Disrupting Real World Infrastructure On-chain: A Conversation with Mahesh

Ramakrishnan

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We sat down with Mahesh Ramakrishnan, an early-stage venture investor, to discuss how crypto economies are recreating physical world infrastructure. Dubbed "DePIN," Decentralized Physical Infrastructure Networks are an exciting application of public blockchains that start to answer the question: "Well, why crypto?"

1. **Can you give a brief definition of DePIN and describe its history from inception to present?**

   DePIN, or (Decentralized Physical Infrastructure Networks) is a blanket term for projects building the next generation of infrastructure by decentralizing the provision and delivery of physical and human capital. It's the name for a movement started by builders that want to build products in the physical world that use elements of crypto primitives and tokenization. By nature, these networks have peer-to-peer elements, and let community members participate in the upside of the network by providing either passive or mechanical "work" to the network. This work can be as simple as verification and hosting (or providing a device to transfer data), or as complex as having participants accomplish tasks (like mapping the road or WiFi routers).

   These networks draw inspiration from the previous generation of Web2 businesses like Uber and AirBnB which began to allow the long tail of consumers and "pro-sumers" to monetize the value of their capital (apartments, cars) and labor (driving, hosting). This revolution is just barely starting however, a myriad issues have been documented with Web2 incumbents, including issues with take rates charged and platform dependencies. DePIN networks, by providing a clear, transparent framework under which earnings are paid, and using a permissionless public blockchain to distribute payments, can represent a step function improvement in systemic trust.

   The movement, only three years old in practice, started with networks like Helium and Braintrust that began to re-write the relationship between corporations, communities, and their resources. Helium famously built the first decentralized wireless network focusing on IoT standards and had a ton of success scaling the supply side without yet scaling the demand side. While that first iteration fell short of business success, it showed other builders that the

model of bootstrapping infrastructure from scratch using a token could be extremely powerful. Today, Helium is rolling out its national phone plan having seen some initial success applying their initial model to mobile data roaming and TelCos. Braintrust, a different approach, used their token to create one of the world's biggest supplies of part time labor - employees willing to take contract work provided by Braintrust. By allowing employees to participate in the upside of the network, Braintrust has achieved incredible retention and an extremely motivated and aligned workforce.

When we started looking at the space in early 2021, we could count the number of DePIN projects on two hands. Two years later, we've tracked over 600 on our DePIN Ninja platform, and have only seen this number continue to accelerate.

2. What does an industry map for DePIN look like? What categories, industry, sectors of infrastructure are DePIN projects disrupting?

While we leave it to the community to define what all of the various subsectors are, I see DePIN most cleanly as driving the decentralization of capital and labor, and there are three subsectors that come out of that.

Physical Infrastructure:

The first sector to break out at scale, physical infrastructure networks range from protocols that provide digital commodities like compute, storage, and bandwidth, to businesses tackling take rate issues like food delivery. These businesses are unified by a simple principle: that certain activities are more efficiently done by incentivized groups of coordinated communities than governments or even businesses. Examples include Filecoin, Helium, Render, and WiFiMap, all of which use token incentives to tie together sprawling hardware footprints and make them useful.

Human Infrastructure:

While lagging physical infrastructure by number of projects, human infrastructure networks have also begun growing. These networks tend to connect people with human capital to others who need human capital. The first company in the space, Braintrust, has scaled to build peer-to-peer mentoring products, and other meaningful community experiences to boost people's human capital. Event related apps like Teleport have also begun to emerge to create differentiated

personal experiences, and we still have our eye on NFTs to deliver the promise to internet-based clubs.

Machine Infrastructure:

Still in its earliest stages, machine infrastructure networks offer the potential to decentralize emerging industries like AI and Robotics, under the unifying premise that more (and more diverse data) will drive the performance of AI. This sector is partially enabled by the growth of physical infrastructure, like decentralized compute.

Early use cases include inference networks, which run any question prompt against a number of end models, and provides the best possible answer across all of the models, and co-owned agent frameworks, allowing people to own bot services in the form of NFTs. Examples include Bittensor, Autonolas, and MachineFi, all of which aim to bring more powerful intelligence, and more autonomy into our everyday lives.

3. **Generally, who are the network participants and what are their responsibilities and incentives?**
Network participants can be anyone from consumers to prosumers, depending on the difficulty of the underlying work. We believe that the earliest use cases to achieve success will be the easiest both in terms of hardware complexity and physical work.

