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The next frontier in cloud computing: Decentralization as a catalyst for disruption

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Mahesh Ramakrishnan
Escape Velocity

Christopher Jensen
Director of Research
Franklin Templeton Digital Assets

Co-sponsor
Prof. Jorge Tamayo
Harvard Business School

The story of David vs. Goliath resonates deeply, epitomizing a recurring motif in human history: the unexpected triumph of smaller, innovative forces over formidable giants. This narrative is strikingly relevant in the history of corporate strategy, where the winds of creative economic disruption have consistently overturned established regimes and reshaped the competitive terrain. In cloud services, we are potentially witnessing the emergence of another pivotal confrontation.

The cloud services industry boasts a small number of extremely powerful scale economies, as Telecom Giants (AT&T, T-Mobile) and Web2 incumbents (Amazon, Microsoft) have created infrastructure monopolies, taking advantage of a historically low cost of capital and robust government subsidies. These oligopolies can use their infrastructure advantages to king-make companies in areas of emerging technology, the strength of which was exemplified by Microsoft's investment in OpenAI, a generational technological asset. In a break from traditional investments and mergers, OpenAI accepted $10 billion of compute credits and infrastructure support from Microsoft in return for 49% of the company, an unprecedented deal both in terms of size and structure.[1] How does one even begin to compete?

Network economies offer a potential solution, as they derive a strategic advantage from decentralized collaboration as opposed to centralized scale. Crypto-powered infrastructure is exemplified by projects such as Filecoin that can generate the necessary network effects to credibly compete with incumbents by turning people and small businesses into infrastructure suppliers. By aligning upfront capex, labor, and rent costs

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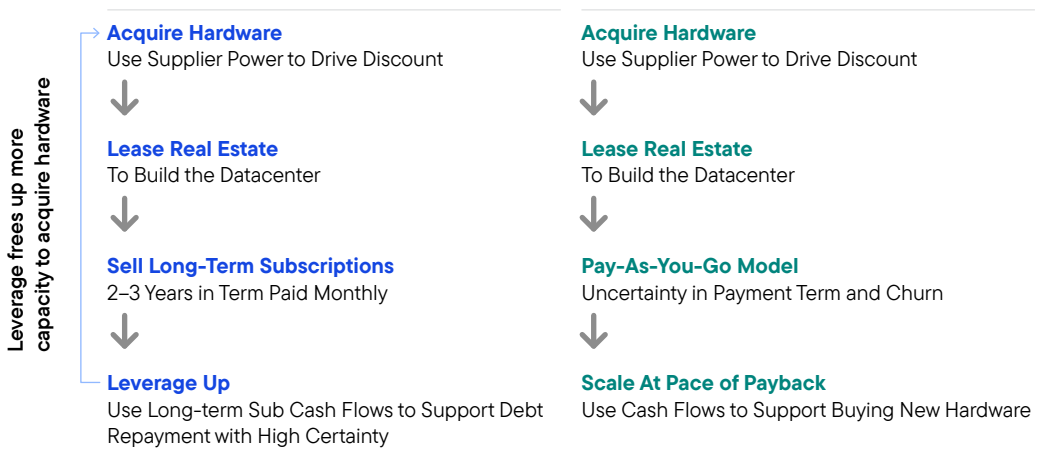
across network participants, decentralized physical infrastructure ("DePIN") networks can create digital commodities like storage and bandwidth cheaply. A prime example, the Filecoin network powers verification, storage, and retrieval for third parties who want to provide cloud services to businesses. Its disruptive business model facilitates the creation of a competitive storage marketplace financed through the fees that decentralized storage providers (SPs) earn for the storage and retrieval of data and incentivizing suppliers with its native currency ($FIL). By joining the Filecoin network, businesses with excess storage capacity have a chance of competing with Amazon's centralized scale on cost by becoming SPs, with high guarantees around security and access. Today, DePIN networks might be the single biggest threat to AWS/Azure's cloud duopoly.

But before we can analyze the opportunity for disruption, we must first understand what has driven incumbents' competitive advantages. In short, it's the combination of scale advantages, regulatory barriers, and strategic market control—these incumbents also influence downstream players reliant on their rails and use their scale to stifle competition. The high barriers to entry for new market participants are considerable, characterized by high capital costs, entrenched supplier relationships, and steep startup costs. However, as traditional monetization models face growing challenges, the opportunity for challengers with better unit economics is growing.

