HOW CARDANO AND SOLANA WILL TAKE OVER ETHEREUM

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ABSTRACT-Cryptocurrencies market value surpassed $3 trillion for the first time In November 2021, as Ether and Bitcoin reached new highs. The popularity of decentralised finance (DeFi), non-fungible tokens (NFTs), and smart contracts has boosted Ethereum's price by over 500 percent this year. Investors are looking for alternatives to Ethereum, which has become the most widely used blockchain network, due to rising demand and higher gas costs. Other projects have taken advantage of this opportunity to enter the market and compete with it. Alternative currencies like as Solana and Cardano are quickly gaining popularity and have shown comparable growth this year. To learn more about them, we'll examine their tokenomics from throughout the Blockchain space in this research. As a result, a battle has erupted between these three cryptocurrencies to determine who will rule the 'smart contract' domain.

Keywords: Ethereum, Cardano, Solana, Crypto currency, Blockchain.

1. INTRODUCTION

Because ETH, SOL, and ADA are all altcoins, it's impossible to illustrate their vast differences. However, the slightest distinctions between them can be found in their blockchains, smart contracts, scalability concerns, and other factors, all of which constitute a common variation. This study will look into all of them.

Cardano is one of the highly valued cryptocurrencies in terms of market capitalization. Given that Charles Hoskinson, a co-founder of Ethereum's proof-of-work (PoW) protocol, went on to build Cardano as an alternative in 2017, it's not surprising to think of it as an Ethereum killer. The native cryptocurrency, ADA, is designed to pay network transaction fees and staking benefits [4].

On the other hand, Solana is a new, high-performance, permissionless blockchain platform designed to host decentralized, scalable applications. Founded in 2017 by Anatoly Yakovenko, Solana is an open-source project currently run by Solana Foundation based in Geneva, while the blockchain was built by San Francisco-based Solana Labs. Solana is a proof-of-stake (PoS) blockchain and uses a new technology called Proof of History (PoH). Its native cryptocurrency is SOL. Solana claims to offer faster transaction times and lower costs than its main competitor, Ethereum [3].

2. ARCHITECTURE

The Cardano blockchain is divided into two layers: the Cardano Settlement Layer (CSL), which is a value ledger where digital asset transactions are settled (where ADA lives), and the Cardano Computation Layer (CCL), allows the creation of "a special purpose token kept by delegates of that ledger who could be regulated entities, and thus creating a permissioned ledger."
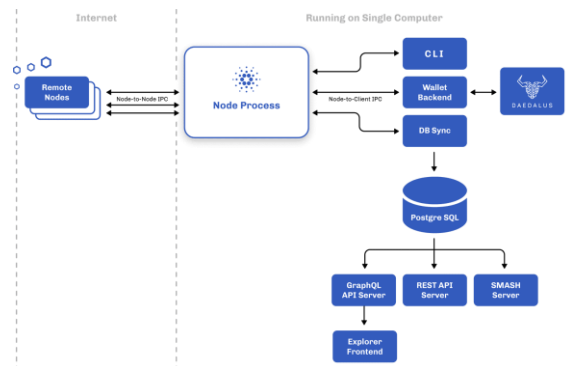

Fig: Cardano Architecture

Since Ethereum is designed to use the Proof-of-Work protocol (PoW), which consumes a lot of energy when validating transactions, many people are searching for more environmentally friendly crypto alternatives. As a result, Ethereum gas fees vary depending on network traffic, with fees clearly rising during moments of strong network activity.

Ethereum has begun the process of upgrading to ETH 2.0, which uses the proof-of-stake (PoS) protocol, in order to mitigate the load. Cardano, on the other hand, offers a challenge to Ethereum since its network has lower transaction fees, making it more efficient at executing smart contracts [20].

