, Filecoin would already be standing up against giants, such as Dropbox, Amazon AWS. All were established providers with extensive features for work and collaboration which were not yet available on Filecoin.

By mid-Dec 2017, over US$4 billion dollars had been raised through ICOs, circumventing capital markets as the traditional means for companies to raise funds, including tech startups such as Filecoin itself.[47] In addition to Filecoin, other projects included the beleaguered Tezos (US$232 million), EOS (US$180 million), and Bancor (US$154 million). These projects took the lion's share of the ICO funding.[48]

By early 2018, interestingly, the US government struck an optimistic albeit cautious tone about cryptocurrencies, ICOs, and blockchain technology. At the Senate cryptocurrency hearing in February 2018, several senators called for efforts to clarify and coordinate regulations on these emerging features of the global digital economy that were still rapidly transforming. While US lawmakers and regulators understood that they ran the risk of stifling innovation and entrepreneurship by being so tough on ICOs, they were aware that more effort would be needed not only to educate the public, but also to go after individuals who were "scamming Main Street investors in ICO pyramid schemes, and worthless cryptocurrencies".[49]

> *I believe every ICO I've seen is a security… You can call it a coin but if it functions as a security, it is a security…. Those who engage in semantic gymnastics or elaborate re-structuring exercises in an effort to avoid having a coin be a security are squarely in the crosshairs of our enforcement provision.*[50]
>
> Jay Clayton, Chairman, US Securities and Exchange Commission

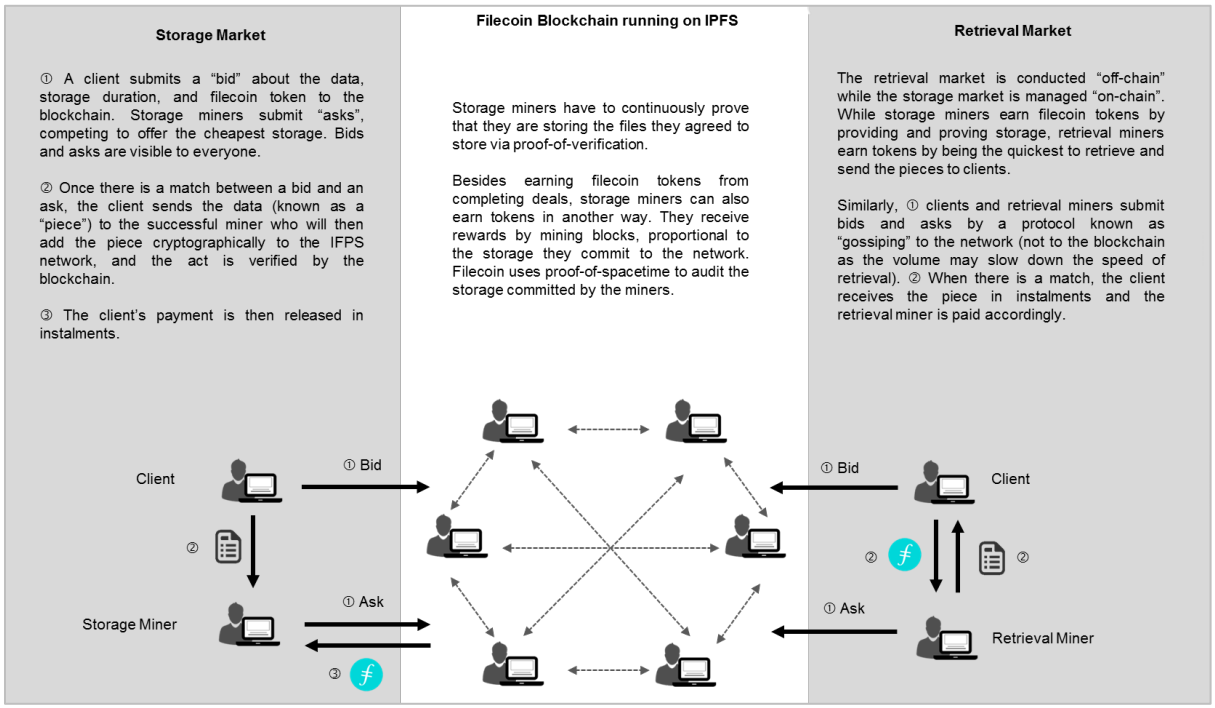
How should we make sense of Filecoin and other blockchain-backed tokens amidst the cacophony of activities and this mixed bag of promises and perils? How much would you trust ICOs? Would you invest in Filecoin? Why and why not?

