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ARK Ecosystem Whitepaper
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Abstract: ARK empowers everyone, regardless of their aim or technical background, to quickly and easily leverage blockchain technology. Our whitepaper will identify well known problems within the blockchain industry and illustrate how ARK technology solves them. In the current hype-driven blockchain landscape, ARK acts as a beacon for individuals, groups, and enterprises seeking to apply blockchain technology to both reach their individual goals and affect change in their local community. ARK's uniquely simple technology stack allows almost anyone to create and deploy standalone blockchains for any use case. These newly created blockchains will have the ability to interoperate through ARK SmartBridge Technology. ARK is also reinventing smart contracts with ARK Logic, a collection of tools including custom transaction types, templates, and plugins. ARK Logic brings security, adaptability, and scalability to decentralized computing workflows. Most importantly, the ARK Ecosystem fosters a growing international community of developers, node operators, blockchains, businesses, and enthusiasts who collectively breathe life into this disruptive technology.

The whitepaper is fluid and ARK is open to community feedback.
*For a deeper technical dive into ARK technology, visit **docs.ark.io**.*

Listen to an audio version of this paper on The ARK Crypto Podcast
*episodes 33, 34, and 35 at **podcast.ark.io**.*

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▲ 1 Introduction

1.1 State of the Industry

In 2008, Satoshi Nakamoto published a ground-breaking paper that presented the first decentralized solution to solve the problem of double spending in digital networks [1]. The ensuing years witnessed a proliferation of projects driven by innovators who understood the vast, transformative potential of blockchain technologies. The exuberance that drove the initial growth of the decentralized technology landscape has yielded to pragmatism and questions about adoption and use-cases. Blockchain projects are now moving from experimentation around decentralized technologies to complete solutions including consensus mechanisms, identity, data structures, crypto-economic designs and smart contracts. But to deliver truly world-changing results, blockchain technologies must be easily accessible to developers, users, governments, and businesses alike [2].

1.2 Eliminating the Barriers to Entry

A core mission of the ARK project is to eliminate the barriers to entry into the blockchain space posed by complex technology. By providing a user-friendly communication layer to the open network of Web 3.0, ARK meets the needs of enterprises, start-ups, and developers requiring sophisticated, decentralized, application-centric blockchains. Blockchains built with ARK Core code, what we call bridgechains, can interlink or work independently. Highly adaptable according to specific needs, bridgechains enable users to exchange data, expand business models, and develop novel use cases.

1.3 ARK as the Perfect Starting Point

The ARK Ecosystem allows blockchain developers to customize a sovereign blockchain complete with required feature sets. ARK's value proposition lies in the array of services offered through the ARK Blockchain Platform. These services include interconnection with different blockchains, seamless integration of custom business logic, flexible development of tailored transaction types, and access to a global, community support system - all rooted in an intuitive development experience.

▲ 2 Blockchain Trilemma

2.1 Blockchains Have Problems

Extant blockchain platforms face a range of well-known and seemingly intractable set of challenges [3]. These include what is commonly known as the Blockchain Trilemma, referring to the balance that blockchains strive to attain between:

> *Scalability* (handling large volumes of transactions at high speed)
> *Security* (guaranteeing the validity of transactions and protecting data)
> *Decentralization* (distributing transaction validation among nodes to eliminate a central point of control and to ensure accuracy and fairness).

The three properties are linked in that an increase in one generally entails a tradeoff with the others. As an illustrative example, the Bitcoin network is optimized for security and decentralization at the expense of scalability. This fact was made amply clear in late 2017, when backlogged transactions on the network resulted in exorbitant transaction fees [55]. One approach that Bitcoin is taking to resolve the issue is layer-two solutions like the Lightning Network [4]. Development of the ARK Technology stack began with consideration of the trilemma and further reflection upon two crucially related challenges, namely:

> *Interoperability* (enabling independent chains to exchange value and information)
> *Sustainability* (creating self-sufficient and self-governing environments).

2.2 ARK's Approach to the Blockchain Trilemma

ARK uniquely addresses each aspect of the trilemma.

ARK achieves scalability through a multi-chain approach and ARK SmartBridge Technology. Highly complex business processes can be run on a bridgechain with only the results being transferred to the main chain, thus increasing efficiency through interoperability.

Security is ensured through a modified version of the Delegated Proof-of-Stake consensus mechanism, wherein token holders determine which nodes are deemed worthy to secure each network, as explained in Section 4.

Decentralization is determined by the needs of the system architects of each bridgechain. ARK's flexible technology can expand to include thousands of nodes, or contract to a few high-powered nodes capable of breakneck performance. Developers using ARK technology hold the power to optimize each network as needed.

◣ 3 ARK Core Values

3.1 Simplicity

ARK believes first and foremost that to be truly useful, blockchain technology must be made simple for both users and developers. ARK tools, projects, and products are designed for widespread use, to allow even novice developers to quickly and efficiently build sophisticated blockchain solutions. Just as Android OS brings mobile development to the masses in an open source environment, so does ARK, with its software development kits, lean and stable Core, versatile plugins, and intuitive user interfaces. Simplicity is the cornerstone of ARK's core values.

3.2 Security

Today's global infrastructure brings with it risks and vulnerabilities. Insecure data silos, untrustworthy middle men, and honeypots represent just a few of the weak points that threaten efficient transactions and flows of data. Blockchains mitigate these risks and ensure security through a unique blend of cryptography, decentralized peer-to-peer networks, and reward incentives. In the landscape of decentralized technology platforms, ARK offers a key advantage over Proof-of-Work networks like Bitcoin by ensuring the security of even small networks (networks with few nodes). This is achieved through ARK's unique Delegated Proof-of-Stake consensus algorithm.

3.3 Speed

On the Public Network, ARK offers fast eight-second block times. This speed can be adjusted as needed on each bridgechain, according to design and application requirements. ARK's customizable solutions allow developers to independently optimize levels of speed, security, and decentralization. Moreover, products like the ARK Deployer enable developers from all walks of life to deploy standalone blockchains much faster than some other solutions currently in the field. This, coupled with well over a dozen SDKs, allows developers to stand up prototypes, MPVs, and production-level solutions quickly.

3.4 Scalability

The ARK consensus mechanism offers further built-in scaling advantages. Delegated Proof-of-Stake means that nodes conserve resources and scale up as needed to handle throughput demand. Moreover, the network does not rely on every single endpoint to meet performance requirements, since end users do not run full nodes. Rather, they run lite clients and leverage their stake in the network to assign responsibility to nodes judged worthy to secure and run the network. This maintains power in users' hands while simultaneously creating a highly scalable environment. ARK technology also achieves higher performance through custom parameters, configurations, and network layouts. ARK removes bottlenecks caused by the conventional 'one chain, many solutions approach' by enabling users to customize their blockchains within a broad ecosystem of linked chains.

3.5 Sovereignty

ARK believes that any organization, community, or other entity within the ARK Ecosystem should retain the right to create a network of utility and governance without obligation to rely on external rules or limitations. This goes against the current trend, wherein one main blockchain network offers leased solutions that require interaction with that main network. This leased approach does not work over the long-term. As technologies and projects on distributed networks evolve over time, the central, governing platform once seen as support is regarded as restrictive and inflexible, in a situation that recalls colonizing countries that assert dominion from afar. Eventually, colonies seek sovereignty to forge their own future, and this rings true in distributed networks as well. The scaling limitations and imposed governance of 'one size fits all' blockchains will turn sour for disparate communities and organizations aiming to evolve autonomously. Blockchains launched on the ARK platform are self-governing and free to engage with each other and the ARK Public Network as desired.

3.6 Support

Blockchain technology that is easy to use and deploy still brings with it the need for support and help. By contributing to the ARK Public Network code base and working hand-in-hand with the ARK team, community developers have a place to both hone their skills and assist other entities who may need help deploying ARK technology. ARK Public Network delegates have become experts in ARK network maintenance and security. Incubators and consultancy firms can also offer solutions and guidance to new projects. Choosing ARK as a blockchain solution means access to a large talent pool of support.

▲ 4 ARK Public Network

4.1 The ARK Mainnet

The ARK Public Network, also known as the "ARK mainnet" came online on March 21st, 2017 [5]. At that time, 125 million ARK were created in a genesis block. The genesis delegates that initialized the network were quickly replaced by live delegates who, having been voted in by the community, began securing the network. Shortly thereafter, block rewards were initialized in the protocol to reward forging delegates each time new transactions entered the ledger. The ARK mainnet operates independently of the ARK business entity, which simply releases code that the ARK mainnet delegates choose to either accept or reject. On the 28th of November 2018, the ARK mainnet upgraded from the now deprecated V1 codebase to the newly developed V2 codebase. This introduced a multitude of improvements to the network for developers and end users [6]. ARK numbers among a very short list of teams that have developed an entire blockchain from the ground up to address real-life business needs and expectations, rather than simply forking and modifying code from another project.