Coming to Solana Architecture, Client messages arrive to the current leader, who incorporates them into

a Proof of History (PoH) stream and broadcasts it to the rest of the network,
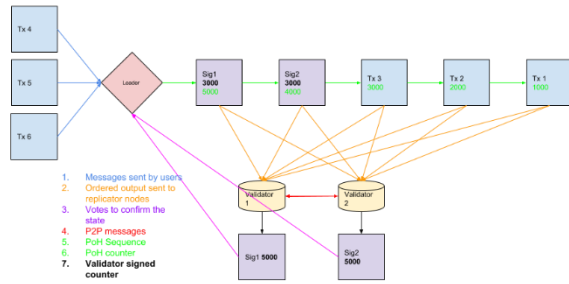

Fig:1[20]

which acts as validators, as illustrated in Figure 1. The problem with this arrangement is that the leader can only absorb 1 gigabit of data and must simultaneously generate 1 gigabit of output to many devices. It can't send the entire set of data to all of the machines since it would take up more than 1 gigabit of bandwidth. Our strategy is to divide the bandwidth among downstream validators, who will then reassemble the stream.

Figure 2 illustrates how the leader divides bandwidth among downstream nodes. In a round robin way, the leader transmits a packet up to 64kb to each validator in the first layer. This validator instantly broadcasts it to the rest of the network's first layer. This should combine the leader's transmission of the second packet to validator 2 with validator 1's broadcast of the first block to the rest of the network.
The leader sends out two different types of packets.

• Data packets, which are pieces of PoH data that show that real-time is passing as transactions are hashed into the PoH data.

• Reed-Solomon codes (RS packets), which may be used to reconstruct the dataset if any of the packets are lost.

Because RS Code packets consume some of the available bandwidth, they lower our throughput, but they also allow each validator to reconstruct the sent data structure if a few random packets are missed.
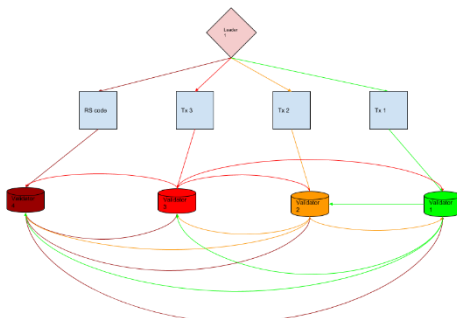The supermajority of nodes weighted by their stake amount plus the number of nodes predicted to fail at

Fig:2

any given moment should make up the collection of first layer validators.
The supermajority of nodes weighted by their stake amount plus the number of nodes predicted to fail at any given moment should make up the collection of first layer validators. The extra RS Code packets and nodes in the first layer will give the network some breathing room in case of dropped packets or hardware failures [22].
Moving to architecture of Ethereum, every client (browser) connects with its own instance of the programme, as shown in the figure below. There isn't a single server to which all the clients connect.
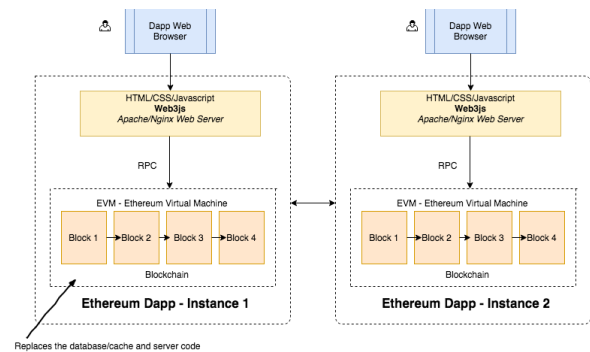

Fig: Ethereum Architecture [20]

It means, in an ideal decentralized world, each person who chooses to interact with a DApp (Decentralized Application) needs a full copy of the blockchain running on their computer. That means, before you can use an application, you must download the entire blockchain and then start using the application.
We don't live in a ideal environment, and expecting everyone to operate a blockchain server in order to use these apps is unrealistic. Decentralization, on the other hand, is based on the principle of not relying on a single, centralised server. As a result, the community has devised methods (hosted blockchain servers, metamask, and so on) that allow you to avoid wasting a lot of your hard disc and RAM downloading and operating a full copy of the blockchain while maintaining the decentralised component. In subsequent courses, we will assess those possibilities.