EXHIBIT 1: MILESTONES OF FILECOIN AND OTHER SIGNIFICANT EVENTS

October 2008	Satoshi Nakamoto published the seminal paper on cryptocurrency, *Bitcoin: A Peer-to-Peer Electronic Cash System*.[51]
January 2009	Bitcoin was released as open source software. Nakamoto mined the first block on the chain.
Late 2013	19-year-old Vitalik Buterin wrote a White Paper on Ethereum.
May 2014	Juan Benet established Protocol Labs.
May 2017	Protocol Labs worked with AngelList to create CoinList. Filecoin would be the first company to list an ICO on its platform.
July 2015	Ethereum was released.
July 2017	Protocol Labs released a White Paper on Filecoin. Original ICO sale date was 27 July, but it was postponed to 7 August. Filecoin managed to raise US$52 million in a token pre-sale ahead of its ICO, from 21 to 24 July. Known as the "Advisor Sale", it comprised 150 "existing investors and advisors of the company who have either helped support IPFS and Filecoin in the past, or have shown potential to be valuable partners as the Filecoin network grows".[52] The US SEC issued investor warning about ICOs.[53]
August 2017	ICO date was pushed from 7 to 10 August. Sale was suspended on 10 August and resumed on 12 August.
September 2017	After a month-long sale, Filecoin's ICO raised over US$205 million. China and South Korea banned ICO funding. The US SEC charged Maksim Zaslavskiy and his two companies REcoin Group Foundation and DRC World (also known as Diamond Reserve Club), alleging that they were selling unregistered securities.[54]
October 2017	Protocol Labs launched the SAFT Project, in collaboration with "Cooley, and many other token creators, legal experts, and investors".[55]
December 2017	The US SEC halted two ICOs, alleging one of conducting offers and sales of unregistered securities and the other of fraud.[56,57] The US SEC also released statement on ICOs, highlighting caution and discernment.[58]

Source: Recreated by authors. Bleev.In. (2017, November 1.) FileCoin WhitePaper Q&A. *Medium*. https://medium.com/@bleev.in.tech/filecoin-whitepaper-q-a-efd22c790569

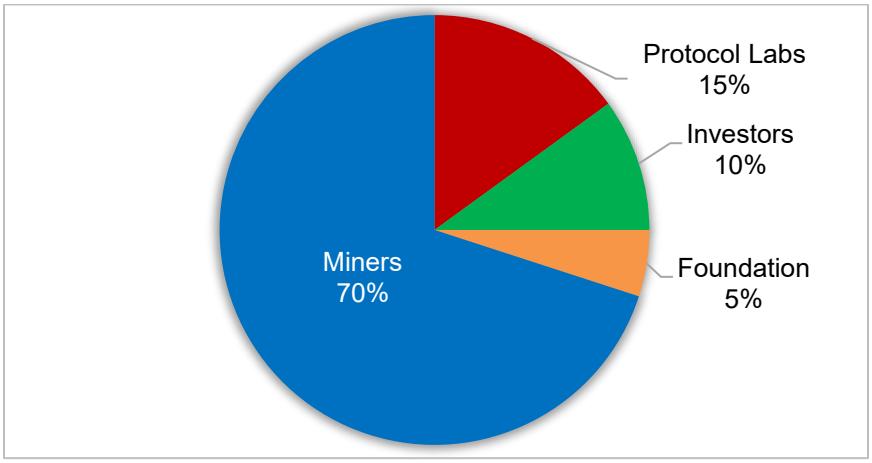
EXHIBIT 2: HOW FILECOIN AND IPFS WERE SUPPOSED TO WORK TOGETHER



Note: Graphics created based on *Filecoin Primer*.

Source: Bleev.in. (2017, November 1). FileCoin WhitePaper Q&A. *Medium*. https://medium.com/@bleev.in.tech/filecoin-whitepaper-q-a-efd22c790569; Shin, L. (2017, July 19). Filecoin ICO, launching next week, aims to resolve token sale problems. *Forbes*. https://www.forbes.com/sites/laurashin/2017/07/19/filecoin-ico-launching-next-week-aims-to-resolve-token-sale-problems.

EXHIBIT 3: DISTRIBUTION PROFILE OF FILECOIN TOKEN SUPPLY



Source: Adapted from page 18 in *Filecoin Primer*.

APPENDIX 1: BRIEF BIOGRAPHIES OF JUAN BENET, NICOLA GRECO, AND OTHERS AT PROTOCOL LABS

Juan Benet founded his first company, Loki Studios, in 2010 while he was an undergraduate at Stanford University. A startup that built location-based and augmented reality (AR) mobile gaming, Loki Studios eventually was acquired by Yahoo for an undisclosed sum in December 2011.[59,60]

Juan received his Master of Science in Computer Science in 2012. About the same time, he co-founded another startup called Athena, a knowledge platform that could map and connect all related concepts into a network. Operations at the startup, however, was put on hold infinitely in 2013. Soon after, Juan founded Protocol Labs in 2014, where he and several others developed Filecoin and IPFS.

Nicola Greco, a 23-year-old MIT PhD student, was the other key contributor to developing Filecoin. Hailed as one of the top 10 young Italians by *Wired*, an influential technology magazine, Nicola had been researching on decentralised infrastructure since 2012. According to his own profile online, he started his technology career since he was a teenager. In fact, Nicola was:[61]

- 14 when he started the petition "Linux in Italian Schools", converting schools to use open source software
- 16 when he started the BuddyPress' developers community, an open source platform for federated social networks
- 17 when he made one of the first unofficial Twitter buttons
- 18 when he wrote software for Telecom Italia which awarded him two research grants
- 21 when he left his undergraduate college a year before graduation to join MIT, working on re-decentralising the Web after his experience in Mozilla

There are several other notable members who worked on developing Filecoin. For example:

Matt Zumwalt was a program manager at Protocol Labs who helped improve the structure of the paper. He received his Master of Science in Electrical Engineering from University of York. Before joining Protocol Labs in 2016, Matt had founded several tech organisations himself, including MediaShelf, Data Curation Experts, and DataBindery, all focusing on improving data quality for various purposes.