Economic change has weakened the business model of incumbents. Traditionally, cloud service firms are optimized through software-as-a-service (SAAS) frameworks allowing high utilization levels on their modular architecture. These "one size fits all" subscription economics, however, don't always make the most sense for the end customer. Driven by increasing data intensity of products, clients are pushing the market towards a pay-as-you-go model for digital infrastructure and providers have had to respond by evolving the SAAS model to one driven more by metered usage, termed infrastructure-as-a-service (IAAS).[2] The IAAS model, while convenient for the customer, reintroduces uncertainty that complicates unit economics by removing the key fourth step of the SAAS process (illustrated below). Higher uncertainty inevitably leads to price competition and a need to recoup outlays through volumes quickly. Margins are driven lower by this, and growth is stifled as uncertainty increases financing frictions. A new way to monetize customers requires a new strategy, with a refocused plan around marketing, sales, etc. The comparison between these business models is laid out below in Exhibit 1.

Exhibit 1: Business Model Shift



For illustration purposes only.

Rather than rely on predictable contracts, IAAS providers must forecast demand. This process introduces assumptions that increase uncertainty of cash flows, making debt financing more difficult than before. This change forces incumbents to price services on a variable unit basis, rather than a bundled fixed basis. This variable unit price is far more subject to market competition, as the lack of long-term contracts reduces switching costs and increases incentives for competitors to use promotions, further affecting customer loyalty and margins. Inevitably, markets defined by commoditized services compete on price—high fixed costs and high uncertainty usually point to the use of meaningful promotion to capture attention. Recouping upfront cost at any price becomes the focus as management teams become minutely focused on financial performance—nowhere is this paradigm clearer than in the airline industry, where Boeing and Airbus discount massively to keep a high level of turnover. While the need for this new strategy is driven by changing demand-side needs, it's also driven by advancements that increase supply side availability. Summarized in three factors below in Exhibit 2, these changes have seeded the ground for alternatives to proliferate.

Exhibit 2: Market Considerations

1

People are in possession of more powerful hardware, and software has become an increasingly crucial driver of infrastructure efficiency and service quality

2

The size of the internet has 100×'d, leading to an explosion in the amount of data available, and computation to make stored data more valuable

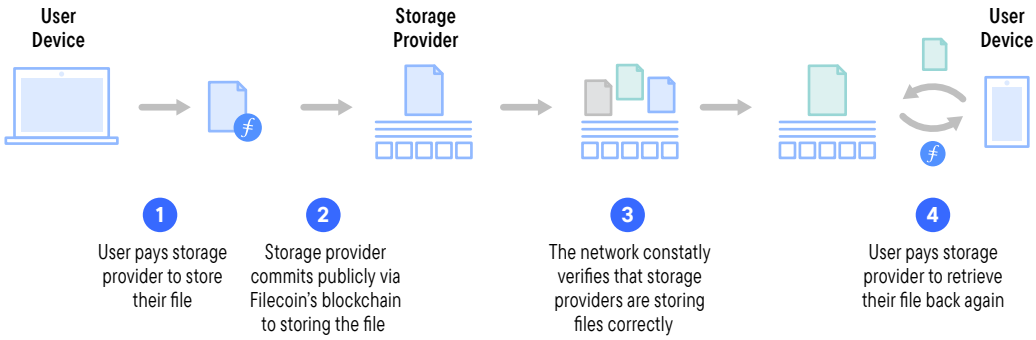
3

Composable software powered by blockchain allows trustless collaboration among parties that may not work together otherwise

Cryptoeconomic networks can offer better cost, security,[3] and product quality than incumbents. While Bitcoin, the earliest cryptoeconomic network, organized big groups of machines to collaborate, it didn't focus on output beyond hashing—thus while Bitcoin controls one of the biggest supplies of compute in the world, that computer is not optimized to be economically useful other than validating the network to process payments. The next network to reach scale, Ethereum, incentivized the creation of useful services, allowing developers to access compute power they could source from peers to build apps. Filecoin has gone a step further, creating a blockchain-based protocol geared toward making it easy for anybody to sell storage services to clients, with a transaction fee model ideal for constant-use IAAS use cases. Moreover, because Filecoin is an open-source, distributed network, hundreds of developers have built tools and services that make provision of storage services to clients extremely easy for businesses with excess resources. Filecoin incentivizes SPs to participate in the network: SPs earn the blockchain's native coin, ($FIL), for doing business on the Filecoin network, further accelerating SP economics and driving down service price. Without a similar scale of upfront infrastructure costs, and being able to use Filecoin's payment network, these SPs can provide storage services just like AWS at a far cheaper cost.

Mining—i.e., joining the network as a SP—is largely carried out by businesses with excess capacity, and groups of individuals co-locating hardware: There are ~2,800 distinct SP systems on the network today providing storage services. Some of the biggest SPs on the network include Seal Storage, 1475, Holon, DCENT, and Greater Heat, who have onboarded significant network capacity and serve multiple enterprise clients. Seal, as an example, is focused on onboarding high-density academic research and has historically optimized their platform around long-term storage of that data. Holon focuses on cutting-edge,

Exhibit 3: Filecoin Platform



Source: Reidhead, Kyle. "Is Decentralized Cloud Storage the Next Big Web3 Industry?." Web3 Academy. February 20, 2023.[4]

eco-friendly storage mechanisms combined with edge computing. Each SP can decide what tradeoffs they support, the specific nature of the service they intend to provide and build a custom service delivery plan around it. They transact mainly in $FIL and receive an incentive for doing business on the network as well as payment from the client. While enterprise-grade SPs may build out a whole support infrastructure, many of the SP businesses are fewer than 20 people and are taking advantage of excess hardware they already own as part of a bigger business.