3. DEVELOPMENT APPROACH

Although both Ethereum and Cardano are decentralised platforms, they differ in a number of major areas, including how they are implemented and developed. Although Ethereum is noted for its rapid development, there are certain disadvantages to moving too quickly. Ethereum promotes speedier development, but at the cost of a more brittle set of software implementations.
Cardano, on the other hand, prefers to take its time before deploying anything in order to thoroughly analyse and improve its technology through a peer-

review process. While some may consider Cardano's approach to be extremely slow, founder Charles Hoskinson sees it as an important component of the process that ensures reliability and stability. Cardano has fewer projects as a result of Ethereum's "first mover" advantage, but this is partly owing to Ethereum's "first mover" advantage.

Anatoly Yakovenko presented a whitepaper in November 2017 outlining Proof of History, a method for tracking time across computers that don't trust each other. Anatoly recognised that a reliable clock makes network synchronisation straightforward from his past experience. When synchronisation is easy, the resultant network can be lightning fast, with network bandwidth being the sole constraint.

Anatoly thought he had the key to bringing 40 years of distributed systems research to the realm of blockchain when he solved the difficulty of getting machines that don't trust each other to agree on time. The resultant cluster would be 10,000 times quicker straight out of the gate, not only 10 times faster, 100 times faster, or 1,000 times faster!

Anatoly's work was initially written in the C programming language and started in a private codebase, then was rewritten in Rust programming Language after Greg Fitzgerald's suggestion that it would increase software productivity and allow applications to perform as well as C programmes. The team changed Greg's prototype Silk to Solana and founded the Solana GitHub organisation on March 28th.

The team scaled up the system to run on cloud-based networks in June 2018, and on July 19th, they unveiled a 50-node, permissioned, public testnet capable of bursts of 250,000 transactions per second. The researchers launched a permissioned testnet operating 150 nodes on a gigabit network in December, dubbed v0.10 Pillbox, and conducted soak tests handling an average of 200 thousand transactions per second with bursts exceeding 500 thousand. On-chain applications written in the C programming language that execute concurrently in a safe execution environment called BPF were also included to the project.

4. CONSENSUS ALGORITHM

Proof-of-Work

Ethereum is still implementing the exact same consensus algorithm as Bitcoin, which requires a lot of energy to validate transactions on the blockchain, by validating transactions using a Proof-of-work consensus mechanism. Many experts feel that, while secure, the Proof-of-Work protocol is unsustainable in the long run, which is one of the reasons Ethereum is switching to a Proof-of-Stake method.

The Cardano blockchain is based on the Ouroboros proof-of-stake (PoS) consensus mechanism, which is widely regarded as the most energy-efficient and secure PoS protocol currently available. Unlike Bitcoin and Ethereum, which are first- and second-generation blockchains, Cardano, as a third-generation blockchain with a Proof-of-Stake mechanism, has been specifically developed to be more efficient and thus more environmentally friendly than Ethereum with a substantial effect? Miners, goodbye.
"The necessary way that a proof-of-stake system like Cardano functions is that some 'validators' put up a stake of their coin to attest the validity of a block in the blockchain. Validators gain a specific amount of cryptocurrency as a reward through this staking system."

Solana is based on a hybrid protocol that combines proof-of-stake (PoS) and a notion called proof-of-history (PoH). Proof-of-stake is a mechanism that allows a blockchain to keep correct data across all of its users. Proof-of-history is a method for demonstrating that transactions are in the right order and were discovered by the right person.

