BUILDING AN OPEN-SOURCE BLOCKCHAIN ECOSYSTEM WITH ARK

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Abstract: Ark aims to create an entire ecosystem of linked chains by providing easy to use tools to deploy your own blockchain. Being highly flexible and adaptable, it allows products to be adopted by the general public much quicker and smoother. By having open source code, it is available to anyone who wants to contribute, or to build their own blockchain based on Ark technology stack. With a new block created every 8 seconds, its transactions are incredibly fast! In this paper we will present the building foundation of ARK Ecosystem, the decentralized organization behind ARK token, what are the challenges we are currently facing in general with blockchain technology and what is the role of the open-source community (ARK community fund, GitHub bounty program). We will also cover basics about the new ARK Core v2, which is a complete rewrite of the core blockchain code, addressed to deliver our vision of blockchain technology.

Key words: • ark • blockchain • open-source software • crypto • programming • javascript • architecture

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1. INTRODUCTION

We are ten years into the decentralisation revolution, since the publication of Satoshi's paper and the introduction of the first decentralised solution to solve the problem of double-spending in digital networks. Currently we are moving through the phase of disillusionment where interest wanes as experiments and implementations fail to deliver. Producers of the technology shake out or fail. Further investment continues only if the surviving providers improve their products to the satisfaction of early adopters[1] [2]. Blockchain project are moving from experimentation around decentralised technologies to complete solutions including consensus mechanisms, identity, data structures, crypto-economic designs and smart contracts. In their convergence report Outlier Ventures[9] stated that: "*Most projects will fail, but the open-source nature of the ecosystem means learnings and code will be available to all*". We can learn and build faster than ever.

There is still a ton of hype around blockchain technology. You can read about how blockchain will erase global hunger, make world corruption free, end poverty - all with seamless technology delivered out of the box. Of course, we believe in such promises in the long run, but in order to deliver this with blockchain technology, we have to make it usable, configurable and seamlessly adjustable. Never before has a "back-end" technology gotten so much attention in media and well - we can basically read about it everywhere [3].

Should a common man have heard about blockchain and blockchain technology? We think not, however the people delivering this technology are still in the so cold "dark-ages" where first tools are still about to be forged in order to deliver the promise that blockchain technology can be harvested to disrupt and engage communities with new trustless solutions and business models that are yet to be discovered [4].

We don't want new blockchain solutions just to replace VISA or Mastercard or other payments systems. Let's be honest, these are optimized and mature solutions doing fastest payments in the traditional economy space. Many speed comparisons in the form of "TPS - transactions per second" between current systems and other blockchain platforms [5] can be found. At first, this looks like a very important piece of information, but in order to deliver the trustless promise, via transactions based on P2P (peer-to-peer network communication)[6], we know that it is possible, but in this case the network itself is not decentralized, but already centralized with fast central servers (nodes) delivering and confirming transactions. These are the models that big corporations will use and we already see them going in this direction with R3 Corda [7], IBM HyperLedger and similar technology [8].

The most common question we hear is "What can blockchain do that other technologies cannot do?" Is it fair to expect a 9 year old technology to outperform all other technologies in the world? [9] And yet, it already does on so many levels, the challenge we are facing is how to make this technology properly architectured and in the end user-friendly in order to deliver mass adoption of this so called "back-end" technology.

In the next section we present ARK ecosystem and how it contributes to the blockchain landscape today.

1.1 How does ARK add value to the blockchain tech landscape?

ARK[10] is looking to eliminate the barrier to entry in the blockchain space that is caused by the immense complexity of the technology. We want ARK to do for blockchain what WordPress did for website development. We are making that a reality with our focus on push-button blockchain technology and by steering our efforts toward meeting the needs of enterprises, start-ups, and developers as our prime customer base first and foremost. ARK will enable simplified deployment of custom blockchains while allowing the deployment of a wide array of services.

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[9] Convergence Ecosystem report by Outlier ventures https://outlierventures.io/wp-content/uploads/2018/03/The_Convergence_Ecosystem_Report_Outlier_Ventures_2018.pdf

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ARK's value proposition lies within that core platform and the utility of the services we are building into the ecosystem. Services such as the capability of connecting to different blockchains via our SmartBridge technology (see Figure 1). We have successfully connected to Ethereum, Bitcoin, and Litecoin blockchains with more in development. SmartBridge allows ARK to move data from one blockchain to another with the use of special Encoded Listener Nodes that can interpret and process data back and forth between different chains. With the integration of one of our next milestones, ArkVM, all ARK blockchains will be capable of utilizing smart-contracts as well and we are concurrently working on an IPFS based blockchain storage solution.