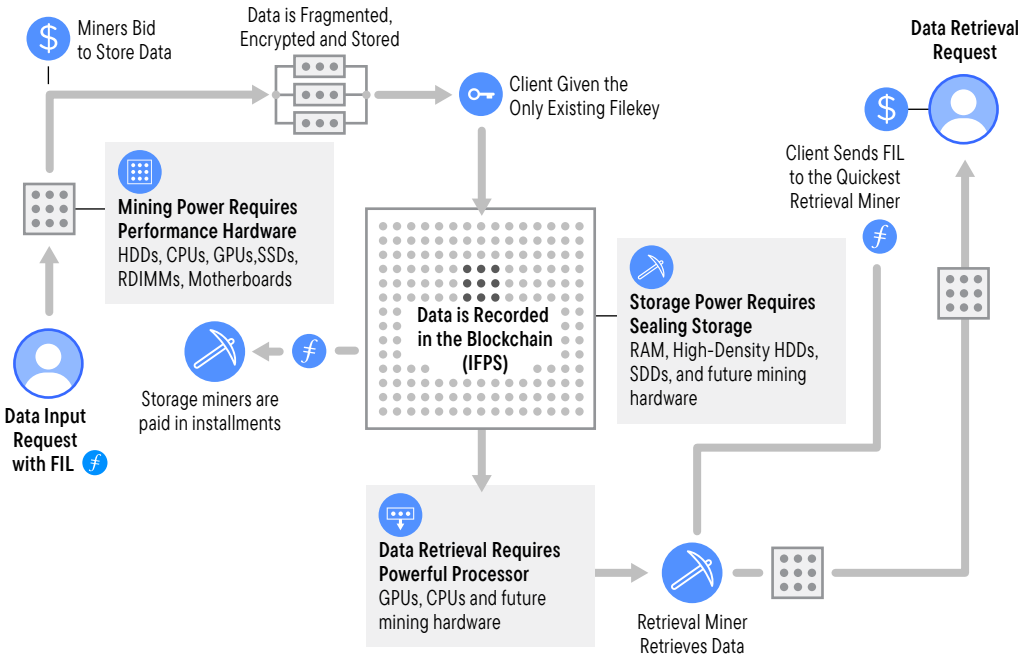
Organizations across the Filecoin ecosystem have also invested significant resources over the last two years to dramatically increase Filecoin's usability—an essential component for Filecoin to become truly enterprise-grade and enterprise-ready. With this influx of network orchestration capabilities, the network is primed for more sellers and users as the network's value is more easily realized and demonstrated. Since November 2023, the ecosystem has welcomed multiple new data onboarding software platforms into the community with more still planned to go live later this year. In response, the proportion of big datasets stored by SPs has rapidly increased, with only ~50% of capacity being used for small projects (0–10 terabytes) today vs. 90% two years ago. This suggests SPs are attracting higher-quality institutional clients as Filecoin's UX improves. How the Filecoin model creates a ripe environment for SP businesses to drive value is laid out below in Exhibit 4.

Exhibit 4: Strategy Considerations

1	2	3	4
Storage providers with hardware can't compete with AWS/Azure pricing at scale, leading to excess capacity	Limited opportunity cost to join the Filecoin network, offering immediate monetization of excess capacity	Filecoin banner allows SPs to weird purchasing power of a scaled player when negotiating deals	Scale of Filecoin further reduces barriers to new SPs joining the network in a virtuous cycle

Filecoin is autonomous, and its token incentive system regulates and encourages appropriate behavior from SPs and users. Economic activity is governed by the proof of "spacetime" consensus algorithm, which empowers validators to continuously verify that stored data is secure and hasn't been changed, rewarding them with the Filecoin token for their contributions. Notably, SPs must stake Filecoin tokens in concert with their provision of storage services: bad acting SPs have their stakes slashed in response to uneconomical behavior, therefore ensuring economic activity on the network is productive. The full storage and retrieval process is laid out below in Exhibit 5.

Exhibit 5: Filecoin Process Diagram



Source: "The Release of Filecoin Could Mean Product Shortages in the Semiconductor Industry." Fusion Worldwide. December 11, 2020.[5]

The Filecoin network is extremely scalable and doesn't bear any of the operating costs of the SPs themselves. It offers an avenue by which SPs are brought together on a common platform, allowing them to benefit from network effects and offer products that compete with Amazon on the price they charge for a unit (GB) of storage. Most big, centralized SPs like AWS will store a set number of copies of your data on their closed systems (usually three copies). But on the Filecoin network, users can choose to store many copies of their data—in whole or in part—encrypted or non-encrypted—across many nodes on the network. Therefore, if one node fails, the data persists.