4.2 Consensus Mechanism

A 2018 technical paper titled "The Latest Gossip on Byzantine Fault Tolerant Consensus" suggested that:

> *"Consensus is one of the fundamental problems and driving forces of distributed computing. It is important because of its role in State Machine Replication (SMR), a generic approach for replicating data that can be modeled as a deterministic state machine. The key idea of this approach is that node replicas start in the same initial state, and then execute requests (also called transactions) in the same order; thereby guaranteeing that node replicas stay in sync with each other. The role of consensus in the SMR approach is ensuring that all replicas receive and execute transactions in the same order. [7]"*

Delegated Proof of Stake or DPOS is the consensus algorithm that validates transactions on the ARK Public Network. Ensuring high performance with block times of eight seconds and maintaining global decentralization, it is the backbone of the ARK Ecosystem. Holders of ARK vote through their wallets for delegates who secure the network, insert blocks into the ledger, and create new ARK. The top

51 vote earners are named elected forging delegates. The members of this group change over time, as a much larger pool of node operators competes to draw votes by offering increased efficiencies and services to voters. Each ARK held represents one vote, and ARK users may change their vote at any time. ARK's unique configuration solves problems of centralization that occur when there are too few validator nodes on the network, or when delegate groups assert dominance over the network via multivoting.

4.3 ARK Inflation Mechanics

Every eight seconds, two new ARK are created and awarded to the delegate that forged that block. Each block is forged by one of the top 51 delegates in a round that lasts 408 seconds. Delegates are selected randomly for each round to protect the network from targeted attacks. If a delegate is prepared when it is their turn, a new block is forged and two ARK awarded. If a delegate is not ready to forge on their turn, it results in a missed block and two new ARK cannot be created. Uptime is therefore incentivized. Barring missed blocks, the network has the capability to generate 7,884,000 ARK per year. This steady generation of a fixed amount of ARK means that the annual inflation rate steadily declines towards zero with each passing year. This is predictable and programmatically controlled, unlike fiat inflation [56].

4.4 Balancing Decentralization and Performance

Too few nodes on a decentralized network creates bottlenecks and centralization. Conversely, too many nodes can impact network performance. Bitcoin's slow block times, for example, allow for a very large number of nodes to reach consensus without much struggle. By fixing the number of forging nodes at 51, the ARK mainnet strikes a balance between decentralization and performance. These forgers work in concert with what are known as relay nodes, which also maintain copies of the ledger and act as the contact points for lite clients.

Aside from node distribution, responsibility for decentralization is also assigned to ARK holders in the form of voting power. Each ARK wallet can execute a special transaction that assigns the weight of the ARK in that wallet to a delegate. This process does not transfer ownership of the ARK in the wallet to the delegate - it simply acts as a quantifiable show of support from the ARK holder that the delegate deserves to be in a top 51 position. The votes are tallied on the network and are used to rank delegates to determine who should be allowed to forge new ARK and secure the network.

If a delegate begins to act erratically or dishonestly, voters can transfer their votes (voting weight) to a different delegate or even to a node that aspires to a top 51 ranking. This creates a dynamic environment where the nodes who have the power to secure the network are in constant flux, as community opinion shifts and new delegates enter the space.

4.5 Preventing Collusion

Some DPoS architectures allow for multivoting [57]. This means that a wallet with 1000 coins can assign its '1000 vote weight' to multiple delegates at once. This leaves open the possibility that a group might collude by using social engineering to disincentivize holders from voting for anyone other than a select group of delegates. In such a situation, one delegate group could potentially secure power and permanence on the network. ARK blocks such collusion at the protocol level. Any ARK holder wishing to vote for multiple delegates would need to divide their ARK among multiple addresses, each voting for a different delegate. This would in turn reduce the voting weight per delegate, and obscure the ownership of wallets.

4.6 Delegate Services

A delegate's role first and foremost is to secure the network. To gain community support however, delegates must also differentiate themselves. In addition to running nodes and securing the network, ARK mainnet delegates often pledge to offer various services including development and testing, public resources and tools utilizing the ARK mainnet, faucets, bounty programs, outreach, art, games, media creation, events, research, and more. In this dynamic landscape, ARK holders and delegates collaborate to determine the future direction of the network and to create a sustainable ecosystem. The important and measurable benefits of this collaboration transfer to any community using ARK technology for their blockchain.

◤ 5 ARK Network Uses

5.1 Role of the ARK Public Network

The ARK mainnet operates differently from other networks built on separate layers in the blockchain space. On some other public networks, a base communication layer with an incentivization protocol acts as a foundation for some type of decentralized application layer, be it storage, CPU-as-a-Service, tokenization, smart contracts, or similar. While ARK technology is highly extensible through plugins, modules, and transaction types, the ARK mainnet remains unbloated, lean, and fast. Using ARK products such as the ARK Deployer, other ARK based blockchains will appear in the ARK Ecosystem to handle specialized tasks as necessary. These newly created chains will then connect back to the ARK mainnet using ARK SmartBridge Technology. The ARK mainnet is intended to take on limited specialized functions only as needed and to facilitate the ARK mainnet as the hub of the ARK Ecosystem.

5.2 A Peer-to-Peer Cryptocurrency

At its core, the ARK Public Network hosts a global cryptocurrency called ARK that can be used for storing and transferring value, similar to Bitcoin, but faster and cheaper. Moreover, ARK can act as a unifying medium of exchange as needed within the ARK Ecosystem, due to its reach and liquidity. With the advent of the ARK Pay module as well as ever-evolving, intuitive lite clients, ARK is well positioned to be an effective network for both store-of-value and value transfer.

5.3 Medium of Exchange for ARK Mainnet Services

Delegates that reach forging status on the ARK mainnet may deploy services that either award or accept ARK. For example, a delegate running bounty campaigns can easily pay bounty recipients in ARK in exchange for providing value to the ARK Ecosystem through development, design, or outreach. Moreover, delegates that deploy or integrate their own platforms on the ARK mainnet can accept ARK for their services.

As an illustrative example, a large e-tailer could deploy a node and gather votes to enter forging status. They would then accept ARK on their e-tailer website for their wares, and offer big discounts to ARK holders and perks to their voters. When goods or services are exchanged, the costs of discounts could be offset using their delegate wallet, which generates new ARK by virtue of forging. This would

theoretically result in a type of 'discount faucet,' increasing their sales by simply running a forging delegate node and accepting ARK, all without actually reducing margins. In this example, the ARK community benefits overall from the increased adoption and enjoys lower prices.

5.4 Convenience in Interoperability

Many ARK based blockchains will have use cases that benefit ARK mainnet users. These use cases can appear in the ARK wallets in the form of a plugin. When ARK users wish to interact with a specific use case, they can do so without leaving the ARK wallet. As the number of available use cases within the ARK wallet grows, so too does the convenience and utility of ARK. Newly created blockchains can also choose to list on fiat or crypto exchanges to give users access to tokens. ARK's approach simplifies the steps required to establish a blockchain and to deploy decentralized applications, all while both mitigating risk for the end user and preserving the sovereignty of bridgechains.

This mechanism can extend beyond bridgechain coins to bridgechain non-fungible tokens, for example, in situations where NFTs become available for acquisition via SmartBridge. Imagine a video game launching a blockchain with a fixed number of specific weapons, items, and powerups on genesis. The assets could then be freely exchanged both within the bridgechain microcosm in question or via SmartBridge using ARK. Such an arrangement of parallel chains significantly if not entirely reduces bloat on the ARK mainnet.

5.5 Liquidity for Small and Large ARK Bridgechains

New blockchain projects frequently struggle to offer basic services for liquidity. Listing on reputable exchanges incurs listing fees, other red tape, and can take significant time. The communities around such young projects face the inconvenience and risk of dealing with small fly-by-night exchanges, which are also subject to hacks and theft. Decentralized exchanges represent one possible solution, but they too suffer from liquidity issues. The end result is that centralized exchanges wield a great deal of power over growing projects and their communities. ARK SmartBridge Technology can step in as a reliable first stage for decentralized exchange of assets and price discovery. The intertwining of ARK bridgechains with the greater ARK Ecosystem and ARK mainnet creates possibilities that benefit everyone.

5.6 Payment Method for Plugin Marketplace

The modular structure of ARK technology lends itself to the creation of a marketplace of both Core plugins and client plugins. While most ARK technology is open source and comes with boilerplate MIT-style licenses, this may not be true for all plugins. Both the ARK business entity and third parties have the ability to develop premium plugins capable of generating streams of income in the form of licensing. License management and fees can be handled on-chain using the ARK mainnet and bridgechain registration, or via other specialized transaction types. Like the Android and iOS application marketplaces, ARK can sustain a premium plugin and licensing marketplace where developers can generate revenue streams. The medium of exchange for such a marketplace will be ARK. Plugin developers will be incentivized to accept ARK, as it will further the adoption of the very technology they utilize.

5.7 Payment Method for Delegate and Talent Marketplace

As the ARK Ecosystem evolves, there will be a growing need for talent and human services. For example, public networks launching new ARK based blockchains as well as commercial interests launching tokenless blockchains using the intuitive ARK Deployer may need assistance in handing off genesis delegates, and/or customizing their chain beyond what the ARK Deployer can offer. In an alternative scenario, private enterprise chains may wish to distribute node ownership across both their internal organization and external operators in the interest of accountability. In this instance, delegates and delegate teams well versed in ARK technology can accept ARK coins from these enterprises in exchange for running tokenless nodes and offering consulting services. It is even within reason that private enterprises may wish to outsource all node operations to delegates in the public marketplace and simply distribute ARK to the delegates for the services of running tokenless enterprise chains.