The ARK platform will be a great place for future blockchain developers to get their feet wet in this budding industry. ARK will allow them to customize a blockchain for their businesses with the features their companies need right at their fingertips, with an all-in-one ARK blockchain sandbox.

Figure 1: ARK SmartBridge concept Sending BTC to an ARK Address

In the next section we will briefly cover Open-source software (OSS)[11], it's concepts and challenges of developing software solutions out in the open, and how do we use the OSS model to deliver one of the best blockchain platforms out there.

2. DEVELOPING OPEN-SOURCE SOLUTIONS BASED ON ARK ECOSYSTEM

If we look at the definition of OSS: "*Open-source software (OSS) is a type of <u>computer software</u> whose <u>source code</u> is released under a <u>license</u> in which the <u>copyright</u> holder grants users the rights to study, change, and distribute the software to anyone and for any purpose*" [12] . With open-source software, anyone is allowed to create modifications of it, port it to new operating systems and instruction set architectures, share it with others or, in some cases, market it.

Free and open source software developing models have made it possible to form new virtual teams, and enable team work between people, who may have not even been acquainted before, to help each other and to follow a common goal.

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Figure 2. Why Open-source software [13]

According to a study by InfoSys [13] more than 78 percent of enterprises run on open source and fewer than 3 percent indicate they don't rely on open source software in any way. IT companies are in the phase of a big shift and transformation in the OSS arena with a healthy and positive mindset that *Open Source Software Gains in Strategic Value.* Big companies like Walmart, GE, Merck, Goldman Sachs, Google and Facebook are also analyzing and moving towards open software [14]. OSS is the core engine of innovation and can be seen as a first approach for enterprise architecture.

Of course, there are ups and downs of OSS, and it depends if you are a developer of OSS or a consumer, as most of the big companies mentioned above. Looking from the consumer side you have more to gain. Where we see the magic happening and how the value is added by observing and helping OSS teams to follow a common goal. Of the reasons why ARK is an "ecosystem" is the fact that **ARK is a living and breathing organism.** If we look at the definition of an ecosystem: *"An ecosystem is a community made up of living organisms and nonliving components such as air, water, and mineral soil"*[15], we can mirror the definition to **ARK - where the living organism is our community with more that 12,000 active users**. Non-living components are presented in the form of tools we use and the products we deliver (ARK blockchain and ARK SDKs in more than 20 programming languages). Our work process is built around distributed best practices, which are promoted and used by GitHub and other big opensource projects. All our code[10] is free, issued under the MIT OSS license.

ARK will continue to support community outreach initiatives through partnerships with college hackathons, local meetups, and by sponsoring major conferences. We are doing anything we can to preach the gospel of blockchain to developers, hobbyists, or really anyone who will listen. We will also be advising and helping new blockchain projects that want to develop their use cases and be powered by ARK technology. One of the good examples of how the OSS model connects and motivates people is ARK Community fund.

As mentioned by Richard Burton: "The hardest mental leap for people when they join crypto is the move from closed to open. Code is worth almost nothing. Community is worth everything. Anyone can fork the code. Very few people can fork a community. Internalising that reality is just impossible for some people ."

ARK realized that from the start and defined the building blocks of the ecosystem, together with the community. The result is one of the strongest communities in crypto space. With more than 12,000 daily active users you get all the benefits (see Figure 1) of the OSS model delivered to you. Cost reduction, quality improvement and quicker time to market are just some of the gains you get by joining our

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[10] GitHub Ark Ecosystem - https://github.com/arkecosystem

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community. If you want to develop solutions on top of ARK, there is always someone available and willing to help you out. It's like a friendly call centre, where everyone helps you and you all work together, of course help is for free. On the OSS developer side, the code (product) is more secure, as it is constantly exposed and under eyes of the experts or hackers that want to gain, by harming the network.

