Filecoin
Virtual Machine

Introducing the
Filecoin Virtual Machine

The Filecoin Virtual Machine (FVM) brings smart contracts and user programmability to the Filecoin blockchain, unleashing the enormous potential of an open data economy.

Vision: Unleash the potential of the open data economy

The next wave of web3 will enable web-scale applications for the data-centric economy. FVM plays a crucial part in this by empowering developers to participate in, augment and harness the power of the billion-dollar data economy to build applications that underpin a more open, resilient, and equitable web.

Mission: Enable web3 applications to leverage Filecoin's large scale storage

FVM allows more people to participate in the creation and capture of value around data. With FVM, any developer can write and deploy custom code to run on Filecoin, allowing them to connect, augment, and innovate around the critical building blocks of the largest distributed and verifiable storage network. Eventually, FVM will unlock the development of applications, markets and organizations that will rival the scale and breadth of services offered by centralized cloud providers.

Opportunities unlocked by FVM

The launch of FVM uniquely positions Filecoin to power an open data economy across a number of opportunity areas:

- **Data onboarding & management** (e.g., tools automating storage deal-making to unlock use cases like perpetual storage)
- **Storage Provider discovery and reputation** (e.g., storage provider reputation services or data retrievability oracles that create differentiation opportunities and enhance the reliability of the decentralized cloud for its users)
- **Decentralized finance and other services** (e.g., to provide access to collateral for the thousands of storage providers offering services on the network and to create new opportunities for tokenholders to participate more actively in the Filecoin economy)
- **DataDAOs & data curation** (e.g., tools facilitating the collective creation, curation and monetization of valuable datasets)
- **Cross-chain interop & integration** (e.g., cross-chain bridges to integrate with other economies or NFT-standards with built-in storage guarantees)

As FVM grows to become an integral part of the Filecoin economy, developers across the ecosystem can prioritize and harness these opportunity areas and the ever-expanding universe of use cases and business models within each. The Filecoin community welcomes this diversity of approaches and the potential for innovation that it holds.

What is the Filecoin Virtual Machine

The FVM (Filecoin Virtual Machine) brings smart contracts and user programmability to the Filecoin blockchain, unleashing the enormous potential of an open data economy. The launch of FVM solidifies Filecoin's position as the L1 uniquely poised to power the open data economy.

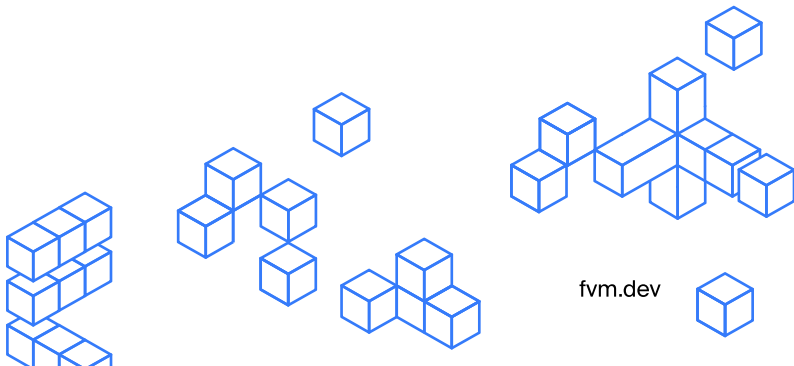
Specifically, FVM allows anyone to interact with Filecoin's state, including the metadata and transactions governing what, how, when and by/for whom data is stored on Filecoin's storage network. While FVM does not directly interact with the data stored on the Filecoin network, it can orchestrate where and how data gets placed, incentivised, and governed, giving rise to the concepts of Data DAOs and programmable storage.

The FVM will also enable a thriving ecosystem of off-chain data indexers, oracles, L2s and more that unlock rich data interactivity.

With the M2.1 release in March 2023, we are launching an Ethereum Virtual Machine (EVM) as a runtime on top of FVM. Developers can port existing EVM contracts with no changes, while connecting them to Filecoin state and storage services. This makes Filecoin compatible with EVM tools, including wallets like MetaMask, and developer tools like Hardhat or Foundry, making deploying and interacting with EVM-based actors easy.