▲ 6 Open Source Software

6.1 ARK Technology is Open Source

Open Source Software (OSS) is a type of computer software whose source code is released under a license in which the copyright holder grants users the right to study, change, and distribute the software to anyone and for any purpose. Anyone is allowed to modify the code, port it to new operating systems and instruction set architectures, share it with others, or in some cases, even market it. Free and open source software development models have made it possible for previously unacquainted people to collaborate and follow a common goal [2].

6.2 OSS is Becoming the World Standard

According to a study by InfoSys, more than 78 percent of enterprises run on open source while fewer than three percent indicate they don't rely on open source software in any way. These statistics indicate the ongoing shift in the OSS arena, as IT and Blue Chip companies adopt a positive mindset recognizing the strategic value gains of adopting open source software. OSS can be seen as a first approach for enterprise architecture [2].

6.3 OSS Brings Benefits

Having adopted OSS from the start, ARK boasts one of the strongest open source communities in the crypto space. Developers and business entities developing solutions on ARK can easily find support across a global network of ARK users. The benefits of the OSS model include reduced costs, improved quality, and faster time to market. Exposed to public scrutiny, OSS code tends to be much more secure than code on private repositories [2].

6.4 Building an Ecosystem

ARK prides itself in identifying as an *ecosystem*, in other words, a community of living organisms and nonliving components. Our thriving, strong, and growing community breathes life into ARK projects, tools, products, and peripherals. ARK's work process is built around distributed best practices, which are promoted and used by GitHub and other big, open source endeavors. ARK open source code is free for use under the MIT OSS license [2].

▲ 7 ARK Core

7.1 About ARK Core

In late 2018, ARK released an entirely new codebase operational on the ARK Public Network [2]. This codebase was developed entirely from the ground up to set the standard for the next generation of deployable DPoS blockchains.

The new architecture 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) on a separate process or server before hitting the mempool, thereby completely sandboxing the activity of the node against attacks [2].

ARK Core is a lightweight but very powerful codebase that functions as the base component of the entire ARK Ecosystem. Authored in TypeScript, the ARK Core's extensive modular architecture empowers developers to modify, configure or extend all aspects of the code base with ease. Now that all inherited legacy code is purged, the ARK business entity sees no future need for another bottom-up redesign, since ARK's modular architecture will handle all further evolution of the ARK Core.

7.2 Dynamic Fees

The ARK Core uses a custom implementation of dynamic fees within a DPoS network model at the protocol level. This is uncommon in DPoS networks by any stretch, and is heralded as a large step forward for DPoS. Dynamic fees benefit both end users and delegates that secure the network. The end user will benefit from the network accepting lower fees, as delegates compete with each other. Delegates gain the capacity to both customize fees per transaction type and offer tiered transaction fees where higher fee transactions post faster [8]. Dynamic fees will also assist the delegates by providing defense from potential attack vectors such as spam attacks.

7.3 Transaction Types

The ARK Core accommodates various transaction types and has the ability to service new custom transaction types via ARK Logic. Below are some of the transaction types that are currently utilized within Core or planned for the future.

Transfer. The transfer transaction enables a user to broadcast a transaction to the network sending ARK tokens from one ARK wallet to another. This transaction type provides the utility of store-of-value and value transfer. It also contains a special data field of 255 bytes called the *vendor field*, allowing raw data, code or plain text to be stored on the blockchain. The vendor field is public and immutable, and is also utilized in ARK SmartBridge Technology [59].

Second Signature Registration. This transaction type enables a user to add an extra layer of security to their address by creating a second passphrase, using mnemonic code for generating deterministic keys via BIP-39 to produce an additional 12 words [41]. Once a second signature has been registered to a wallet, the owner of the wallet will then be required to input their primary and secondary passphrase when sending a transaction to the network [59].

Delegate Registration. A user or organization can register their address to become a delegate and secure the network. Upon accumulating sufficient vote weight, the delegate will begin forging transactions and receiving block rewards. The delegate assigns a custom name to their address to differentiate it from other delegates [59].

Vote & Unvote. A key feature of the ARK DPoS model is that each address can vote for one delegate of their choosing to secure the network. A vote and unvote transaction type is therefore necessary to enable this functionality. Once an address votes for a delegate, funds can enter and leave the address as needed, and vote weight adjusts automatically. Voting does not send funds to the delegate's ARK address in question - it only assigns vote weight [59].

Timelock. A transaction of this type acts as a simple logic function that restricts the spending of an amount of ARK at a specified address until a predefined future time or block height is met. This is useful for hash-based contracts and payment channels [59].

Multipayments. This type is designed to reduce the payload on the blockchain by enabling multiple payments to be combined and broadcast to the network as a single transaction. This benefits the end user and delegates by lowering transaction fees per payment and reducing congestion. Initially and depending on testing, the ARK Core will allow 400-500 payments to be combined within a single transaction. Eventually, the number of payments per transaction will be able to scale as needed [59].

Delegate Resignation. This transaction type will enable delegates to block potential voters from voting for them if they choose to withdraw their status as delegates. A non-reversible transaction can be sent to the network to indicate that the delegate should no longer be included in any future forging rounds [59].

IPFS. This transaction type utilizes a special data field similar to the vendor field to store Interplanetary File System data on the blockchain. This provides an easy way to timestamp and optionally encrypt and verify files. This implementation of the IPFS transaction type won't allow storing data on the blockchain - for that, special IPFS nodes are needed [59].

Business Registration. This transaction type enables users and businesses to register on the ARK mainchain. For more information, see section 11.5.

Bridgechain Registration. This transaction type, which requires business registration, grants users and businesses access to the ARK Deployer suite for bridgechain launching. For more information, see section 11.5.

More transaction types can be implemented into Core based on community need, and the ARK Public Network can select which transaction types to support to keep the main network lean. Consult *roadmap.ark.io* for status updates on various transaction types.

7.4 Multisignature Protocol

The ARK Core will implement a multisignature protocol, or *multisig*, redesigned from the legacy version. ARK's multisignature implementation will require multiple

keys to authorize an ARK transaction to be broadcast to the network. This implementation will enable users, developers, and businesses to divide responsibility of possession of ARK tokens. A practical implementation of multisig can be found in large Bitcoin exchanges, where a trusted group of individuals controls keys to one single wallet/address. Consider the example of an exchange controlling a cold wallet containing ARK. This exchange could implement a '3-of-6' multisig which would give six separate passphrases for one address. This address will only be allowed to send transactions if three out of six keys sign, thus distributing responsibility of holdings while increasing security and minimizing risk. The pending ARK multisignature implementation is quite similar to Bitcoin multisigs using Schnorr multisignatures [43].

7.5 ARK Core CLI

As of v2.2.0, Core has become a Node Version Manager (NPM) module that can be installed and interacted with globally. A built-in Command Line Interface (CLI) is now also available. NPM is the world's largest software registry, and installation of Core is now effortless for anyone regardless of technical background. The CLI, which now integrates ARK Snapshot Manager, is an essential tool that enables any node operator to update, manage, or monitor their node installation without the need for external programs. All ARK-based bridgechains will also be able to take advantage of the ARK CLI toolset.

7.6 Core Plugins & Modular Architecture

ARK Core is split into multiple standalone packages using Lerna to manage their development and publishing. Each part of the Core can be replaced by custom implementations. For example, a custom *core-logger-logstash* package could replace the default logger without affecting the stability of other components. All plugins are interconnected via the Core Plugin Manager package, which functions as a container to hold all of the instances that are shared across plugins [2].

The plugin manager enables the provision of different Bootstrap functions for processes like starting a relay node or a forging node. The plugin manager accepts two parameters, the path to a folder that contains a plugins.json file, and an optional parameter containing options like including and excluding plugins from the Bootstrap process or plugin-specific options not included in the standard configuration file [2].

Future plugins released by the ARK business entity as well as third party plugins will integrate into Core, adding new benefits. When deploying a custom blockchain,

additional use case plugins can be developed and integrated without affecting the stability of the existing code.

7.7 ARK Webhooks

The webhook API has been integrated into ARK Core to enable developers to listen to specific events from the ARK blockchain. Webhooks provide other applications with real-time information without polling and adding stress to the network. On average, 98.5% of polls are wasted and increase the workload on the server, making webhooks much more efficient. Based on user specifications, webhook notifications will be sent out with every block update, including transactions sent, transactions received, and other timing events built on the ARK blockchain [9].

7.8 ARK Core Docker

ARK Core is now available for Docker, the industry standard for packaging applications into a container. The Docker image includes all dependencies such as the language runtimes and libraries within the container, making an all-in-one node installation quicker and easier [10].

7.9 ARK Snapshot Manager

An all-new local snapshot system has been developed, allowing node operators to use their copies of the database when needed. When starting a new node or rebuilding a node due to errors, local copies allow for fast and safe synchronization. The ARK Snapshot Manager, now integrated into ARK Core (as of version 2.2.0), provides simple commands such as *dump, restore, rollback, truncate,* and *verify*.

7.10 ARK Utilities

ARK Utilities is a separate library providing common functions for working with data and performing frequent tasks while simultaneously increasing performance across the ARK Core. Elements of the ARK Utilities library replace many of the third party dependencies on Core, and the dependency layer as a whole enables the provision a common API. This allows developers to swap out or affect changes to the implementations as they identify performance issues and other shortcomings, all without affecting the API. Extensive real-world testing has proven ARK Utilities to offer improvements as high as 12x over other libraries such as Native and Lodash [11].