2.1 ARK community fund - ACF

The ACF[11] is an entirely community owned and operated vehicle for matching developers and entrepreneurs with potential seed funding through the use of the ARK ecosystem. The ARK Community Fund (ACF) is a fund that is run by the ARK community members[16]. It can be seen as supplemental to the core development of ARK ecosystem and shall support the ideas and projects of ARK community members to help promote the advancement of the ARK Ecosystem. The ACF has two main purposes[16]:

- to provide a possibility to those ARK community members, that would like to support the ARK Ecosystem with contributions of ARK tokens for community purposes.
- to provide a place for community developers to request funding, for projects to develop tools, software or hardware which supports the ARK Ecosystem.

Potential projects are able to submit applications to the team running the ACF to be considered for funding which can range from simple apps to more complex an custom solutions, as well as marketing efforts to help with recognition of ARK brand across the globe.

3. INTEROPERABILITY AS ONE OF THE BIGGEST BLOCKCHAIN CHALLENGES

Blockchain is HERE! In order for the blockchain technology to be mass adopted we need to deliver seamless communication between different blockchains. Richard Brown, CTO at R3 Corda, defined this as: *Universal interoperability - business needs the universal interoperability of public networks with the privacy and power of private networks [17].* Interoperability simply means inter- and cross-blockchain communication.

ARK is at its core defined to address the challenge of interoperability with so called SmartBridge field. ARK ACES - Aces Contract Execution Services[18] is a perfect example of a solution addressing interoperability issues between different blockchains and is developed as a community project for anyone to join in and help improve, add new features or report issues faced when using ACES (see section 3.2).

Interoperability should be addressed at different levels. Looking at ARK technology stack we are addressing this with ARK ACES for cross-chain communication. As for interchain communication (two different blockchains with the same technology stack should be able to "talk" with each other - i.e. enabling atomic swaps, sharing data, using the same consensus mechanism). We don't want to bloat the main network (the famous CryptoKittes [19] example) by pushing all the stakeholders on the same level of technology - there is no blockchain to rule them all. To address this we deliver options to clone our technology (by using ARK Deployer) and enable users, local communities, and other value chains to start their own network where the most of the workload will be done, and when needed the communication with master chain will be used. By using the master chain, all the bridgechains gain the benefits, such as being already listed on exchanges, established trust and presence, all the technology in the back-end can be reused.

3.1 ARK deployer

One of the key tenants of ARK's business model is the Push-Button blockchain deployment. Our goal for ARK is to create the core experience and modular ecosystem that does for blockchain what

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[11]ARK community fund - https://arkcommunity.fund/

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WordPress has done for websites and blogging. ARK Deployer is a lightweight deployment script for creating your own ARK based blockchains - bridgechain. By utilizing the ARK Deployer, developers can create their own blockchain in a matter of minutes. ARK Deployer is just the first step in building a more robust ecosystem that will be user friendly, customizable, and will feature the same caliber of user experience you have all come to expect from an ARK project.

The ARK Deployer script is being published for developers, hackers and tech enthusiast to launch their own blockchain based on ARK technology, start learning how the ARK ecosystem works, and get accustomed to the code. Installation instructions and code can be found at: https://github.com/ArkEcosystem/ark-deployer.

ARK Chain is launched with preconfigured ARK blockchain parameters and can also be adjusted to fit your custom needs. ARK Deployer configures, deploys and integrates the following:
1. Deploys ARK node in auto-forging mode on a single computer / server, with 51 forging genesis delegates (clones the ARK node and sets their custom parameters, creates their own genesis file with auto-forging delegates).
2. Deploys ARK explorer that is already configured and talking with installed ARK node (clones, configures, installs and integrates ARK explorer with the ARK node).
3. Configures ARK API for the developer to start exploring, hacking and developing solutions based on ARK Ecosystem technology.

A Vagrant[20] script is also available, where we even automated the deployer steps (read instructions in GitHub repository).

There are also other blockchain solutions targeting this challenges, blockchain suck as Polkadot, Aion Network, MultiChain, BlockNet, Stratis and some others. All this blockchain solutions recognized that in order for a technology to succeed and grow, a *strong network needs to be built and value must be delivered by using supporting protocols talking to each other*. While some hybrid blockchain networks address this challenge successfully, they also take into account that 99% traffic is made off-chain and 1% on-chain for state management only [21].