Data verifiability differentiates Filecoin from other centralized SPs whose solutions present more like a black box. When dealing with confidential data, provenance is increasingly important. Because all information is transparently stored in highly secure places that clients can verify themselves, Filecoin is well suited for high-sensitivity datasets that can't afford data loss/modification. According to DeStor's Filecoin Network Data Client Explorer,[6] major storage clients range from The Starling Lab and the Internet Archive to the Web3 platform OpenSea and the Layer-1 network Solana, which stores its entire block history on Filecoin. We also see it commonly used to store large research datasets for universities, as well as highly sensitive medical and genetic record data due to the security

guarantees provided by verifiability. Solana, which considers Web2 giants among its biggest competitors, potentially has issues storing its entire history on AWS where a centralized competitor could evaporate its entire business with a *misclick*. Filecoin eliminates this platform storage risk.

Filecoin's fee-based transaction model also makes it uniquely suited to serve pay-as-you-go IAAS use cases, which are better aligned to its business model than that of centralized giants. Today Filecoin generates fees[7] (~$23 million in 2023 at the current token price)[8] from clients to SPs. These clients are typically paying for storage in $FIL directly, but also have the capability to pay in stablecoins. SPs and storage clients negotiate deals for duration, amount, and price directly. Fees can be inherently seasonal for large clients who store big troves of data where they typically pay storage and transaction fees upfront and annually.

The majority of Filecoin's costs are paid through token emissions, meaning Filecoin mints new tokens to distribute. This also means that most costs aren't paid for in cash and that protocol revenue is actually used to buy and burn tokens thereby reducing net new emissions, a mechanism similar to a buyback. Filecoin's structure follows Chris Dixon's model for Overcoming the Bootstrapping Problem:[9] Token holders bear the costs of Filecoin's growth as it scales, expecting that ecosystem growth will result in bustling economic activity that makes the protocol valuable.

Below (Exhibit 6) we show how Filecoin's cash flow generation would change if the revenue the protocol generated 50×'d overnight to illustrate how scalable the model is. If revenue 50×'d, miner incentivization costs would remain the same (the subsidy isn't scaled as a function of revenue as it's programmatically encoded), as would Filecoin's R&D costs. The only cost that would increase would be its sales and marketing costs from additional headcount. As such, as Filecoin significantly increases revenue, it also swings to being cash flow positive. Note that because Filecoin conducts economic activity in their $FIL token, this analysis is priced in millions of $FIL to elucidate some of the mechanics at play and intends to show how viral adoption of the new products coming to market might affect unit economics. Simply put, new demand on Filecoin generates cash flow at a rapid rate.

Conducting the analysis in Exhibit 6 in $FIL terms illustrates how much operating leverage there is within the Filecoin system. The Filecoin network is just software—there isn't a 10,000-person team somewhere managing this—there is no central team at the core.

Exhibit 6 (Millions of $FIL): Filecoin Scale

	Filecoin Today ($FIL)		Filecoin 50x Today ($FIL)
Revenue	**4.9**		**245.0**
− Labor Cost of Running Data Centers	0.0	Gross revenues in $FIL scale without any change in cost or incentives	0.0
− Miner Incentivization Costs	(49.7)		(49.7)
Gross Revenue	**(44.8)**		**195.3**
− Research & Development	(10.7)	Only USD cash expenses (sales & marketing) rise as revenue explodes	(10.7)
− Sales & Marketing	(0.7)		(36.8)
− General and Administrative	(3.6)		(3.6)
Illustrative EBITDA ($FIL)	**(59.7)**		**144.4**
EBITDA Margin	*NM*		*59%*

Sources: Company Filings, Messari, EV3 and Franklin Templeton Analysis.[10]

Exhibit 7: Filecoin Sensitivity

Filecoin EBITDA Margin Scenario Analysis

		Sales and Marketing Margin			
		5%	15%	25%	35%
Multiple of Network Size vs. Today by Revenue	1	NM	NM	NM	NM
	20	30%	20%	10%	NM
	50	69%	59%	49%	39%
	100	82%	72%	62%	52%
	500	92%	82%	72%	62%
	1,000	94%	84%	74%	64%
	10,000	95%	85%	75%	65%

Sources: EV3 and Franklin Templeton Analysis.

Other than marketing, costs don't really increase even as revenues scale 50 times—EBITDA margin swings as high as 59% with this increase and could go as high as 85% as revenues scale further. Most costs today are incentives to help SPs compete on the network but should the network scale massively, one would imagine you'd need fewer incentives to keep suppliers engaged. As the network scales revenue by bringing productive storage onto the network, the fees earned directly remove $FIL tokens from circulation and deliver greater ownership to token holders.

