Chapter 1

What is Solana?

Preamble

Depending on who you ask, Solana means a hundred different things to different people. To some, it's a highly performant blockchain. To others, it is a database masquerading as a blockchain, with reliability issues. To others, still, it is a centralized VC scam coin, that can't get out from under SBF's haunting shadow. Talking about Solana evokes visceral reactions, either negative, from the many detractors quick to point out its many challenges, or its die-hard proponents, who can't imagine using anything else. Regardless of how you feel, it is here where we will leave our baggage. This book is an exploration into the thriving tapistry of code and vibrant ecosystem that is Solana. From its HFT-style traders and MEV searchers, to its distributed systems wonks, to the NFT apes, we are all aligned on one thing: Solana is a marvel in distributed networks, and a home for the tinkerers pushing the capabilities of modern blockchains. This book is for the glass eaters.

Solana's Origin

Solana's co-founder, Anatoly Yakovenko, conceived of Solana after two historic coffees and a beer, with the ultimate goal of creating "a blockchain at Nasdaq speed." At the time, eminent blockchains like bitcoin or ethereum handled transactions at no more than 12 transactions per second. Conversely, Nasdaq settles millions of trades per day, which is 1-2 orders of magnitude greater than most blockchains. Further, he was frustrated by the fact that retail users often suffered structural disadvantages when trading stocks online, thwarted by sophisticated traders with better latency, and faster access to information. What he needed was a blockchain that was fast, not only in handling throughput (transactions per second), but also in terms of distributing information quickly, such that users would not suffer from stale data. Anatoly knew that in order to handle transactions more quickly, they should be processed in parallel. The hard part, however, was in determining how to sequence these transactions when they share a single, common state (the blockchain). Enhanced by his Silicon Valley speedball, Anatoly had a epiphany, and conceived of something he called *proof of history (PoH)*–a means of establishing the passage of time (history), such that transactions could be timestamped and correctly ordered, despite being processed in parallel.

Solana is a Blockchain Network

In very basic terms, Solana is a proof-of-stake network of computers running client software. This network comprises a distributed, completely virtual machine–a turing-complete "cloud" computer–that manages and stores data to its blockchain. Some of the network clients are *validator* nodes that verify transactions, confirm

them, and append them to the blockchain. Other clients are *remote procedure call (RPC)* nodes or servers that users use to interact with the blockchain, and to forward data to the validators.

The Solana blockchain is known for its high performance. In 2023, it regularly confirms 4000 transactions per second, enabled by its Sealevel parallel runtime. Solana is the only major layer 1 blockchain with parallel transaction execution; most blockchains process transactions sequentially, or are effectively "single-threaded". The enabling technology for Solana's parallel execution is proof-of history (to be explained later). Another feature is its incredibly low latency, made possible by its Turbine block propagation protocol, which promotes fairness and equal access to real-time blockchain data.

Proof of Stake (PoS)

Solana is a proof-of-stake consensus network, which requires capital (Solana's native token, SOL) to be staked with a validator. The stakers earn fees for staking their tokens, and each validator is given a voice to vote on the validity of submitted transactions, and an opportunity to create blocks for the chain during its "leader" position. The frequency of opportunities to be a leader is directly proportional to how much stake a validator holds. Solana's mainnet-beta cluster is comprised of more that 3000 independent validators, all participating in a tightly choreographed dance, rotating leader positions for each *slot*, or a short time window to generate blocks. These several thousand nodes are distributed globally, contributing to the network's resilience against natural phenomena, censorship, and various types of attack.

Proof of History (PoH)

As stated before, Solana's parallel runtime is enabled by this novel concept of proof of history (PoH). The essence of the algorithm is that it runs SHA-256 hashes repeatedly, which takes a small but finite amount of time, which represents the ticking of a clock. In this sense it is similar to a *verifiable delay function (VDF)*. By the nature of how hashes work, we couldn't get to the next hash without knowing the previous one. Another useful fact about these hashes is that they take less time to verify than they do to compute. Therein lies the beauty of the algorithm: each hash, which is embedded in a block, effectively timestamps the transactions that are included in the block. This is what allows the network to establish correct transaction ordering while also propagating blocks asynchronously. Next, the correct sequence of blocks can be quickly verified, then reconstructed by the receiving nodes, and the blockchain can quickly recover from partitions, or forks, that would otherwise cause conflicts around *consensus*.

Solana the Token

Solana's native token, SOL, is multi-function in nature. SOL is the native "gas" token that you use to pay fees in the network to execute transactions, which are both burned and distributed to the validators for their service. SOL is also the token that serves as a deposit for account storage space on the blockchain, so-called *rent*. All accounts, whether it is for an SPL token (Solana's ERC-20 equivalent), an on-chain program, or just raw data, require space, and typically a finite, recoverable deposit is placed in the account to make it *rent-exempt*, and permanent until the account is closed. Finally, SOL is the capital used in Solana's proof-of-stake consensus protocol that ensures alignment between validators and the rest of the network. Validators put stake at risk to be given the privilege to create blocks and validate transactions. Nodes with more capital at risk get more opportunities to create blocks, and earn staking rewards. Operators that misbehave in the consensus ritual may lose their stake, either by users unstaking from their validator, or even being slashed. Currently, Solana's mainnet-beta cluster does not slash validators, but it will in the future.

Solana as an Ecosystem

That's a great machine you have, but what's it good for? Many benefits extend from having a globally-distributed, high performance execution engine with a common state that everyone can agree on, and that promotes equitable access to information. The premier use case was in a central limit order book (CLOB) for trading tokens; blockchain at Nasdaq speeds realized (well, an early version). With this order book, trades could be matched quickly, and settled in less than a second, giving finality to the trade that conventional stock echanges could only imagine.

While the CLOB is at home on Solana, other types of decentralized finance, or *DeFi*, are possible, including borrow/lend platforms, automated market maker (AMM)-based decentralized exchanges (DEX), and various types of synthetic assets. All of these use cases benefit from the extremely low transaction costs of the network, currently just 0.000005 SOL (much less than a penny).

Another use case is non-fungible tokens (NFTs), that may represent access passes/credentials, collectibles, or even titles to durable goods. Developments in NFT compression are now enabling extreme cost reductions in minting NFTs, such that it is possible to create millions of them for less than $100–currently impossible on other networks.

Another emerging application that is uniquely well-suited to Solana is decentralized physical infrastructure (DPIN). Uncoincidentally, the Helium Network has found its home on Solana, whereby it manages and compensates providers of their decentralized communications networks using the blockchain, and providing access to users of both long-range and 5G wireless networks.

Recap

In the first chapter, we have already covered the essence of how the Solana blockchain works, its practical value as a distributed network, and, while neither exhaustive nor definitive, a short enumeration of the applications for which it is well-suited. At this point, we hope you are as excited about the possibilities and design space for such a unique, and performant blockchain.