3.2 ARK contract execution services - ACES
ACES is a community based project solving the problem of interchain transactions and communication. ACES enables the blockchain economy by allowing micro-chain projects to connect to the liquidity and functionality of the entire blockchain ecosystem. We cannot achieve this with protocol-specific interoperability, but protocol-specific interoperability is almost certainly cheaper, faster, and possibly more trustless than a protocol-agnostic interoperability. ACES focuses on protocol-agnostic interoperability because it allows us to integrate all potential future developments in the space. Protocol-agnostic interoperability combined with protocol-specific interoperability is a powerful concept that adds massive efficiencies to the entire space [18].

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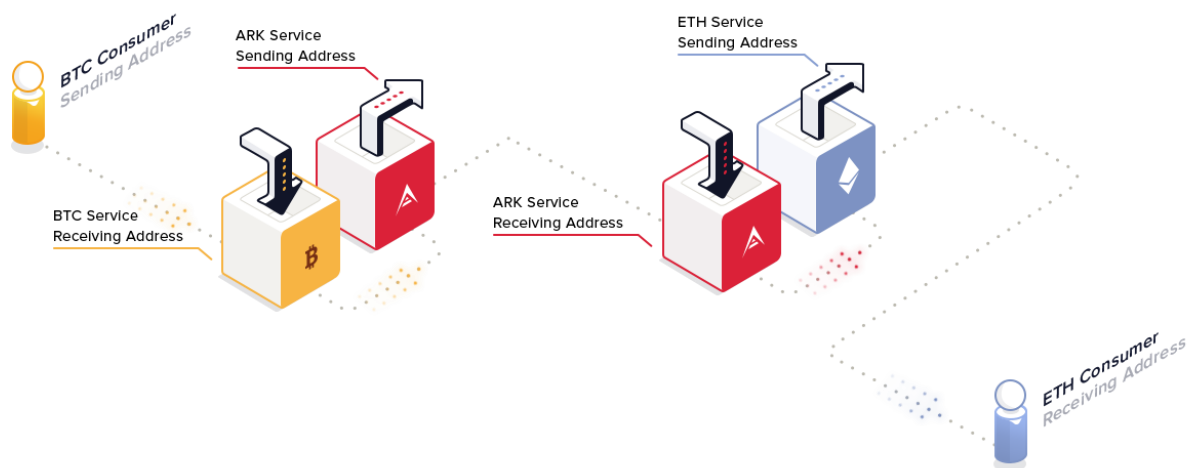ecosystem with ARK

Figure 3. ARK ACES concept

Interoperability should be cheap and empower users. That's where ACES comes in. There are many possible avenues for implementing trustless and decentralized mechanism into the ACES ecosystem in the near future. As such, our focus will remain on making tools easy to launch and develop so that even when decentralized tools are ubiquitous, users and developers can continue to customize software to their needs and contribute to the success of this ecosystem.
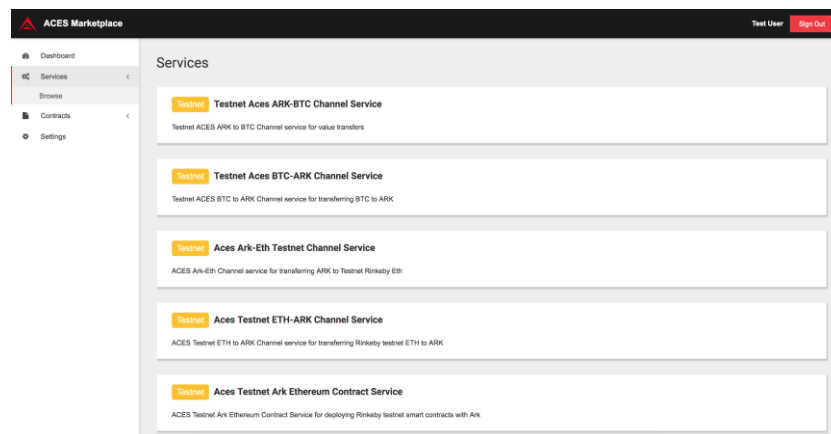

Figure 4. ARK ACES services overview

ACES emphasis is to deliver a marketplace12 directory and customized services which will enable participants in the blockchain economy to launch interoperability businesses. These businesses could be viewed similarly to the type of businesses that operate on Amazon. Some may be small and unprofitable, just experiments or hobbies. Others may be massive multi-million dollar operations squeezing out small margins on high volume[18].