Take for example WifiMap, which rewards owners and mappers of WiFi hotspots for growing the number of nodes on the network. There is no differentiated hardware needed (people already own WiFi routers and phones), and the physical work required is as simple as asking a question: "hey can i add your hotspot to this network." The value accrual is simple: hotspots added to the WiFi network see an increase in traffic to the stores that added them. This is obvious, as WiFi use requires proximity, so the network is able to generate value and reward the contributor in WiFi tokens based on the perceived value of that hotspot's connectivity. WiFiMap has hundreds of millions of hotspots on the network, bootstrapped through this simple mechanism. The network pays for its own growth through dilution.

The responsibility of the mapper is to add nodes to the network by onboarding hotspot owners, and the responsibility of the owner is just to keep his hotspot on. So long as the map continues to drive traffic, the network can create economic

value, which WiFi can monetize through services (speed tests), subscriptions (sim cards), and advertising. We believe use cases like these, which empower groups of people to do simple work at scale can be extremely powerful.

4. **What aspect(s) of crypto – tokens, cryptography, immutability, network effects, smart contracts – do DePIN projects benefit from? Why do these networks need a blockchain?**

DePIN projects can benefit from all of the above: each of those factors is a different piece in the ultimate puzzle of creating hyper secure, fast, and easy to access digital infrastructure. The relative pace at which each of those primitives becomes crucial in DePIN will however vary with the stage of the project.

Tokens (or in-app currency) are a central part of DePIN already - strategic use of tokens to drive incentivization of crypto is the secret sauce to DePIN's viral growth. However, the use of these tokens needs to be targeted, and must be carefully structured to avoid redundancy, lest you waste dilution on building unproductive infrastructure. Projects like Hivemapper and WifiMap have been pioneers here, putting into place creative dilution structures that only reward useful work. Hivemapper for instance, pays full rewards to the first mapper of any given piece of road, and far fewer to each subsequent mapper. By doing so, it self-governs to help ensure only useful coverage is contributed.

Immutability is core to the use of blockchains in these projects. If DePIN is going to underlie the next generation of digital infrastructure, including government/defense infrastructure, it needs to be extremely secure. The immutability of the underlying blockchains and the cryptography ensures that tampering, foreign or otherwise, is immediately apparent. There's nowhere to hide for bad actors in this space. Lastly, network effects and economies are so important to why this works, and drive scaled pricing: with more nodes, you have more supply so can charge less (when it comes to digital commodities). We expect the biggest networks that achieve initial escape velocity to keep getting bigger.

5. **Many DePIN projects look to challenge incumbents: Helium 5G vs Telcos, Hivemapper vs Google Maps, Render and Akash vs general and special-purpose computing giants. What themes do these projects share that give them a structural advantage over incumbents?**

They share the use of network economies to tackle some of the biggest scale economies of all time.

When you look at the sectors DePIN threatens, they're all defined by scale economies. Cloud services today is home to one of the most powerful scale economies of all time, as Telecom Giants and Web2 incumbents have created infrastructure oligopolies, taking advantage of a historically low cost of capital to create sprawling footprints and king-make companies in areas of emerging technology. Infrastructure advantages represent a colossal barrier to entry to any player who wants to compete in software. With antitrust and regulators notoriously unwilling to take aggressive stances, traditional business models will likely have an extremely difficult time competing with these incumbents who have massive cost of capital, distribution, and regulatory advantages.

But the strategists at Harvard Business School would tell you only network economies have a chance of beating scale economies, and rapid increases in the availability of computational resources gives them a chance. Peer-to-peer organization, combined with open-source, composable software offers a radically different approach to a similar problem, and moves the battleground from cost of capital to collaboration. Using the cloud services example, this has three main categories on which DePIN wins.

1. Capex: DePIN networks either take advantage of existing hardware, or move the industry to a next gen version of commoditized hardware which can lead to significant upfront cost advantages vs. incumbents

2. Location: Part of the power of community is taking advantage of their fixed costs: people already pay rent/mortgages and have access to space that traditional companies would need to buy and lease. The DePIN community doesn't have to pay for additional land, like datacenter or tower companies do.

3. People: Given the role of software in managing the whole network including payments, DePIN protocols need fewer people vs. traditional businesses. By taking significant installation, service, and maintenance personnel cost out of the P&L, DePIN margins are stronger likely than incumbents.

There are a number of points of competition in which DePIN seemingly comes out on top vs. incumbents. By turning an industry defined by fixed cost into one variable cost, cemented by network effects, DePIN can challenge these cloud services monopolies on their own ground and benefit because of their structural advantages in pricing.

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