Proof-of-stake

Owners of cryptocurrencies commit, or "stake," their coins to a validator under Proof-of-Stake. A validator is a computer that has its own copy of the blockchain and runs the blockchain software. In a proof-of-work blockchain like Bitcoin's, these validators are the equivalent of miners.

Validators are chosen to add the next block of transactions based on how much their stake is (how many coins they have promised to the network), how long they have staked for, and a variety of other factors, rather than competing with other computers to solve complicated problems as in Proof-of-work.

The goal is to determine the amount of commitment among network participants and to reward them for it. The network gets more decentralised and safer as the stake grows in relation to circulating supply.
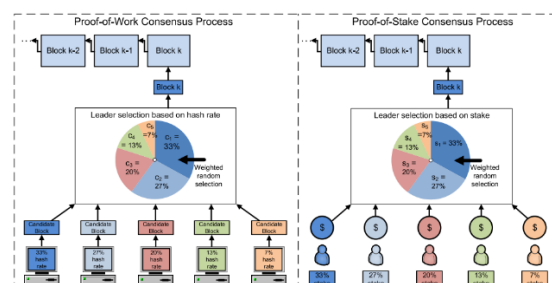

Fig: PoW and PoS consensus mechanism comparison [22]

Proof of History

Proof of History is a set of calculations that may be used to cryptographically confirm the passage of time between two occurrences. PoH ensures that a blockchain is extremely fast while maintaining decentralised security. All Solana events and transactions are hashed using the SHA256 hash method. This function is used by Solana to take an input and generate a one-of-a-kind result that is extremely difficult to predict. Solana uses the output of a transaction as the input for the next hash. The transaction sequence is now included in the hashed output. This hashing technique results in a long, uninterrupted chain of hashed transactions. Without the use of a traditional timestamp, this feature creates a clear, verifiable sequence of transactions that a validator adds to a block. Validators may easily check how much time has elapsed, as well as the next block of transactions for the slot they were assigned to, because hashing takes a certain amount of time to finish. This is called as proof-of-history sequence.

How proof-of-history works

1. Validator A is assigned to slot one and spends five seconds finding the next block.

2. Validator B is assigned slot two and takes five seconds to find the following block, amounting to the passage of 10 seconds.

3. Validator C is assigned to slot three and takes five seconds to find a block. By the end, a total of 15 seconds has passed.

This procedure takes the same amount of time for each validator. We know validator C is allocated to slot three, and we know that slot three should only begin at the 10-second point because each block takes the same amount of time. As a result, validator C cannot begin before or after the tally has reached the 10-second mark [28].

5. SCALABILITY

Ensures that the Cardano ledger can process a high number of transactions without slowing down the network. Higher bandwidth possibilities are also provided through scalability, allowing transactions to carry a substantial quantity of supporting data that can be managed simply inside the network. Cardano is working to develop Hydra, which will enable multiple side chain capabilities, to meet these needs, and is implementing several solutions (such as data compression).

The bandwidth problem lies at the heart of the scalability trilemma in blockchain technology. Given a limited amount of bandwidth per node, raising the node count will extend the time it takes to broadcast all data to all nodes in most blockchain networks today, which is a major issue. There are, however, several ways to improve the way data is disseminated. There are a variety of new data propagation mechanisms available, each of which is tailored to a certain use.

Moving on to Turbine, Solana's block propagation protocol was created to address this problem. Turbine is a Solana protocol for quickly and securely propagating blocks over the network. When a Leader node streams data to other nodes in the network, Turbine creates a random route for each data packet via the network. Turbine is used for streaming and merely utilizes UDP to send data. As leaders (block producers) stream their data, The block is broken up into 64KB packets by the leader. The leader generates 2,000 64KB packets for a 128MB block and sends each one to a separate validator.

Each validator then retransmits the packet to a set of peers we refer to as a neighbourhood. The network may be seen as a tree of neighbourhoods, allowing it to extend much beyond 1,000 validators. Each community is responsible for sending a percentage of its data to the other neighbourhoods.