There is a reflexivity piece to consider here as well: because Filecoin's costs are paid in $FIL tokens, an increasing token price can increase costs to the network. The same number of tokens is paid to SPs, but the dollar value of those tokens is higher. Below (Exhibit 8) we present an illustrative analysis of what the cash flow generated by the

Exhibit 8 (Millions of Dollars): Filecoin Buyback

	Filecoin 2023 50× Pre-Buyback ($MM)		Filecoin 50× ($MM) Post-Buyback
Revenue	**1,102.5**	Conservatively assume revenue doesn't increase with token price	**1,102.5**
− Labor Cost of Running Data Centers	0.0		0.0
− Miner Incentivization Costs	(223.7)		(447.3)
Gross Revenue	**$878.9**		**$655.2**
− Research & Development	(47.9)	Reflexive analysis assumes removing 7% of circulating supply doubles token price	(95.9)
− Sales & Marketing	(198.5)		(198.5)
− General and Administrative	(16.0)		(32.0)
EBIT	**$616.5**	Filecoin can scale revenue massively without scaling costs at all	**$329.0**
− Interest Expense	0.0		0.0
Operating Income	**$616.5**		**$329.0**
+ Depreciation and Amortization	0.0	Assumes 2023 EBITDA is used to buy back $FIL tokens	0.0
+ Interest	0.0		0.0
− Capex	0.0		0.0
Illustrative EBITDA	**$616.5**		**$329.0**
+ Non-Cash Costs Paid With Token Dilution	287.6		575.1
Illustrative Cash FCF	**$904.1**	Rising token price increases accounting costs, but doesn't affect cash generation	**$904.1**
EBITDA Margin	*56%*		*30%*
Cash FCF Margin	*82%*		*82%*

Illustrative analysis does not consider taxes and assumes the buyback of tokens has caused price to double to $9/FIL

Source: EV3 and Franklin Templeton Analysis.[11]

network would look like in US dollar terms, considering the tokens removed from circulation as part of the buyback. We look at the effect of using the fees generated from the course of business to remove 7% of the total tokens at a fixed price and assume that the token price doubles in response to the supply shock. Because of the reflexive token structure, a higher token price means Filecoin is paying out more in incentives (in US dollar terms), which has the effect of bringing more SPs into the ecosystem. However, while the network looks less profitable on the face, it still generates just as much cash flow because while token issuance is dilutive, it isn't a cash cost. We also conservatively assume revenue is unchanged, when a higher token price and increased usage would likely increase revenue in US dollar terms as well.

Using this analysis, we can clearly see that while reflexivity leads to higher headline costs for the Filecoin network, those costs are non-cash costs that don't affect the cash generation of the protocol. Free cash flow is still ~$900 million in either case.

Next in Exhibit 9, we compare what a scaled Filecoin would look like compared to a Web2 competitor like AWS in US dollar terms. Note this isn't a perfect comparison (comparing a company vs a protocol), as AWS has hardware expenses and a full organization behind it, and Filecoin's incentives are a non-cash expense. The most important difference to call out immediately here is the difference in fixed costs: while Amazon has signicant fixed costs, Filecoin has none. The largest difference is capital expenditures: while Amazon spent $22 billion on hardware capex to create and scale datacenters and another $22 billion on operating costs of those datacenters (real estate, energy), Filecoin has no such comparable costs. Filecoin covers this by directly incentivizing SPs, who themselves spend the capex to buy hardware with storage capacity and keep the machines running.

Exhibit 9 (Millions of Dollars): Filecoin vs. AWS

	AWS 2023 ($MM)		Filecoin 50× ($MM) Post-Buyback
Revenue	**90,757.0**	Filecoin has no labor cost, variable cost is paid in token inflation to miners. AWS bears this alone	**1,102.5**
− Labor Cost of Running Data Centers	(5,445.4)		0.0
− Miner Incentivization Costs	(21,781.7)		(447.3)
Gross Revenue	**$63,529.9**	$FIL emissions drive G&A and R&D spend. There is no organization to support vs. AWS which has >130,000 employees	**$655.2**
− Research & Development	(11,671.8)		(95.9)
− Sales & Marketing	(16,336.3)		(198.5)
− General and Administrative	(10,890.8)		(32.0)
EBIT	**$24,631.0**	FIlecoin can scale revenue massively without scaling costs at all	**$329.0**
− Interest Expense	(2,713.3)		0.0
Operating Income	**$21,917.7**		**$329.0**
+ Depreciation and Amortization	21,706.6	Mining drives capex to the edge of the network, and is accounted for in infrastructure cost	0.0
+ Interest	2,713.3		0.0
− Capex	(24,504.4)		0.0
Illustrative EBITDA	**$21,833.2**		**$329.0**
+ Non-Cash Costs Paid With Token Dilution	0.0		575.1
Illustrative Cash FCF	**$21,833.2**	Filecoin costs are paid in tokens—the network uses limited cash other than sales and marketing	**$904.1**
EBITDA Margin	*24%*		*30%*
Cash FCF Margin	*24%*		*82%*

Illustrative analysis does not consider taxes and assumes the buyback of tokens has caused price to double to $9/FIL

Source: EV3 and Franklin Templeton Analysis.