Building solutions on top of OSS concepts and make a living organism is our promise and our long term vision. To deliver a sustainable ecosystem, where all stakeholders can flourish and grow - is our common path to help spread mass adoption of blockchain technology.

Next section will briefly mention the new ARK core v2 and how we used what we learned in the last year to improve, iterate and deliver a completely rewritten core - that will help all of us to deliver the vision of ARK, Satoshi and other decentralised solutions out there.

12ARK ACES Marketplace - http://marketplace.arkaces.com

4. ARK CORE V2 - THE NEXT FRONTIER

In order to prepare for the next generation of deployable DPoS blockchains, we understood very quickly that we had to thoroughly rethink the legacy code and to move to our own, completely rewritten from scratch. Throughout the current time period of version v1, and with experience gained during the development of ARK, we have been able to identify several key elements in the core design that could be optimized. Now, we embark on a new voyage to completely overhaul the ARK core code as well as the protocol as a foundation of our ambitious roadmap.

The new architecture (see Figure 5) has been completely rethought to decouple delegate forging activity, transaction pool management, and API interface on separate threads. Transactions will need to pass complete SPV (Simple Payment Verification)[22] on a separate process or server **before hitting the mempool,** completely sandboxing the activity of the node against attacks.

ARK-core v2 is completely **configurable**, meaning you can adjust the blockchain mechanics to your preferred setup. Users are able to adjust block times, number of delegates, block size, customize fees and set block rewards. This configuration is a living setup, meaning it can be adjusted when you arkchain is already running, all you need to provide is the block height parameter - from where the new configuration will be valid and in use.
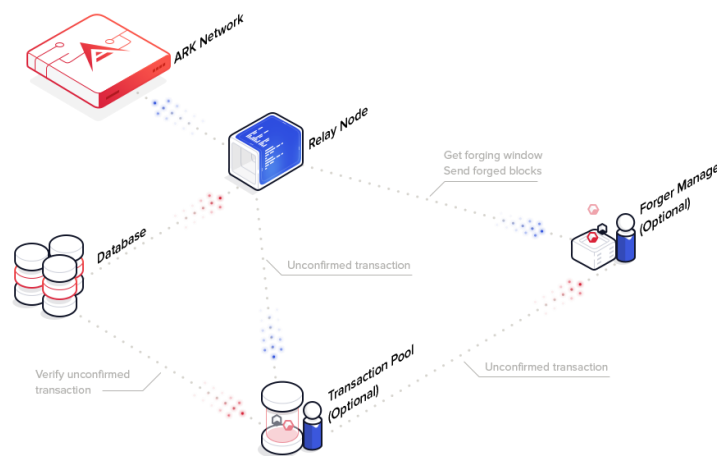

Figure 5. ARK core v2 Architecture

The database communication will be decoupled with an interface layer so it will be possible to use your own favorite technology like MySQL, SQLite, PostgreSQL, or MsSQL (so far). It will also be possible to override your own database interface and pass it to the node. Initial internal tests are already showing impressive results with lightning fast rebuilds using SQLite as backend, leveraging the multi-core capabilities on our test servers. The security will be hyper-enhanced using a completely independent transaction pool, responsible for keeping a list of unconfirmed transactions that could then be broadcasted or passed along to the forger, to forge a block. Finally, the forging process will be completely independent and self contained. It will be architected in a way to switch communications with other relay nodes if the original relay node is getting attacked or forked.

We have designed the relay nodes to be as light and stable as possible and we recommend these relay nodes if you are building a business over ARK blockchain (exchanges, smartbridge, etc…) instead of a light client, since it will allow for more powerful computations such as Complex SPV Proof of Balance, or Batch Verifications.

4.1 New plugin system

ARK Core v2 will be split into multiple packages using Lerna to manage development and publishing of those packages. The benefit of this approach is that it is easier to focus on smaller parts of the whole

system in isolation. Each part of the core can be easily replaced by custom implementations, imagine a core-logger-logstash package that replaces the default logger. All of those plugins are interconnected via the *core-plugin-manager package*, which functions as a container to hold all the instances that are shared across plugins.