⬣ 8 ARK Peripherals

8.1 Expanding on Core

Driven by a lean, extensible, and powerful Core, ARK can expand its value proposition through useful peripherals including Software Development Kits (SDKs), external products, open source projects, branded plugins, and more. The entire range of peripherals is available on any deployed ARK blockchain, offering users and developers all they need right out of the box.

8.2 ARK Software Development Kits

With ARK SDKs, developers can employ the programming language of their choice to build applications utilizing the ARK blockchain. Each implementation is split into two sub kits: *Client* and *Cryptography*. Client sub kits help developers fetch information from the ARK blockchain about its current state, such as which delegates are currently forging, what transactions are associated with a given wallet, and so on. Cryptography sub kits assist developers in working with transactions, such as signing, serializing, deserializing, and the like.

The following SDKs are currently available:

> *C++*. C++ is widely used in embedded systems software engineering. C++ can be run on microcontrollers such as Arduino and Raspberry Pi, and its addition pushes ARK further into the world of IoT [12].

> *.NET*. The .NET motto is *Any developer, any app, any platform!* As such, this framework is very popular in corporate settings. It is the perfect tool for startups and hobbyists who are just starting out with ARK [13].

> *Elixir*. Elixir takes advantage of the Erlang VM, which is known for running low-latency distributed and fault-tolerant systems while also being successfully used in web development and embedded software domain [14].

> *Go*. GoLang is an open source programming language developed by Google and designed for building fast, simple, and reliable

software. GoLang is often compared to Python for its user-friendliness [15].

Java. Java is a general-purpose computer-programming language that is concurrent, class-based, object-oriented, and specifically designed to have as few implementation dependencies as possible. With ARK's Java SDK design, it is easily to re-use Java Crypto and Client packages to integrate into popular frameworks such as Kotlin, Groovy and Scala [16].

JavaScript. JavaScript is an object-oriented computer programming language commonly used to create interactive effects within web browsers. ARK Core is written in TypeScript, a more stringent iteration of JavaScript [17].

PHP. PHP is an extremely popular open source scripting language that is well suited for web development as it can be embedded into HTML. PHP is used as a server-side programming language for over 80% of working websites [18].

Laravel. Laravel is an important member of a new generation of frameworks [19]. It is a free, open source, PHP web framework with expressive, elegant syntax intended for the development of web applications [20]. Laravel is extremely popular with developers ranging from hobbyists to enterprise level. Laravel is very highly ranked according to Github [44].

Symfony. Symfony is a set of reusable PHP components and a PHP framework for web projects. It allows for rapid production and maintenance of PHP web applications and ends repetitive coding tasks. This also benefits developers as they can also add their own modules. Symfony is popular in the enterprise space [21].

Python. Python is a great starting language widely taught in universities and used for working with beginner and IoT-friendly devices such as the Raspberry Pi. Python is easy to learn, readable, powerful, and fast. The wide availability of Python IDEs along with Python's exceptionally large library make it an especially accessible and popular language [22].

Ruby. Ruby is a dynamic, reflective, object-oriented, general-purpose programming language. It supports multiple programming paradigms including functional, object-oriented, and imperative. It also has a dynamic type system and automatic memory management [23].

Rust. Many large and small companies use Rust for a variety of tasks such as command line tools, web services, DevOps tooling, embedded devices, audio and video analysis and transcoding, cryptocurrencies, bioinformatics, search engines, Internet-of-Things applications, machine learning, and even major parts of the Firefox web browser [24].

Swift. Swift is a powerful and intuitive programming language for macOS, iOS, watchOS and tvOS. Writing Swift code is interactive, the syntax is concise yet expressive, and Swift includes a host of features that make it particularly developer-friendly. Swift code is safe by design, and produces software that runs lightning fast [25].

Wolfram. The Wolfram Language leverages built-in computational intelligence that relies on a vast depth of algorithms and real-world knowledge carefully integrated over three decades. Wolfram is heralded as the first true computational communication language for humans and AIs. Wolfram is adding full read and transactional write support for ARK [26].

RPC. The JSON-RPC compliant SDK was created to aid organizations with the integration of ARK in their existing RPC based infrastructure when extenuating circumstances make using the ARK Public API less than ideal [45]. All operations provided by the JSON-RPC can be performed using the ARK Public API [27].

8.3 ARK Test Suite

Most software developers are aware of how difficult it is to get full test coverage over different testing phases that must take multiple stakeholders into account [58]. 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 - things get dicey.

With these challenges in mind, it was paramount to select a powerful and flexible testing framework. Upon assessing the market for options, it was decided that the Jest Framework best suited ARK's needs. 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 [2]. We are establishing a common base for ARK developers, delivering the best possible tools, like powerful mocking, snapshot testing, built-in code coverage, and zero configuration. ARK Test Suite also facilitates cross-team collaboration with testing appearing uniform across different sections of code. By doing so, we deliver valuable implementation examples that enable newcomers to learn and understand the existing code, as uniformity ensures platform integrity.

8.4 ARK Explorer

The ARK Explorer is a fundamental tool, designed and developed from the ground up using the leading developmental frameworks Tailwind CSS and Vue.JS [38]. Sporting an aesthetically pleasing design, the ARK Explorer boasts features such as light and dark mode, multi language support, and token price tracking.

The ARK Explorer provides the user with critical data such as viewing the latest transactions and blocks, searching for wallet addresses and transactions, viewing wallet address rankings, and monitoring delegates for visibility on network state.

8.5 ARK Desktop Wallet

The ARK Desktop Wallet is a multi-functional application written from scratch using VueJS and TailwindCSS and implementing the latest Electron framework [30]. The structure of public and private key generation follows the same specifications as Bitcoin, with the exception of using BIP-39 passphrases for end user ease of use. A custom implementation of BIP-32 for Hierarchical Deterministic Wallets is provided to ARK users. The ARK Desktop Wallet supports multiple transaction types and enables end users to determine transaction costs via the introduction of dynamic fees. Customization was an important factor

during wallet development to ensure that developers, businesses, and end users could personalize the the application for their own requirements. Accordingly, the Desktop Wallet is now modular with the advent of wallet plugins. Bridgechains can implement use cases directly into the ARK Desktop Wallet, and third party developers can enhance its features. With support for multiple ARK networks enabled, the ARK Desktop Wallet is a key tool for all users in the ARK Ecosystem.

The ARK Desktop Wallet is a lite client, working in tandem with ARK DPoS to deliver a seamless experience. Users can launch the wallet and interact with the blockchain immediately, with no need to sync. Bridgechain registration in Core 2.6 will automate the addition of all bridgechains to the application for virtually effortless discovery and management. All ARK and ARK bridgechain wallets are additionally compatible with the Ledger Nano hardware device, offering passphrase management in a secure sandbox. The wallet is integrated with Changelly on the ARK Public Network, enabling users to acquire ARK using other cryptocurrencies and fiat from directly within the wallet.

The ARK Desktop Wallet is available on the Windows, Mac and Linux operating systems.

8.6 ARK Mobile Wallet
The ARK Mobile Wallet is a hybrid application that uses the same code base for Android and iOS to help coordinate development across platforms. In the future, however, native apps will be developed to achieve better performance. The ARK Mobile Wallet currently uses the Ionic framework and ARK's TypeScript API to interact with the network via mobile device [31]. The wallet supports multiple transaction types and the dynamic fee implementation of the desktop wallet.

The ARK Mobile Wallet is available on the Android and iOS operating systems.

8.7 ARK Pay
ARK Pay is a simple open source library that brings ARK to online retailers. ARK Pay is an officially supported plugin that provides developers with a plug-and-play module to allow easy implementation of ARK as a payment method on websites and within web-enabled applications. ARK Pay also utilizes a customized URI scheme, enabling the auto-fill of wallet parameters via clickable link or QR code [32].

The next iteration of ARK Pay will also enhance the transaction management experience. The custom developed backend will have verification and order processing on the server side instead of polling the blockchain via public API. By simply inputting their network parameters, ARK bridgechain developers will also be able to quickly install the ARK Pay plugin.