Evan Miyazono was a research scientist at Protocol Labs who joined in 2017, after he had completed his PhD in Applied Physics at California Institute of Technology (CalTech).

Jeromy Johnson was a software engineer almost since the inception of Protocol Labs in 2014. According to his LinkedIn account, Jeromy was "passionate about distributed computing and big data" and enjoyed "working on problems that are bigger than a single machine".[62]

David Dalrymple, even though was not a staff of Protocol Labs, helped made several suggestions that improved Filecoin. David graduated from MIT Media Lab with a Master of Science in Media Arts and Sciences at age 26 in 2017.

APPENDIX 2: BRIEF INTRODUCTION ON BLOCKCHAIN TECHNOLOGY AND FILECOIN

Blockchain technology was borne out of decades-long research in cryptography, the science of coding and decoding content. It formed the technological basis for cryptocurrencies, such as Bitcoin and other token platforms, including Filecoin.

By using what is called a cryptographic hash function, a series of text was transformed into standardised data that were typically shorter and fixed in size. Besides being encrypted, the hash output also had a unique identifier that could not be replicated. The hash outputs were arranged in blocks. In turn, the blocks would connect to one another according to time sequence, forming a chain that in theory could not be amended at all. In order for the connection to form, a "hasher" or a miner had to solve a complicated mathematical problem. When the miner completed the task, a new block was added to the blockchain and the individual would be rewarded with bitcoins. Given the amount of computing power needed to solve the problem, however, miners had to work together in hashing or mining pools where they could consolidate resources to earn bitcoins more effectively.

The process through which an algorithm ascertained that the mathematical problem was solved and a new block could be legitimately added to a blockchain upon after verification was called "Proof-of-Work". Bitcoin relied upon the Proof-of-Work system. Instead of Proof-of-Work, however, Filecoin would use "Proof of Storage" which comprised two components, "Proof-of-Replication" and "Proof of SpaceTime".[63] While Bitcoin and other cryptocurrencies' verification was to be an end goal in itself, Filecoin's verification would lead to storage being available and/or a morsel of information being stored at a very specific moment, hence, proofs of Replication and of SpaceTime. Juan and his supporters called this "useful work" as it led to outcomes that were "valuable to the network, beyond securing the blockchain" instead of "wasteful work".[64]

The rise of cryptocurrency tokens and blockchain technology had produced unexpected winners and losers. Because of the thirst for computing power, bitcoin miners had turned to using graphic processing units (GPUs) originally designed for gaming to solve the complex mathematical problems to extract tokens. This was because GPUs, as a class of computer chips designed to relieve the central processing units (CPUs) in computers of the heavy lifting required to render pictures and videos, turned out to be also powerhouses for processing hash functions in mining cryptocurrencies. GPU chip producers, such as Nvidia and AMD, saw their stock prices rising, while gamers lamented on the scarcity of GPUs and its high price on e-commerce sites.

Many established companies, including Telegram and Kodak, announced that they had planned to jump on the blockchain, cryptocurrency, and ICO bandwagons.[65,66] Even Singapore Airlines was exploring transforming its miles reward programme Krisflyer into a digital wallet built onto blockchain technology.[67]

Endnotes

[1] Filecoin. (2017, September 13). Token sale completed [Blog post]. https://filecoin.io/blog/sale-completed

[2] *coindesk*. (2017, September 7). $257 million: Filecoin breaks all-time record for ICO funding. https://www.coindesk.com/257-million-filecoin-breaks-time-record-ico-funding

[3] Protocol Labs. (2017, July 19). *Introducing Filecoin, a decentralized storage network* [YouTube video]. https://www.youtube.com/watch?v=EClPAFPeXIQ

[4] Shin, L. (2017, July 19). Filecoin ICO, launching next week, aims to resolve token sale problems. *Forbes.* https://www.forbes.com/sites/laurashin/2017/07/19/filecoin-ico-launching-next-week-aims-to-resolve-token-sale-problems/#28651302384b

[5] See Note 4.

[6] Protocol Labs. (2017, July 25). *Filecoin Primer*. See page 11.

[7] See Note 6.

[8] Allison, I. (2016, October 21). How IPFS is reimagining the Internet. *Newsweek.* http://www.newsweek.com/how-ipfs-reimagining-internet-512566

[9] See Note 8.

[10] See Note 3.

[11] coinlist.(2018). Filecoin. *coinlist website*. https://coinlist.co/filecoin

[12] Y Combinator. (2017, June 30). *IPFS, coinlist, and the filecoin ICO with Juan Benet and Dalton Caldwell* [Blog post]. http://blog.ycombinator.com/ipfs-coinlist-and-the-filecoin-ico-with-juan-benet-and-dalton-caldwell

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