The plugin manager allows us to provide different Bootstrap processes for things like starting a relay node or a forging node. The plugin manager accepts two (2) parameters, the path to a folder that contains a plugins.json file and an optional parameter that can contain options like including and excluding plugins from the Bootstrap process or plugin specific options that are not available from the configuration file.
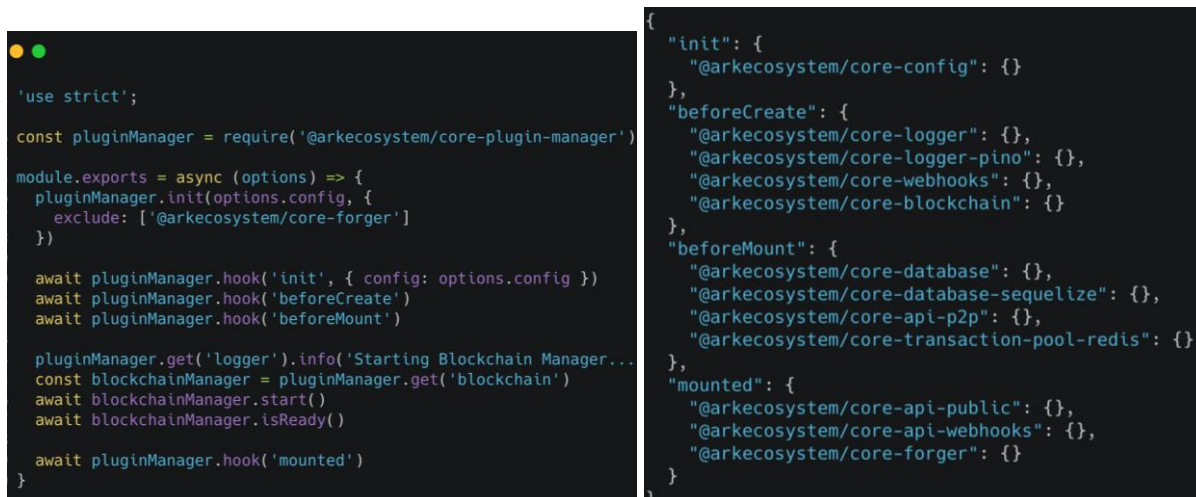
```js
'use strict';

const pluginManager = require('@arkecosystem/core-plugin-manager')

module.exports = async (options) => {
  pluginManager.init(options.config, {
    exclude: ['@arkecosystem/core-forger']
  })

  await pluginManager.hook('init', { config: options.config })
  await pluginManager.hook('beforeCreate')
  await pluginManager.hook('beforeMount')

  pluginManager.get('logger').info('Starting Blockchain Manager...
  const blockchainManager = pluginManager.get('blockchain')
  await blockchainManager.start()
  await blockchainManager.isReady()

  await pluginManager.hook('mounted')
}
```

```json
{
  "init": {
    "@arkecosystem/core-config": {}
  },
  "beforeCreate": {
    "@arkecosystem/core-logger": {},
    "@arkecosystem/core-logger-pino": {},
    "@arkecosystem/core-webhooks": {},
    "@arkecosystem/core-blockchain": {}
  },
  "beforeMount": {
    "@arkecosystem/core-database": {},
    "@arkecosystem/core-database-sequelize": {},
    "@arkecosystem/core-api-p2p": {},
    "@arkecosystem/core-transaction-pool-redis": {}
  },
  "mounted": {
    "@arkecosystem/core-api-public": {},
    "@arkecosystem/core-api-webhooks": {},
    "@arkecosystem/core-forger": {}
  }
}
```

Figure 6. Plugin registration left and plugin lifecycle hooks on the right

4.2 Listening to blockchain events with webhooks

Webhooks implementation is a realization of Ark Improvement Proposal—AIP15 [23]. Webhooks enable ARK blockchain app developers to listen to blockchain events in a simple manner (by subscribing to events and waiting for callbacks). Polling is just wasteful and inefficient for both the client and server side. On average, 98.5% of polls are wasted and increase the workload on the server, making Webhooks much more efficient.

Best practices and happy developers with efficient tools are all part of our motivation to deliver ARK Ecosystem as a platform—while providing a stable and efficient base to build blockchain apps.