8.8 ARK Deployer CLI

ARK Deployer CLI is a lightweight deployment script for creating ARK- based blockchains. Designed to be user-friendly, ARK Deployer CLI enables the following:

> Deployment of ARK node in auto-forging mode on a single computer or server, with a chosen number of forging *genesis delegates*. Genesis delegates act as initial placeholders until node operators in the field replace them. Custom parameters can be configured such as block times, transaction fees, block rewards, transactions per second, and so on. Bridgechains can under certain conditions theoretically attain thousands of transactions per second.
>
> Deployment of ARK Explorer pre-configured to immediately sync with the installed ARK node.
>
> Configuration of the ARK API to enable developers to start exploring, hacking, and developing solutions based on ARK technology [33].
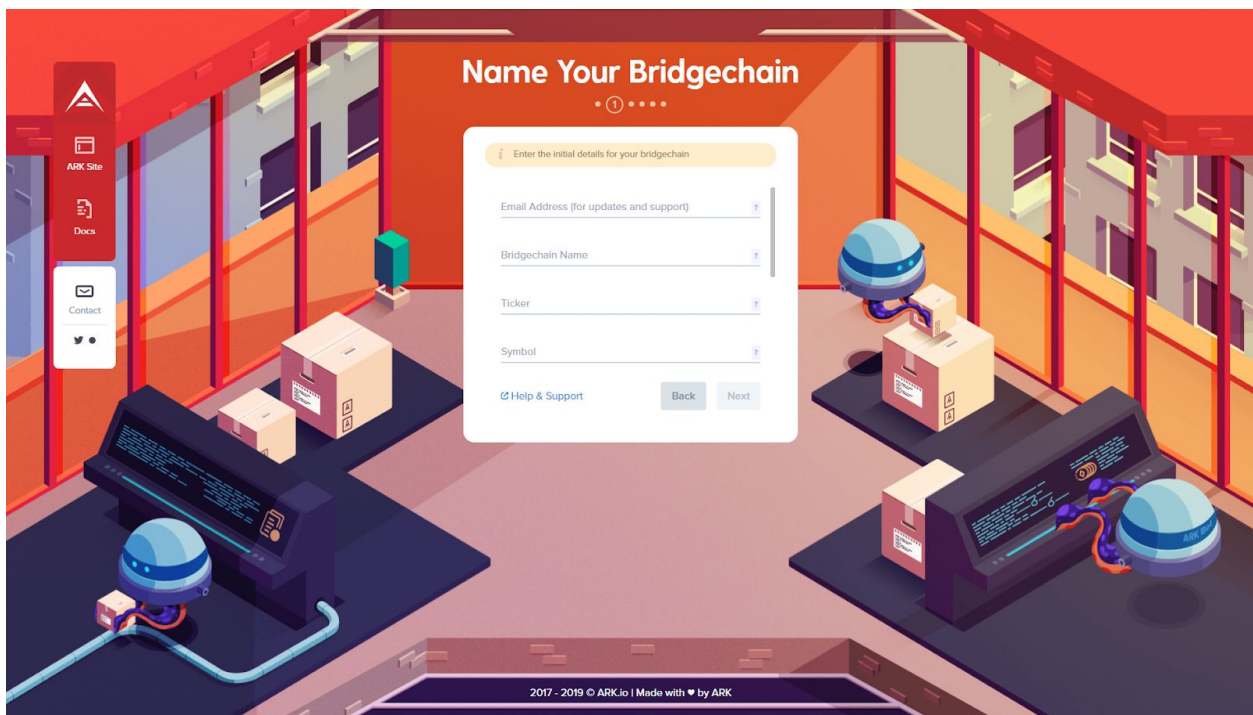
8.9 ARK Deployer GUI

ARK Deployer has been upgraded with a graphical user interface that will allow developers to visually configure their blockchain parameters and selected plugins without the need to interact with the Deployer CLI. Over time, complex processes will become simpler, and creating custom blockchains will become akin to designing a website with WIX or Squarespace.

There are three steps in the deployment process:

Prepare. Use the documentation hub to learn how to design an ideal network, create and connect to servers, and configure GitHub.

Customize. Use the graphical user interface to customize blockchain parameters. There are three levels of customization offered - Basic, Intermediate, and Advanced. All three result in a full-featured blockchain, but use default values as needed to speed up design time and offer a better user experience.

Deploy. Install the new bridgechain on a genesis node and create seed peers. The documentation hub provides procedures and guides on how to do this.

ARK Deployer Graphical User Interface at deployer.ark.io.

▲ 9 ARK Logic

9.1 Bitcoin Scripts

Before Bitcoin, it was simply not widely possible to digitally transfer wealth online without some form of centralized intermediary [34]. Bank transfers required banks, and credit card transactions required credit card companies and merchant processors. Digital currencies relied on centralized servers with trusted parties to store account information, transaction data, and often, assets backing the value of the currency. By removing central authorities from the process of transferring money over the Internet, Bitcoin laid the groundwork for a 'trustless' economy.

Using cryptocurrencies, one can send funds to anyone on the network without relying on a centralized authority. Shortly after Bitcoin's launch, Satoshi proposed further functionality using 'Bitcoin Scripts' to enable more than simple send and receive functions on the network [35]. An example of Scripts in action would be multisig, where multiple users must sign before funds are released. Bitcoin has since pivoted away from complex on-chain logic.

9.2 Ethereum Virtual Machine

Ethereum adopted and expanded the programmable money concept. While Bitcoin Scripts are analogous to the punch-card computer programs of old, Ethereum is comparable to first 'operating system' that directly addressed virtual money in a decentralized environment. Ethereum smart contracts run within the EVM, or Ethereum Virtual Machine, using a new language called 'Solidity' that can execute functions ranging from simple 'if-then' statements to entire applications, all with far less technical acuity than required by Bitcoin Scripts. Ethereum smart contracts represented a large step towards fully programmable and autonomous money transactions [36].

9.3 Smart Contract Example

A basic instance of a smart contract is the common ICO, or Initial Coin Offering. In this straightforward example, an organization accepts a liquid asset (Ether) at a specific address, and when Ether arrives, the smart contract automatically sends a new asset back to the source address at a given, fixed exchange rate. The smart contract autonomously handles transactions until a specific amount of time has elapsed or a specific limit is reached. The organization can then use its newly

acquired Ether to conduct operations, while the holders of the new asset are free to trade it or use it for products and services.

9.4 Smart Contract Immutability

Even smart contracts as simple as the example above have been identified to contain critical bugs, and as their complexity grows, so does the frequency and potential impact of these bugs. In 2018, in fact, a code auditor determined that twenty-five percent of all smart contracts contain critical security issues [37]. Vulnerabilities and critical flaws can be patched in normal software systems, but smart contracts are final and cannot be modified once deployed. While the immutable contract is the foundation of 'trustless' exchange (meaning that the system does not rely on trust to function), it is entirely incumbent on smart contract authors and pre-auditors to guarantee the contract code. In this context, lack of understanding of Solidity, hasty deployment, and inability to react quickly to new information all pose substantial threats to safe smart contract execution.

9.5 Smart Contract Bloat

Standard smart contract architecture sustaining versatile and complex applications generally requires a Virtual Machine, similar to the EVM and others. This essentially provides the 'runtime engine' in which the applications reside. Virtual machines run a variety of applications, and this usually results in a bloated system that requires heavy resources to run simple tasks. By deploying modular solutions using custom transaction types and plugins, ARK distributes the workload and removes overhead, making ARK technology far more scalable than other platforms.

9.6 Smart Contract Complexity

The complexity of smart contracts poses even further problems: the Solidity language utilizes a multitude of granular functions to build applications. However, this can result in awarding too much raw power to the developer, who may inadvertently introduce potential exploits into a program. By distilling common business logic into 'building blocks' that can be assembled in a controlled environment, ARK mitigates the risk of faulty code while nonetheless supporting highly sophisticated smart contract solutions. An initial goal of Ethereum was to bring decentralized computing to the public by offering smart contracts as an efficient and safe way of carrying out business and consumer transactions. The ARK platform pursues the same goal, but with a host of user-friendly applications designed to minimize risk and error.

9.7 ARK Logic as a Solution to Smart Contracts

From the outset, our intent was to provide a solution addressing the Blockchain Trilemma and the well known limitations of blockchain technology. Many of these solutions are integrated into SmartBridge technology which, via an ecosystem of linked chains with specific use cases, allows for greater flexibility and scalability. Equally important, we address the aforementioned issues with smart contracts, which until now, have lacked flexibility and obliged developers to learn new languages.

ARK delivers more than just automation and distributed relay execution - in other words, the basic functionality of any smart contract. Via modular architecture based on plugins, we enable organizations to leverage existing expertise to develop secure and efficient blockchain applications. ARK plugins behave like normal TypeScript applications, with the exception that they run on ARK Core and therefore integrate all the capabilities of the blockchain engine. By developing a plugin, users are able to draw on the expressive capability of common programming languages to develop tables, storage options, Web servers, GUIs, and more, all on top of ARK Core technology.

9.8 ARK Logic is Flexible

Offering blockchain solutions that are flexible, user friendly, and adaptable is a necessary first step towards mass adoption. A prime example of this logic, one that is the basis for all of ARK technology, is the ARK Deployer. Developers can define custom behavior of the DPoS mechanism, adjust block time and TPS, change number of delegates, and adjust the fee mechanics and block rewards. At the transaction level, we introduced the novel concept of adding custom transaction types that still follow the blockchain processing rules, but which can be custom tailored as needed. Custom transaction types, unique plugins, and a fractal network of interconnected bridgechains handling specific use cases all combine to maximize flexibility for developers.

9.9 ARK Logic is Scalable

At ARK, we draw on the principles of decentralized computing and apply them to the design of our network architecture. Where many other blockchain projects aim to act as global supercomputers, we recognize that modular programming approaches can better address pressing scalability problems. If a business or organization has a need for specific processing power, custom applications requiring faster confirmation times, or oracles that address a specific business process, the best solution is to launch and configure an application-specific chain

and implement a module addressing the needed business logic. Such an approach offers three main benefits:

Strain on the main ARK network is reduced as resource requirements move from mainnet to bridgechain

Stability is improved, as a bridgechain can be run in an isolated environment, free from the bloat of external operations

Upgrades become easier as logic can be modified and improved, in contrast to the finality of smart contracts. The application can scale indefinitely provided that consensus is reached.