A three-level network, starting with a single leader at the root, may reach 40,000 validators in two hops — or around 200 milliseconds if each network link is 100 milliseconds on average.

The problem in this method is that it is not secure. Adversary nodes, for example, can choose whether or not to rebroadcast data, or whether or not to rebroadcast erroneous data. The leader creates Reed-Solomon erasure codes to deal with aggressive nodes. Each validator can reassemble the complete block without getting all of the packets thanks to erasure codes.

6. ENVIRONMNENT IMPACT

Cardano is called as the "Green" Blockchain. As Cardano employs the proof-of-stake (PoS) approach. Bitcoin transactions utilise far more electricity than PoS projects because PoW is more resource-intensive, it is estimated that the Ethereum, the second-largest cryptocurrency network, consumes 112.6 Terawatt-hours of electricity each year, more than the Philippines or Belgium require. The average Ethereum transaction requires 268.6 kilowatt-hours of electricity, which is equivalent to the amount of electricity consumed by an ordinary American household in 9.08 days. whereas Cardano uses only approximately 0.01 percent of that and Solana uses 0.003186TWh. Furthermore, Cardano's network does

not require the high-tech equipment. It produces less electronic waste since its rigs don't need to be upgraded as regularly [6].

The Solana Foundation announced that the Solana blockchain has achieved carbon neutrality for 2021, as part of its commitment to reduce Solana's already minimal environmental effect.

The Solana Foundation will support a process called refrigerant destruction, which is listed by Green America as one of the most effective strategies to cut carbon emissions. The Foundation is funding to offset the Solana network's carbon impact for the whole year of 2021.

According to the Solana Foundation's most recent analysis, a single Solana transaction needs just 1,939 Joules of energy, which is less than the energy necessary to do two Google searches. It's the equivalent of running your refrigerator (810,000 J per hour) for roughly 11 seconds or leaving an LED lightbulb on (36,000 J per hour) for a little more than 3 minutes. It also consumes far less energy than transactions on other popular blockchains, such as eth2 (126,000 J), Ethereum (777,600,000 J), or bitcoin (7,412,400,000 J). With 1,663 validator nodes and an estimated 67,000,000,000 transactions, the Solana network consumes an estimated 11,051,066 kWh per year. This is the equal of 1038 American families' typical power usage.

Despite this low energy use, the Solana Foundation pledges to decrease the environmental effect of the Solana ecosystem even further. The Foundation intends to launch a programme by the end of 2021 to help make Solana's validator network carbon neutral and offset the ecosystem's footprint [29].

7. PROJECTS ON SOL AND ADA

Over the course of three months, Cardano's ecosystem grew to include more than 100 projects. Hence, DeFi to NFT initiatives will continue this tendency to grow.

Sundaeswap (SUNDAE) - is a decentralised cryptocurrency exchange for the Cardano blockchain. It enables blockchain users to supply liquidity and create a market where others can trade their native tokens. Swappers pay a nominal charge in exchange, and liquidity providers get a return on their investment.

Ardana (DANA) - is a Cardano-based asset-backed stablecoin system and decentralised exchange with a stable asset liquidity pool. The stablecoin is overcollateralized with Cardano native assets on the blockchain, and the decentralised exchange allows for highly capital efficient stablecoin transactions. Ardana's staff includes technological talent from well-known firms and blockchain initiatives, including Apple, Microsoft, Barclays, the Central Bank of

Jordan, Jane Street, Mina Protocol, Cardano, the Plutus Pioneers Program, and Emurgo Academy.

MELD - is a decentralised and trustless lending protocol managed by the MELD token and implemented on the Cardano Blockchain utilising smart contracts. "To place it simply, it's a DeFi project that permits anyone to obtain fast cash loans utilising their crypto assets, as well as investors to leverage their fiat investments to earn higher profits." MELD also offers a variety of products, such as MELD debit cards, which may be used to obtain a line of credit for cryptocurrency investments."