Filecoin pays this cost in tokens (created through dilution) but doesn't have to put up any physical infrastructure themselves. By serving as a platform for other storage providers, Filecoin remains capital light even as they provide a capital-intensive product.

In Exhibit 9 on the previous page, we allocate token emissions to Filecoin cost buckets as mapped by the whitepaper and show illustrative EBITDA on a comparable business to what Amazon lays out for AWS in its filings. To take a snapshot here, we assume an initial fixed price of $4.5 per Filecoin ($FIL) token that doubles because of the buyback. Finally, we illustratively assume, like we did above, that any sales/marketing expense Filecoin bears is paid in cash.

Once Filecoin is at scale, as fixed token emissions don't really change, revenue scales massively. As such, Filecoin can produce higher margins at scale than Amazon, and explosively so in cash terms. This analysis also hits home the value of Filecoin's incentive structure on decentralizing capex, a massive contributor to cash burn for Web2 businesses: the network benefits from scaling usage without scaling fixed costs. Overall, Filecoin's structure at scale is significantly more flexible and profitable than AWS, which suggests that should it get to scale, it could be a runaway winner.

While the potential for Filecoin to dominate the cloud services markets clearly exists, one must question why it hasn't happened: after all, Filecoin has been around since 2014. Part of the answer relates to technological progress. The largest technical challenge in Filecoin's early days related to latency: consensus mechanisms require high download speeds and low latency to coordinate across geographically dispersed machines. Without high speeds, the performance of Filecoin significantly lacks central providers with private networks as slower consensus drives slow service speeds around storage and retrieval. Filecoin requires today's mobile infrastructure (which have 10×'d data speeds in the last decade[12]) as a baseline to enable performance in line with AWS. Similarly, the nature of computation capable devices has rapidly accelerated: an iPhone today has transistor density 171,000 times (!) greater than a supercomputer in 1980, and 90× greater than an Apple Macbook Pro in 2010. The proliferation of compute-capable devices has increased the pool from which Filecoin can pull storage capacity, resulting in higher quality capacity, and better service (more available devices to store results in faster retrieval and proximate caching).

However, even with these improvements, worryingly, utilization of the network remains low at ~18%. We suspect three causes: a combination of initial oversupply of capacity, tough business development tradeoff choices going after cold storage which drove a UX problem with data retrieval being a clunky process, and the fact that we're super early and compute-over-data is just taking off, as we highlight below. On the demand side, protocol revenue has also been extremely volatile due to early storage products on Filecoin not finding product market fit themselves. While storage is a commodity (like oil), how it is delivered varies depending on the data type and end use in computation (similar to how there are multiple ways to refine oil). With an initial gearing toward cold storage, the teams building on the network underinvested in easy-to-use retrieval for the data they stored. This led to a clunky user experience, where people would find it easy to store data, but hard to retrieve what they needed instantaneously. As such, early clients were limited to those focused more on provenance and less on accessibility.

This is rapidly changing as a few companies are trying to tackle scaling retrieval including Banyan and Flamenco loudly, and Storage Net quietly. With the scale these businesses bring, data onboarding fees for clients have decreased significantly to drive more engaged use. We see this as an important competitive development, relative to cloud service incumbents like AWS that offer extremely low barriers to initially store data (with significant subsidies) but charge high fees on retrieval on the back end.

Trust is also important to address. One of Filecoin's core innovations is verified storage: All data stored on Filecoin's network is verifiable by the client at any given time which should make for a higher trust solution. However, blockchains and crypto are still broadly misunderstood. Incidents like FTX's bankruptcy have continued to contribute to a perception around lack of safety with these platforms; many corporations have blanket policies not to work with crypto-enabled platforms for fear of regulatory retribution. Like the scaling of technological architecture mentioned above, the trust issue is also one that will inevitably be solved by time. While politics can be uniquely tribal, technology is not—over time the market will be able to differentiate between issues caused by human action (FTX fraud, hacking accounts) and technology.