Moving processing logic from mainnet to bridgechain is in sum, a simple and effective solution that offers the same benefits as sharding and payment channels, both of which present a host of stability and security issues that result from their complexity.

9.10 ARK Logic is Simple
We addressed the Blockchain Trilemma with knowledge and experience earned both through extensive work with companies who have launched successful projects using ARK technology, and the continuous development of the platform since 2016. We support ARK users with extensive and thorough documentation, guidebooks, tutorials, code examples, and a vast network of community developers that we cultivate. ARK Logic components such as modular plugins and TX templates will combine with the above elements to make creating and deploying decentralized applications extremely simple, but ARK technology is far from basic. The 'keep it simple' approach of ARK Logic is designed to allow anyone to create or enhance their project in the most efficient and standard way.

◭ 10 SmartBridge Technology

10.1 The Need to Interoperate

The ARK SmartBridge solution addresses a major issue that hinders the adoption of blockchain technology: the isolation of individual main networks. Currently, interoperability is largely controlled by central exchanges that oversee asset transfer. ARK, in contrast, allows data and asset transfer without the need for custodial third parties.

Two protocols define SmartBridge communication:

> *Protocol-Specific SmartBridge.* This represents communication between various chains based on ARK Core technology that operate within the ARK Ecosystem network of bridgechains. This is also known as bridgechain communication.

> *Protocol-Agnostic Smartbridge.* This represents communication between blockchains that use different consensus mechanisms, tokens and protocols, for example Bitcoin and others. This is also known as cross-chain communication.

10.2 ARK-ARK SmartBridge Mechanics

Protocol-Specific SmartBridge refers to a communication layer targeting ARK-based application-centric blockchains. In addition to standard token swaps, communication across bridgechains will enable both bridgechain validation and the ability to exchange both data and information. Protocol realization was recently made possible with the release of the brand new Core v2, and by expanding functions supported by ARK Logic.

The bridgechain protocol will operate via *core-bridge*, a module that operates in tandem with the new bridgechain registration transaction type that carries proof of trust/ownership of the originator of the registration transaction. Bridgechain registration means that any new bridgechain will need to be registered via our mainnet. The ARK Public Network will act as a proxy, main highway, and decentralized guard for interchain communication.

ARK has been upgraded for event triggering with the use of webhooks and basic event emitters. Events are used inside the Core to trigger blockchain actions and the delivery of webhook payloads. Additionally, custom plugins can utilize the event emitter package to trigger their own actions in response to blockchain events. Conceptually, this feature is similar to the *Hooks* implementation in WordPress [49], as well as the lifecycle hook access provided by JavaScript frameworks such as Vue and React [50] [51].

Due to the need for strict protocols around blockchain data creation and retrieval, events are strictly reactionary. Core events are not capable of changing data at runtime. The *transaction applied* event, for instance, passes a complete transaction instance, not raw transaction data that can be altered in the style of a WordPress filter. Another way to represent the event API is in the context of a *publish-subscribe pattern* [52]. In this pattern, ARK Core packages can act both as publishers and subscribers of events.

Bridgechain protocol transactions enabling coin transfers will need to be confirmed on three levels: the sending blockchain, ARK mainnet, and the receiving blockchain. The bridgechain protocol logic will be replicable, meaning that any bridgechain is able to act as a self-governing mainnet, thus making a horizontal connection through the web of blockchains and enabling exit via ARK mainnet.

10.3 ARK-ANY Smartbridge Mechanics

A community project called *ARK Contract Execution Services* (ACES) has demonstrated two-way transfers between ARK and Bitcoin, Litecoin, and Ethereum, including issuing smart contracts from ARK to Ethereum, regardless of the underlying protocols. ACES can adapt to any blockchain as needed [54].

Communication takes place through a special data section called vendor fields. At 255 characters, each transaction can be used to send text, instructions or code. This can also be used for hashing functions or even to trigger events such as smart contracts on other blockchains.

Intermediary nodes known as *encoded listeners* comb through this data for tasks to perform. These encoded listeners can be programmed and run however the operator sees fit, including running an exchange pool similar to ShapeShift or Changelly. Competing encoded listener node runners can launch ACES nodes for various coins, creating an encoded listener marketplace [48].

ACES is not a fully decentralized solution, even though it can result in multiple interaction points between two chains that are independently operated, providing redundancy. It is worth noting, however, that aside from handling other blockchains, ACES can also handle communication between ARK-based chains. ACES can be used while the decentralized SmartBridge Technology between various ARK-based blockchains is developed, and other blockchains or tokens that wish to migrate to ARK can do so via ACES token bridge. ACES is currently undergoing upgrades following the ARK Core redesign, and aspects of the ACES approach are now integrated into the Core itself. An example of this approach that uses the plugin/module implementation is the ARK and HyperLedger Fabric integration. The plugin-enabled execution of HyperLedger SmartContracts functions via ARK SmartBridge by using the vendor field as an interface [53].

Following the release of ARK v2, the immediate focus of the team is on building the ecosystem and optimizing interchain among ARK-based blockchains. Subsequent efforts will develop Protocol-Agnostic Smartbridge.

11 ARK Business Strategy

11.1 Business Strategy Introduction

The Gartner technology hype cycle focused on emerging technologies visually represents on a curve the high and low expectations that accompany the adoption of breakthrough discoveries. It shows how *Innovation Triggers* lead to a period of inflated expectations, and subsequently to widespread disappointment. It is out of that dip, what the chart describes as a *Trough of Disillusionment*, that true productivity emerges [39]. We believe that blockchain technologies are now exiting this dip in expectations, making this the perfect time to focus on executing plans to build a customer base, gain strategic value, and create new revenue streams for the ARK business entity.

The way forward is to deliver solid and easy-to-use technology to enable new use cases and disrupt the existing ones. The key challenge here is to provide the tools and technology that makes this an easy switch, and this is where ARK's main vision originates. By working with and soliciting the input of adopters and the community, we continuously strive to improve the platform and to implement new features that meet evolving needs.

11.2 ARK SCIC Business Entity

ARK is currently incorporated in France as a cooperative society known as an SCIC (Société coopérative d'intérêt collectif). It is the first of its kind in the crypto world, and one of the first blockchain projects to incorporate in the EU [40]. ARK has met with the AMF, which is similar to the SEC, to ensure regulatory compliance. ARK also has close ties to the French government and has contributed to Article 26 of the Loi Pacte and both Parliament reports on blockchain and cryptocurrency [46] [47].

11.3 ARK Team

The ARK team is rooted all over the world and has no main office. Team members come from the United States, France, Spain, Brazil, United Kingdom, Germany, the Netherlands, Slovenia, Finland, Bulgaria, Ukraine, and beyond. We have been expanding and hiring talent regardless of market conditions, and we hold multiple years' worth of working capital in various cryptocurrencies and fiat.

11.4 Moving to a Customer & Value Centric Approach

ARK's initial business strategy was to develop a solid foundation of technology to sustain custom solutions and applications built by others. With a newly redeveloped Core and large family of peripherals, ARK can now shift focus to the organizations and open source communities that will use the technology. ARK will use its own tools and ARK Logic templates to expand current offerings and attract developers in selected industries of interest. Following this, the ARK business entity will focus on providing true value to those that need application-specific blockchains. ARK's toolset will always be versatile enough for any use case, but the ARK business entity intends to offer help and guidance for specific industries through tools and tailored features. Focusing on key industries will drive adoption as it reduces barriers to entry.

Our value-centric proposition, in other words the specific value offered to customers that drives purchase or adoption, rests upon an API-centric technology solution. We understand this latter API proposition as a distinguishing feature that singularly positions ARK as a provider of flexible, sophisticated, and easy to use blockchain applications [42].

By supplying industry-tailored tools and solutions, ARK helps organizations improve their product offerings, address customer needs, and expand operations through blockchain technologies. The community and ARK digital marketplace further facilitate growth with support networks and additional offerings that complement the features of the ARK Core.

11.5 Transformation Into a Digital Marketplace

The benefits of the ARK Core component-based architecture extend far beyond a modular and flexible codebase. ARK Core is the basic foundation for a host of novel business-oriented applications that are assembled with plugins, which can be fully customized with ARK Logic and plugin development tools. Developed in JavaScript and TypeScript, an ARK plugin can be anything from a simple API expanding and enabling storage of additional data on the blockchain, to a brand new HTTP server with custom underlying logic, delivering new application interfaces and support for any business need. Our range of available SDKs, libraries, and utilities free developers to concentrate their focus on business application development.

Every plugin can introduce its own licensing and support conditions, all of which can be stored on the ARK mainnet in the form of a transaction. Some plugins will

run solely on bridgechains, and some will run on the mainnet as needed. For the plugin to reach mainnet, a wide consensus between public delegates is necessary.

In this context, the digital marketplace is a convenient destination to discover, buy and sell applications, services, and solutions built with ARK's technology stack. The marketplace operates on transaction types to be introduced on the ARK Public Network to connect service providers, developers, startups and larger enterprises.