How FVM will shape the future of the Internet

- **FVM enables developers to become builders of the data-centric economy.** In every aspect of our lives, there is an exponential increase in data — data is fueling the upheaval of the Fourth Industrial Revolution. The core tenets underpinning the data economy (cloud storage and compute as well as content-delivery networks and more) were worth a combined $300B+ in 2022. FVM creates boundless opportunities for innovations and enables developers to harness the power of the trillion dollar data economy.
- **FVM will massively expand the utility and value of the Filecoin network.** Filecoin is a unique economy of 3,800+ storage provider systems globally contributing storage capacity to the network, with more than 130M FIL locked as collateral and continuously earning block rewards. FVM will unlock new revenue streams and markets and provide access to DeFi collateral to further grow this valuable economy.
- **FVM is an important moment in the evolution of Filecoin.** With 13+ EiB of capacity Filecoin is the largest open access storage network. Unlocking programmability via FVM moves Filecoin closer to its bigger vision. With further advances around data retrieval and large scale computation, Filecoin will open up access to the data economy. Products and services built on Filecoin may eventually rival those offered by the centralized cloud providers.
- **FVM enables the use of the power of web3 to address coordination failures at a global scale.** With FVM, any number of unaffiliated parties may form an incentivized collective around the creation, curation and preservation of important datasets.
- **FVM enables the use of the power of web3 to address coordination failures at a global scale.** With FVM, any number of unaffiliated parties may form an incentivized collective around the creation, curation and preservation of important datasets. Such an organization could also use FVM-powered tools to jointly capture the value it creates and attribute it back to its members in direct proportion to their relative contribution: Imagine researchers using the proceeds of selling access to a database of bacterial pathogens (which may be used to inform antibiotic diagnostics or improve drug discovery) to finance the continued curation and maintenance of said database. Or an ever-expanding encyclopedia rewarding its most active contributors directly as opposed to letting the value flow through an intermediary foundation. Or individuals monetizing their contributions to the training data of an AI model. FVM enables communities to own and benefit from collective data governance.
- **FVM is flexible and composable allowing its systems to scale larger than any single organization could.** With FVM, developers will be able to write custom smart contracts in Rust, AssemblyScript, Go and compile them to Wasm bytecode, and potentially other privacy-preserving programming languages for zk-SNARKs like Lurk. FVM enables rapid deployment creating seamless scalability, efficiency and consistency. Additionally, its composability unlocks opportunities to bridge to other protocols, networks and economies. Ultimately, this may result in fiercer competition and more pressure to innovate across all sectors of the data economy.



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How the Filecoin Virtual Machine works

FVM provides a runtime for smart contracts (called 'actors' on the Filecoin network). It is based on WebAssembly (Wasm), and is inspired by VM hypervisors and OS virtualization. FVM can support actors written for a variety of execution environments, including Ethereum Virtual Machine (EVM), Secure EcmaScript (SES), eBPF, and actors that compile to WebAssembly. This new capacity allows for developers to create apps, markets and organizations built around data stored on Filecoin. FVM is an open technology that can be adopted by other networks with ease.

- **And a whole lot more.** FVM can support allocation of collateral to storage providers, organize around data, and create infinite persistence of data on Filecoin. Massive social networks will be able to leverage DataDAOs to share revenue with creators. Large language models can be built, trained and used on open source infrastructure with open data. New CDNs with thousands of endpoints will be created that will eventually serve all kinds of data, creating smooth data access opportunities for the world's most valuable datasets. All this will be possible in ways that benefit creators and communities rather than large corporations. FVM will be built in the interest of humanity rather than the interest of a particular datacenter, corporation or social network.

How FVM energizes the next generation of builders

For the thousands of developers and storage providers active in the Filecoin ecosystem as well as the numerous other stakeholders, there are many compelling reasons to believe in the potential of FVM.

- **Thriving community:** FVM boosts the utility of the Filecoin network and continues to energize and unite the participants of the Filecoin economy, including 3800+ storage provider systems offering their services to the network, many thousands of developers innovating with Filecoin technology, and many small and large investors - who all want more tools to transact, collaborate, and grow.
- **Open source to the core:** Filecoin and FVM continue to foster an open and collaborative ecosystem that's all about the best ideas. FVM is highly cross-compatible thus accelerating the adoption of Web3 technologies alongside and in partnership with other powerful ecosystems.
- **Promising trajectory:** The Filecoin network is already the world's largest decentralized storage network, outsizing the next-largest decentralized storage network by 400x. The launch of FVM is one of several exciting upcoming upgrades that will continue to solidify Filecoin's standing as a powerful L1 and uniquely position it to cater to internet-scale use cases.
- **Easy on-ramp:** With EVM as the first runtime to launch on top of FVM, developers can leverage tried and tested developer tooling infrastructure and build on existing EVM-based smart contracts. Testnets have been live and improving for months, giving early developers a head start in building.
- **Unparalleled utility:** FVM is an important pillar that stands to uniquely increase the utility, and capacity of the Filecoin blockchain and the ability to create value with Filecoin-powered products and services.
- **World-class support:** Numerous programs have and will continue to inspire and support pioneers to build with FVM with capital and world-class mentorship across FVM-specific grants, hackathons, community events, accelerator programs, and more.

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March 7, 2023

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