Drunken Dragon Games (FT) - is a Cardano NFT game similar to Ethereum's Axie Infinity. Pixel Tiles (FTs) are collected and tradeable tokens on the Cardano Blockchain. They represent adventurers who players will dispatch on epic adventures, as well as items that will be used to decorate and develop your Inn & Tavern.

Empowa (EMP) - bills itself as the world's first "RealFi" platform, with an aim to improve affordable housing on the African continent, beginning with Mozambique.
"It's a one-of-a-kind decentralised property development and digital collectibles platform that aims to use the power of community to empower people who are largely disadvantaged by the financial system" [25].

Solana provides a cost-effective environment for DApp developers to create applications. This open source blockchain, which has over 350 Solana projects, may benefit everyone.

Raydium is a Solana blockchain-based automated market maker (AMM) and liquidity provider. Raydium, unlike other AMMs, delivers on-chain liquidity to a central limit order book, giving pools access to all Serum order traffic and liquidity. The protocol has already sparked a lot of interest, with the market cap for Total Value Locked just surpassing $700 million (TVL). Fusion Pools, another of Raydium's ventures, offers dual-yield benefits for both liquidity providers and stakers.

Maps.me is a mobile app that uses OpenStreetMap data to generate offline maps. It now has over 140 million members and has just added DeFi capabilities to the app, which include typical travel reward programmes and discounts, as well as ecosystem governance tools. Maps.me's ecosystem is developing to become a travel-oriented crypto wallet, with services such as payments, hotel booking, fund transfers, and asset management, as people use the app most when they're travelling.

Audius is a blockchain-based music streaming network that gives content artists more control over their work. It's been around for a few years, and it was first used on Ethereum. However, after extensive testing, the team has decided to switch to Solana in order to better serve its fast-growing user base, which currently numbers over 1 million monthly listeners.

SolFarm is a yield aggregation platform with vault techniques that compound themselves automatically. SolFarm uses Solana's low-cost blockchain transactions to enable frequent compounding methods, allowing LP stakeholders to profit from higher APYs without the need for active management [11].

The Solana projects' success pushed the price of SOL to a new all-time high in November 2021. Solana's cost-effectiveness attracts new Dapp developers to the network every day, expanding its ecosystem and strengthening the entire Solana community.
As a result, Solana competes with Ethereum, the market's most popular smart-contract platform, a lot of interest, with the market cap for Total Value Locked just surpassing $700 million (TVL). Fusion Pools, another of Raydium's ventures, offers dual-yield benefits for both liquidity providers and stakers [12].

As a result, Solana and Cardano competes with Ethereum, the market's most popular smart-contract platform.

8. COMING UPGRADES TO SOL AND ADA

Cardano has released another update to its blockchain network on Tuesday, February 1. The improvement has been detailed by the developer firm Input-Output Global. These changes correspond with Cardano's consensus structure and data processing requirements. The Cardano blockchain's block size and transaction throughput will be improved with the new version. Due to increased demand for Cardano, Input Output Global announced that the block size will be increased by 11%, from 72 to 80 KB. Each transaction will now use the increased "CPU," i.e., the amount of Plutus script memory units, as a result of the update. From 12.5 million to 14 million memory units each transaction, this has been boosted by as much as 1.5 million. Cardano's on-chain application ecosystem has also seen a spike in traffic as a result of this. The blockchain load on the network reached a new high last week. On the Cardano blockchain, the number of blocks utilised has surpassed 95%. This is proof of Cardano's rising popularity in the crypto world.

As the consensus enters the Basho phase, the Cardano team's intentions for upgrading the network are to monitor network performance. This phase includes focuses on decentralisation and transaction processing scalability for DApps and wallets. Furthermore, the team is working on a big improvement to its consensus layer. This update, is known as "diffusion pipelining," would leverage blockchain to overlap transaction stages rather than processing them sequentially. The blockchain's speed will be greatly increased as a result of this. Cardano will become even more appealing to decentralised exchanges (DEXs), high-performing DApps, and other NFT marketplaces as a result of these significant advances. Cardano can now introduce a more complex dApps architecture as a result of this development and will run faster and more efficiently [10].