With ARK's new API v2 you will also get Webhooks capability, that will call and deliver data based on event conditions.

4.3 ARK testsuite based on jest technology stack

Test suites are an important part of any serious development environment, more so with blockchain technologies where each mistake can end up being very costly. As most of software developers are already aware on how hard it is to get full test coverage over different testing phases (functional tests, integration tests...) that must take multiple stakeholders into account. Now add blockchain mechanics to that recipe and think about how to test distributed systems, their mechanics, security, block propagation, transaction management, transaction pool handling, fork management, client api... - where to start.

With this challenges in mind we had to pick the right tool, that is flexible and enough powerful. We have chosen Jest Framework[24] as our base testing framework. Jest was developed and is used by Facebook to test all of their JavaScript code including React applications. Jest is also used by Airbnb, Twitter, Pinterest, Instagram, and Oculus.

With the growth of our team we are establishing a common base (see Figure 7) for developers, delivering the best possible tools (powerful mocking, snapshot testing, built-in code coverage, zero configuration) and making cross team collaboration smooth with testing appearing uniform across different sections of code. By doing so we deliver priceless implementation examples enabling newcomers to learn and understand the existing code [25].
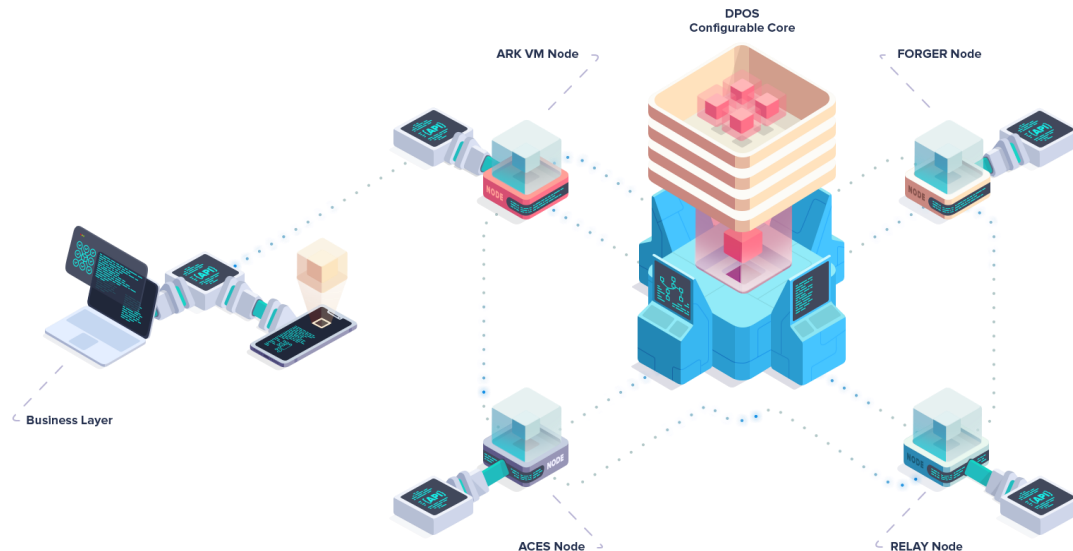

Figure 7. Parts of the ARK Technology stack

5. CLOSING THOUGHTS

A quick overview of blockchain technology and its top challenges where presented. Inter- and cross-chain interoperability is the key issue that needs to be addressed for the mass adoption of blockchain technology, thus enabling business and organization to deliver new business models, delivering true decentralized nature via trustless networks. Across the plethora of different altcoins/products targeting specific solutions, there are a few building entire ecosystems or platforms that promise to deliver the toolset to establish your own blockchain with already existing and tested ARK Technology stack (see Figure 7). ARK Ecosystem is one of them.

Understanding the power of OSS development model and adjusting it in to a collaborative effort, together with the community, will enable us to develop trustworthy applications and deliver them faster to market. We are here to solve a problem and help educate the world on the possible solutions that are available beyond banks and beyond traditional thinking. We believe a blockchain project should aim to achieve easier and much more user friendly solutions.

The end goal for any blockchain project should be that consumers don't even need to know that there is a blockchain under the hood - it should all be intuitive and easy to use, like email, but just like in email, there will be a slight learning curve that must be dealt with through education and time and we are doing our best to play an important role in the future.

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