Utilization remains a first-principles driver of growth, but market growth is more important. The real question is whether the Filecoin Virtual Machine, which brings compute-and-training capabilities, will allow builders to access new primitives in the form of compute-over-data (smart contracts on Filecoin). Conceptually, this is a return to the capabilities of on-premises server storage. Compute-over-data allows for the processing of computation to occur directly where the data is stored, vs. being transferred to a central location for processing. This is an important limitation for projects using big datasets that are compute power intensive, as latency creates massive cost and speed impediments. As the field of AI scales, driven by underlying LLMs trained on data, resource efficiency will become a bigger problem, and model training could become prohibitively expensive for startups. Today LLM projects consume enormous amounts of resources inefficiently training models with trillions of parameters over cloud servers, not to mention undergo critical security events with each data transfer. With Filecoin's compute-over-data architecture, models can be trained and deployed locally, leveling the playing field for smaller players trying to compete with behemoths. Beyond just competitive cost, ecosystem participants expect that direct integrations with Filecoin's compute layers will drive the majority of building activity going forward, as proximity to the data layer allows developers to create contextual products that are impossible without composable software. Filecoin is facilitating smart contracts driven by private data. At an extreme, and combined with encryption tech coming to market, Filecoin offers the possibility that apps will be able to compute over people's private data, without ever revealing the actual contents of the data, creating brand new identity primitives and the acceleration of permissionless commerce. Jonathan Victor, cofounder of Ansa Research, had this to say about the transformation:

"Compute-over-data and the launch of FVM is Filecoin's steam engine moment and will allow developers to use stored data in dynamic ways to create brand new services and primitives. FVM makes Filecoin the destination for any project experimenting with AI-driven insights from large datasets. It's not even going to be close on a cost basis versus centralized providers of storage and compute."

Some of the early projects are building new capabilities for SPs in the Filecoin ecosystem. Using Filecoin's smart contract capabilities, a team has created a primitive for SPs to borrow $FIL to fulfill their token leasing obligations. Others, like IoNet and Bacalhau are creating GPU networks directly on Filecoin, leveraging the extensive resources the network already has. Compute-over-data will expand the range of what the protocol can be used for greatly, the result of which should be significantly more hosted and stored data on the network. Exciting new use cases needs to be a priority, as the network will need >10 times revenue to breakeven on an illustrative EBITDA basis.

As demand for cloud services surges, it is anticipated that scaling Filecoin's compute infrastructure will prompt a swift and competitive response from the industry. Unlike traditional industries with simple corporate structures, differences between Filecoin's decentralized architecture and AWS/Azure's centralized structure will take traditional mergers off the table. This leaves two options more likely than any other:

1. Price competition: Given Filecoin's cost structure is flexible and driven by non-cash token emissions, price wars would just lead to significantly deteriorating margins for incumbents making them unlikely to engage
2. Collaboration: More likely as incumbents can use the Filecoin network, and capture pricing differences themselves

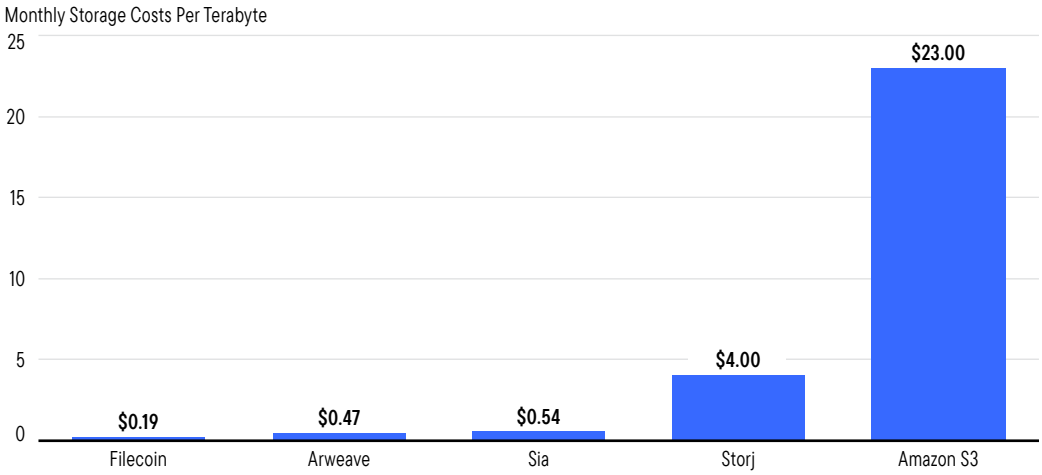
Collaboration is a more likely outcome than price competition: structural cost advantages of Filecoin make it infeasible for big tech giants to compete at scale. We note how the earliest disrupted incumbents in crypto have responded to the challenge to global payments driven by stablecoins. Notably, incumbents such as PayPal[13] understand the value proposition as so differentiated as to risk regulatory interference in their core business to participate. It makes far more sense to collaborate with crypto incumbents (in this case Paxos) to drive better products for consumers.