Coming to Solana's updates, Solana openly acknowledges to a 'performance degradation' after being struck by a series of network instability lately for two or three days, which is clearly specified in the top right of Solana's blockchain explorer as well as solana beach blockchain explorer. It explains why it hasn't performed as well as other completely operational cryptocurrencies. Engineers have now issued version 1.8.14 in an attempt to alleviate the problem, according to the article. The next updates, according to the source, are targeted at enhancing the network's status, with the Solana Mainnet release slated to include even more changes. In addition, Solana appears to be planning to take this a step further in 2022, focusing on NFT-based games rather than generative art and capitalising on the expanding play-to-earn industry.

9. ETH vs SOL vs ADA

	Ethereum	Solana	Cardano
Number of Transactions per second	15	65,000	250
Average fee per transaction	$18.6	$0.00025	$0.25
Network Latency	22.13 sec	0.4 sec	20 sec
Number of Validators	2209	1709	2924
Total no. of Transactions (approx.)	1.07B	70B (Till date)	32M (till date)
Staked Reward	18.10%	5.8%	5.9%
Staked Value	$115.2B	$84B	$22B
Market Cap	$354B	$54.6 B	$41.1B
Circulating Supply	120M	327M	33.74B

Rate of Inflation (Annually)	4.5%	1.5%	2%
Burn Rate (Annually)	4M	None	None

The numerical stated above are as per the documentation of this report are best of our knowledge and research; however, these current values may vary based on various factors and listings in different blogs. These current numbers may vary based on numerous factors and listings in different blogs.

In early 2021, the percentage growth of all 3 crypto currencies were at the same level. After the first quarter, Solana's value increased steadily as compared to the other two. In the middle of August, Solana's value skyrocketed and increased by 15.02K% at the end of the year, while the Cardano increased 876.7% and Ethereum increased by 518.6%.
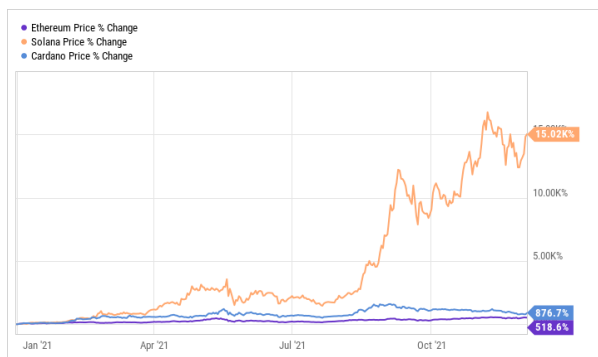

Fig: Price Comparison[23]

10. SUMMARY

These two crypto platforms are known as Ethereum killers because of their Proof-of-Stake (PoS) consensus. Cardano is being advertised as a more ecologically friendly alternative to Ethereum, as well as one of the most important Web 3.0 initiatives. It also boasts a solid founding team, significant links to the cryptocurrency world, and an Ethiopian collaboration.

Solana's technology is arguably superior to Ethereum's, and it offers low-cost, rapid transactions to its customers. Because of its early adoption of NFTs, Solana has a large following, and in the cryptocurrency world, community is virtually everything. People are opting to mint their projects with Solana rather than Ethereum because of the superior technology and reduced tax rates.

Since ADA is still in progress for smart contract acquisition, Solana exceeds Cardano in terms of smart

contracts. Traders also had great hopes that the arrival of Cardano's much-anticipated "Alonzo update" would open unlimited possibilities for the cryptocurrency's development, but those hopes were dashed. This has elevated the stakes of SOL in comparison to ADA.

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