ARK plugins, whether released to the digital marketplace or not, will be tied to the business and bridgechain on-chain registration transactions that ARK users will complete before developing on the network. These transactions will retain information about the registering entity, and will thus block bad actors from distributing malicious code by posing as well-established developers. Details of these registration transactions are as follows:

> *Business Registration on ARK Public Network.* An individual, team or company will be able to issue a business registration transaction in the same way a delegate registration transaction is issued. The proposed fee for this transaction will be high enough to ensure that only serious projects are allowed into the ecosystem. The terms of the registration transaction will require detailed information from the registering party including website, GitHub, VAT ID if applicable, contact email, etc. This transaction will serve as a required first step towards the next phase, in which the registered business on the ARK Public Network can request a bridgechain launch via the ARK Deployer GUI.

> *Bridgechain configuration on ARK Public Network via ARK Deployer.* An ARK address that is registered as a business or organization can send a bridgechain registration. This will serve as an input to the ARK Deployer which will use this address to generate the chain specifications such as genesis block, initial wallets and passwords, mainnet, devnet and testnet specifications. This establishes the authenticity of the bridgechain, opening doors to certain strategic value opportunities within the ARK ecosystem, such as the *Powered by ARK Program*. Unregistered chains will not have access to these same resources.

Entry into the Powered by ARK Program via bridgechain registration simply means that the team behind the project is serious, capable, and that the project was assessed and evaluated by the ARK community and team. Not all registered bridgechains will be eligible for the Powered by ARK Program, which is centrally managed by ARK.io.

New transaction types and plugin deployment using ARK Logic go hand in hand with the functionalities of the ARK Deployer, which serves as the primary vehicle for building, launching, and managing blockchains. The deployer user can register a new bridgechain and preselect the set of modules and plugins included in the bridgechain launch. This will enable users to launch custom bridgechain specifications adapted to specific industries of interest and to customize their chain for any use case with third party tools and plugins.

11.6 Industries of Interest

The ARK business entity will soon start using its own tools to tailor solutions and add-ons for specific industries. Players in these industries will have ready-made tools out of the box to utilize in deploying their blockchain solutions, using ARK Logic. As more entities in these fields use ARK technology, the building blocks can be refined and expanded such that the industry tools are continually updated. After creating industry-specific toolkits and ARK Logic templates, the ARK business entity will promote adoption of these solutions through strategic partnerships, to facilitate the usage of the solutions among organizations, and form strategic partnerships within these sectors as needed.

Gaming. Blockchain has the power to revolutionize both game design and player interaction with gaming ecosystems. Decentralized infrastructure enables immutable ownership of in-game digital assets, completely transforming the control and flexibility that players currently have in centralized gaming environments. What's more, persistent issues with hacking, duplication, and theft are mitigated through the encryption provided by blockchain networks, all leading to massive increases in security for both gaming infrastructure and players' digital possessions.

Exchange of assets between games may also be enabled with a common game asset protocol built on a network of ARK blockchains connected to a marketplace for non-game digital

assets and currencies. Non-fungible tokens allow for serialized, uniquely identified, transferable in-game assets.

Blockchain transforms in-game mechanics and processes to promote trust and accountability within gaming environments. A re-imagined system for payments and monetization could lead to huge cost savings for both developers and gamers, leading to increasingly fair and optimized in-game economics.

By utilizing ARK blockchain technology, the gaming sector will be able to tackle key challenges related to security, ownership, and fairness. Faster and more flexible payment systems, new ways of building credibility, and improved transparency will create further opportunities throughout the industry.

Internet of Things. As the IoT industry grows, it is increasingly plagued with issues surrounding security, poor connectivity, and slow performance, all of which limit its ability to fully penetrate the commercial and industrial sectors. Industry leaders are crying out for a scalable solution that will enhance security, improve network performance, and reduce the reliance on centralized cloud servers, and this is where blockchain technology shines.

With its innate immutability and decentralized nature, blockchain technology addresses the key challenges that the IoT industry faces, from device security to the authentication and encryption of information.

IoT devices running over decentralized networks benefit from both low risk of being compromised via a single point of failure and reduced reliance on expensive, centralized data centers. Moreover, a lean, scalable network capable of supporting millions of connected devices reduces bottlenecks and delivers improved network performance and reliability.

By utilizing ARK technology, the IoT industry can benefit from a more secure, robust, and resilient network architecture that doesn't

fall victim to data collusion, network tampering, or single points of failure - all while delivering significant cost savings and efficiency gains.

Government. Governments and public sector entities around the world have been experimenting with blockchain technology over the past few years. This testing is now turning into adoption in many instances, as the value of blockchain-powered infrastructure and public services is recognized. By utilizing blockchain technology, government operations can increase efficiencies and more effectively deliver public services. Additionally, blockchain technology streamlines internal processes, which can lead to widespread cost savings.

Decentralized blockchain infrastructure removes single points of failure and provides additional layers of security and protection for critical government systems and citizen data. Blockchain secures access to citizen records, deters fraud, and upholds compliance, thereby improving trust throughout the system.

Specific blockchain use-cases in government environments include digital identity, voting, payments, registries, and record management. By transforming the way data is generated, processed, and shared, blockchain based services allow citizens to monitor how their personal information is used.

ARK blockchain technology offers the government sector a range of benefits including increased operational efficiencies through streamlined processes, greater cost savings through disintermediation, improved trust and transparency, and enhanced data security.

Supply Chain Management. Limited visibility and inaccuracies across logistics networks are serious and persistent issues in the supply chain management industry. Lags and black holes can

seemingly place inventory in multiple places at once, or more worryingly, nowhere at all. This poses a critical problem for a fast-paced industry that relies on getting the right product to the right place, at the right time. Decentralized digital ledgers increase by an exponential factor the capacity for oversight of player activity across global supply chain networks.

Implemented into logistics operations and shipment tracking, the consensus-based blockchain ledger can be leveraged across a supply chain to link nodes, or points of transit, which would be required to agree with finality where inventory is at any one time.

Moreover, decentralized logic and workflows allow actions to be executed based on predefined conditions. This eliminates the 'middle-man' whether that be intermediary systems or labor, generating significant cost savings for supply chain organizations.

ARK technology can uniquely offer the supply chain industry greater oversight and control of inventory, enhanced data security, and process automation, all resulting in increased efficiency and cost reduction.

11.7 Outreach

In addition to building the ARK Blockchain Platform, the ARK business entity is committed to engaging in outreach initiatives that fulfill multiple concrete goals that add strategic value to the ecosystem, spread awareness about ARK solutions, and educate the public about the tremendous potential of blockchain technologies. These initiatives include:

Conferences. To date, ARK has sponsored nearly a dozen blockchain conferences and expos. Conferences are useful to present ARK achievements and progress to the greater blockchain community. They encourage adoption and allow peer review and feedback to take place. In addition, conferences position ARK in front of organizations and enterprises looking to utilize blockchain technology.

Hackathons. ARK seeks to expose budding talent at universities and campuses globally to the numerous advantages that the ARK platform offers. To date, ARK has sponsored nearly a dozen

hackathons, which are short competitions among teams of computer science students and developers who create projects that are judged and awarded prizes. ARK is also utilizing a strategic partnership with Major League Hacking to create an ARK blockchain workshop. Going forward, ARK intends to organize virtual hackathons, where teams need not be in the same geographical location to compete.

Meetups and ARK Advocate Program. Building a strong community is important to the success of any ecosystem. Agents of the ARK business entity attend meetups to present on ARK technology. In 2019, the ARK organization will launch an Advocate program in which ARK agents will train, certify, and fund ARK enthusiasts to deliver presentations and even host ARK-specific meetups of their own.

Powered by ARK Program. The Powered by ARK Program is designed to allow all projects building with ARK technology to form relationships and build stronger ties to the overall ecosystem. Once accepted, bridgechains in the PBA Program will be able to directly interface and collaborate with ARK, the community, and other bridgechains — strengthening the ecosystem and helping to maximize their success. Bridgechains in the PBA Program benefit from priority support from the ARK Development Team, and projects that reach higher levels in the program can benefit from ARK outreach initiatives that can increase awareness of the project.

Market Research. The ARK business entity has recently recruited market research experts to identify pain points in industries of interest and to propose ARK-based solutions for them. As organizations and entities adopt ARK technology, their respective communities can merge with the ARK community to bring greater strategic value to the overall ecosystem.

Strategic Partnerships. ARK partners with businesses, organizations, and other projects whenever tangible strategic value exists. Partners include blockchain projects, exchanges, service providers, and others. For the ARK business entity, strategic partnerships afford industry access, exposure, and increased capabilities.

Delegate Collaboration. The ARK business entity is fully aware of the significant and untapped support available from ARK Public

Network delegates. Delegates launch campaigns to attract votes which usually include plans to deploy additional community services beyond securing the network. The ARK business entity has in turn the capacity to offer seed funding beyond the block rewards delegates receive. This funding can quickly add community impact to a delegate's deployed service.

Bounties & Contests. Numerous programs are in place to reward community members who help build the ARK project by contributing to the ARK GitHub repository and beyond. The *ARK Development & Security Bounty Program* awards community developers with ARK for contributing to both project development and ARK's rigorously maintained documentation repositories. Participation in this area has been enhanced through ARK's bounty program (organized in partnership with Bugcrowd) focusing on discovering vulnerabilities in the code. For non-technical community members, ARK regularly runs contests involving expanding the ARK presence on social networks or growing the community by educating others about ARK core values and goals.