A very similar situation to Filecoin, one can look at what's happening in the telecom/bandwidth space, where a similar idea, Nova Labs has already struck an agreement to use Helium[14] with a national incumbent (T-Mobile) to support the T-Mobile network, and another with Telefonica for international roaming. Facing a very similar paradigm around cost disadvantage, T-Mobile decided that leveraging Helium to offer collective phone plans was the most economically efficient move. Helium Mobile has since launched its service nationwide and is able to price their unlimited data phone plan at ~$20/month (vs. competitors who charge more than 8 times that).[15] With the Telefonica deal, Helium Mobile will additionally be able to offer their low cost offering in Mexico, and allow Telefonica clients to roam onto their US network.

The next few years will yield several partnerships, as incumbents realize the cost advantages of these networks can be leveraged for their own use. Customers, at the end of the day, are still king, and big tech has a better stranglehold on its customers than any set of companies in history. The growth of these networks also gives some hope to other big tech incumbents without cloud services engines; no doubt Apple, Meta, and others will do everything they can to break the Amazon-Azure duopoly, especially as the power of that infrastructure begins to affect their ability to compete. Collaboration will likely be the long-term outcome as cloud-based SPs can use Filecoin as backend infrastructure and capture the spread from providing storage directly to customers. Doing so can be

extremely economically beneficial for them, as they turn their own fixed cost model into a variable cost one. Filecoin's biggest problems to date have been around scaling UX: while storage is a commodity, the user experience is not. This is where big tech incumbents can significantly accelerate usage forward, and capture the entire price spread, effectively capturing a >$20 spread on each terabyte of data (Exhibit 10).

Exhibit 10: Storage Cost Comparison



Source: Kassab, Sami; Bloomber, Seth; Grigore, Mihai. "The Essential Guide to Decentralized Storage Networks." Messari. January 12, 2023.

DePIN truly has the ability to eat infrastructure the way software ate most of commerce. Cloud services is a winner take all market, as the end resource is often commoditized and therefore the markets depend on who can sustain the lowest price for the resource they offer. This goes to production cost, and areas that DePIN wins are those where incentivized communities can greatly lower production cost by contributing excess capital/labor like spokes around a central hub of revenue-driving infrastructure. The fact that they are winner-take-all markets further justifies the win-at-all-cost strategy that token incentivization champions. That token incentivization can then drive a MOAT. The Lindy effect holds as true in crypto as most internet-native markets. One of the lessons we've learned the hard way with DePIN is that the first company to earn real revenue gets way ahead, because that revenue is useful to sustain the network and back the token in the early days by supporting SPs. At minimum scale, token value accrual is a big barrier to entry, as once the flywheel is going, the token allows the network to borrow forward resources in ways that allow faster growth through incentivization of the right partnerships and suppliers in equity-like form. Getting this token economy going allows you to incentivize at scale without a centralized step. As an example, Uber scaled significantly by raising billions centrally and distributing cash as incentives to drivers. DePIN models would allow direct incentivization of the end party which gives the network unbelievable access to the end labor supply and allows companies to experiment with equity incentivization in contribution for work, which we believe is a stickier and fairer prospect for storage providers. Other upstarts continue to iterate on this model. Moving away from Filecoin's programmatic token incentive structure, Helium and Nova Labs have begun experimenting with targeted incentivization, driving the ability to price discriminate: varying incentives based on service quality. By specifically incentivizing the highest value service, these dynamic models let networks better optimize exactly who they deliver incentives to. We suspect over time Filecoin's token structure may evolve to include this powerful mechanism.

Filecoin has yet to cross the chasm from a differentiated, loud contender to an all-encompassing protocol driving computation, but its strength in providing digital commodities on premises is a significant driver of long-term potential. The network has sizable embedded operating leverage, and scale in demand will reverberate meaningfully through the system. As compute-over-data proliferates as a more powerful standard of data management than core cloud, and as oligopolies move to clunky IAAS models, we expect attention and revenue on Filecoin to accelerate meaningfully. Digital infrastructure, despite being a public utility, is heavily concentrated in the hands of a small number of companies because of massive scale advantages and regulatory capture. This has welfare consequences to citizens, who have come to rely crucially on the internet in their day-to-day lives and would suffer from oligopolistic king-makers driving the internet's future. Technology should be a rising tide for all boats by radically lowering delivery costs and dramatically increasing inclusivity. While the first phase of the internet, structured around open protocols, began to fulfill this promise, the second saw gatekeepers erect high walls to charge ever higher tolls. DePIN is a radical way that the Internet can return value to communities and users. By allowing people to own and improve the infrastructure around them, DePIN spurs software-enabled collaboration at a scale that has only previously been available to corporations and governments. DePIN could offer a unique solution to escalating questions around resource productivity and welfare. Digital infrastructure's importance is only going to grow, and involving communities in their supply is a powerful way to increase equity. With minimal disruption to their lives, people can create tons of economic value. From education to remote work, the internet penetrates an increasing proportion of how we live, learn, and grow. Should Filecoin's model scale to provide useful storage coverage, it may represent a capitalist example of how returning the means of production to workers can create massive economic value.

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