Social & Rich Media. ARK has a strong presence on Steemit, LinkedIn, Slack, Discord, Reddit, Bitcoin Talk, Twitter, and Instagram. The ARK business entity publishes a detailed blog that acts as a hub for public relations. ARK maintains a range of educational videos on YouTube, and presence on YouTube will be expanded throughout 2019. ARK also hosts a weekly audio podcast, available on iTunes, Google Play, Stitcher, Soundcloud, Spotify, and Castbox.

Tier-0 Program. ARK's in-house development team focuses on the core elements of the ARK technology stack. As such, they must prioritize development in areas such as the Core, SDKs, wallets, block explorer, Deployer, and marketplace. The ARK Tier-0 Program comes into play for cases where ideas could be executed outside of these main areas, for example in the form of plugins. Community developers would be able to browse the listed Tier-0 projects and offer their talent and expertise to execute the project.

⛰ 12 Conclusion

12.1 Blockchains Are Here to Stay

Satoshi Nakamoto's work on Bitcoin and decentralized currencies in general initiated a paradigm shift in conventional thinking about social and commercial transactions. Indeed, the growing number of blockchain projects delivering platforms and innovative decentralized applications confirms the vast potential of these technologies. In this fast-evolving space, ARK is positioned as a robust solution for developers and organizations who are seeking streamlined and efficient ways of integrating blockchain solutions. With a few clicks, anyone - from the single, solitary innovator seeking to realize an idea, to the developer team of an established, household name enterprise seeking to transition to decentralized systems - can launch a blockchain and tap in to a global support network.

12.2 What the Future Holds for ARK

In a successful ARK Ecosystem, hundreds, if not thousands, of communities, businesses, enterprises, and organizations use ARK technology to deploy blockchains custom tailored to their needs. Other blockchain projects with tokens on a restrictive mainnet begin to break off and form their own ARK-based network, addressing their **scalability** concerns and reaching higher planes of flexibility using ARK Logic. They enjoy the freedom to evolve through the **sovereignty** they receive with ARK. They benefit from the **speed** and **security** ARK offers. They appreciate the **simplicity** of ARK technology. They receive needed **support** from the ARK Public Network, ARK business entity, and ARK community. These ARK-based chains interoperate via SmartBridge Technology with a thriving ARK mainnet that unifies through cross-chain protocols without regulating the distributed network.

12.3 Get Involved

You play a key role in the success of ARK and you can bring tangible value that is truly appreciated by the whole of the ecosystem. If you are a developer, you can improve the code on Github by tackling issues and submitting pull requests. You can apply your own ideas to develop additional peripherals and plugins using ARK. You can become an ARK mainnet delegate, or even launch your own chain.

If you aren't technically inclined, you can bring your own skills and talents to the table by asking questions, voting for delegates you support, accepting ARK for your business, receiving funding for an idea through the ARK Community Fund, and even helping the team in non-coding projects on the ARK Community Committee. ARK is for everyone, and together we can bring to the world the true vision of *Point. Click. Blockchain.*

◭ 13 Resources

Network Resources

wallet.ark.io: Download the official desktop wallet

android.ark.io: Download the official mobile wallet for Android

ios.ark.io: Download the official mobile wallet for iOS

explorer.ark.io: ARK Public Network blockchain explorer

Developer Resources

github.ark.io: Access the ARK codebase repositories

docs.ark.io: Technical documentation and guides

bounty.ark.io: ARK Development & Security Bounties

guidelines.ark.io: Protocols for contributors

Public Relations Resources

roadmap.ark.io: Progress on project statuses

blog.ark.io: Information on news and releases

steemit.ark.io: ARK Blog syndication on Steemit

Discussion Resources

slack.ark.io: Real-time ARK discussions and help

discord.ark.io: Real-time ARK discussions and help

reddit.ark.io: Official community Subreddit

bitcointalk.ark.io: ARK Bitcoin Talk forum page

Social & Rich Media Resources

twitter.ark.io: ARK Twitter account

instagram.ark.io: ARK Instagram account

youtube.ark.io: ARK Youtube channel

podcast.ark.io: ARK Crypto Podcast

Community Resources Not Affiliated with ARK.io

ArkDirectory.com: Community-managed library of links

ArkDelegates.io: Browse ARK Public Network delegates

ArkTippr.com: Interact with Reddit using ARK

ArkThoughts.com: Community opinions on ARK

ArkTimeline.com: Interactive timeline of ARK achievements

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▲ 15 Legal Details

As used herein, the following capitalized items shall have the meanings set forth below:

1. "Company" or "ARK business entity" shall mean ARK Ecosystem SCIC, a company registered in France with its principal office of incorporation listed as 1394 Rue du Village, 39750 Villeneuve-sous-Pymont, France.

2. "Website" shall mean the website of the Company on which the Know Your Customer procedures, GDPR regulations, and multi-jurisdiction compliance has taken place. [http://ARK.io]

3. "Blockchain" shall mean a digital ledger or database which is chronological, consensus-based, decentralized and mathematically verified in nature.

4. "Cryptocurrency" shall mean a digital asset designed to work as a medium of exchange using cryptography to secure the transactions and to control the creation of additional units of the currency.

5. "Innovative" shall mean a new or emerging technology, or new uses of existing technology, that provides a product, service, business model or delivery mechanism to the public.

6. "Passphrase" and "Private Key" shall mean a personalized code which is paired with a public key encrypted with algorithms.

7. "Services" shall mean any service provided by the Company, including the services available to users created by third parties. "Community Services" and "Delegate Services" denote third party services not affiliated with the Company.

8. "User" shall mean any acquirer and holder of ARK.

9. "Virtual Token" shall mean a form of digital medium recordation whose utility, value or application is restricted solely to the acquisition of goods or services, either solely within the DLT platform on or in relation to which it was issued or within a limited network of DLT platforms.

10. "ARK" (always spelled entirely uppercase) shall mean a Virtual Token, created by the Company, intended for accessing goods and services within the ARK Ecosystem as outlined in this whitepaper.

11. "ARK Ecosystem" shall mean the environment in which future blockchain developers and users interact. Both a living and a technological construct. Where both community members and developers contribute to the creation of tools, services, products, and peripherals.

12. "Whitepaper" shall mean the document published on the Website that describes the ARK project and the complex issues it aims to solve. In addition, it will detail the characteristics and purpose of the ARK token.

ARK Characteristics, Features, Rights, Warranties, and Exclusions:

1. ARK may be used by You as an instrument for accessing certain goods and/or services within the ARK Ecosystem.

2. ARK forms a digital medium recordation whose utility solely entails the utilization of services within the ARK Ecosystem.

3. Your use of ARK shall be subject to the Terms and Conditions available on the Website.

4. All materials within the Whitepaper are provided on an 'as is' basis. The company makes no warranties, expressed or implied. In addition the Company negates all other warranties, including but not limited to, warranties or conditions of merchantability, fitness for a particular purpose, or non-infringement of intellectual property or other violation of rights.

5. The Company provides no guarantees of the future use or value of ARK, whose value may fluctuate and may be reduced to zero.

6. You are not expected to make a profit from the acquisition of ARK and shall have no expectation of profit from the future success of the Company's business and/or the efforts of the Company or other persons.

7. ARK does not in any way represent a share, debenture, stock or unit of the Company. ARK does not represent ownership interests or grant ownership rights, control and voting rights in the Company, nor do they grant any rights to receive a share of the Company's profit nor any distribution of assets upon the liquidation and winding up of the Company.

8. The Company is not obliged to redeem ARK at any given time.

9. ARK does not represent securities, commodities, swaps, future investment contracts, or either securities or commodities or a financial instrument of any kind. Purchases and sales of ARK are not subject to the applicability of any law which may govern or regulate any type of financial instrument.

This Disclaimer and all other documents referred to in this Disclaimer including the Whitepaper do not constitute a prospectus or offering document, and does not represent an offer of sale to the public, nor is this Whitepaper solicitation of an offer to buy an investment, a security, commodity, a future contract or a swap on either a security or commodity.

10. The acquirement of ARK is not for investment purposes and the User should not acquire ARK with such intentions. ARK is not designed, developed nor intended to be used for investment purposes and should not be considered as a type of investment. You acknowledge, understand and agree that the holding of ARK does not constitute a guarantee, representation or warranty that the holder will be able to make sure of any assets or profits generated or held in the name of the Company.

11. You acknowledge and agree that You are not acquiring ARK for purposes of investment or speculation, arbitrage strategy, for immediate resale or other investment purposes.

12. Nothing within this whitepaper constitutes any form of advice: legal, financial, or otherwise. If you require any form of advice, you should consult with the appropriate professional within your jurisdiction.

13. ARK retains ownership of copyright and all other intellectual property contained within this Whitepaper and all rights are expressly reserved.

14. You are solely responsible for the determination of what your fiscal obligations are for any transaction used to access services with ARK. Fiscal Obligations within certain jurisdictions vary and may include accurate record keeping and certain transactions may be subject to tax.

15. If one part of this disclaimer is deemed to be unenforceable by any court, the other provisions within this disclaimer will continue to be in effect.

16. Cryptocurrency and/or Blockchain Technology remains unregulated in a multitude of countries and jurisdictions. Changes within Your country or jurisdiction may impact your access to services and or the ARK token. The Company cannot guarantee that possible regulatory changes shall not impact You or activities you perform while using the ARK token to access services within the ARK Ecosystem.