



PCHAIN

POSITION PAPER

**The first native multi-chain system supporting EVM in the world.
Making large-scale blockchain applications possible.**

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All contributions will be applied towards the advancing, promoting the research, design and development of, and advocacy for a new blockchain-based peer-to-peer network and protocols for running smart contracts to solve the problems with existing blockchain networks through the usage of multi-chain systems. The Foundation, the Distributor and their various affiliates would develop, manage and operate the PCHAIN Network.

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ABSTRACT



PCHAIN

The Internet has greatly enhanced the efficiency of information dissemination. Human society has fully stepped into the self-media age after two decades of rapid development. The blockchain, which is hailed as the internet of value, has dramatically increased the efficient distribution of digital assets and made self-financing possible. A broad range of industries will be remodelled by the blockchain in the future, just as the Internet has reshaped the traditional industries. There are usually two ways to achieve a historical breakthrough, one is through finance and the other is through technology. The combination of finance and technology is called Fintech and the core of Fintech is the blockchain. Blockchain was born with financial properties. Blockchain without financial properties can only be called a DLT distributed ledger. Other Fintech technologies, such as big data, cloud computing, artificial intelligence, can be applied to support finance. Nevertheless, finance is not the native property of these technologies.

Blockchain technology began with Nakamoto's Bitcoin, a peer-to-peer cryptocurrency system [1]. Ethereum [2] expanded Bitcoin's capabilities and intended to provide a blockchain with a built-in fully-fledged Turing-complete programming language for writing smart contracts, thus opening up a new blueprint for the restructuring of a variety of industries. Ethereum runs a smart contract based on the Solidity language that serves as a platform for writing and deploying DApp (distributed applications/blockchain applications).

Finance is the exchange of funds and assets. In the new economic blueprint formed by the blockchain, it manifests as digital currency represented by bitcoin and digital asset represented by smart contract. Digital currency and blockchain record payment transactions in a distributed accounting system. Smart contracts allow users to customise rules and write code to express their logic. Both utilise the features of decentralisation and immutability of the blockchain to ensure the recording and delivery of value.

Blockchain systems for smart contracts are faced with the following major problems at the same time:

- 1) There is a lack of a unified and effective Oracle. In the closed bitcoin ecosystem, all the data in the system is generated by the system, so there is no problem of the validity and authenticity of the data/knowledge itself. In a smart contract environment, however, there is a need to obtain the external system data/knowledge, and the validity and authenticity of external data/knowledge often becomes the bottleneck and obstacle of smart contracts.
- 2) Insufficient support for large-scale transactions. Inevitably, single-strand competition causes the waste of resources and browsing and restoring transactions are more complicated.
- 3) Increasing demand for cross-chain support. Handling the compatibility problems for smart contract data is far from easy.

The PCHAIN Network is a new infrastructure level public chain system with native support for multi-chain applications and EVM, providing an open, scalable platform for third party developers in the industry and making it possible for large-scale enterprise applications based on smart contracts.

The core technologies underlying the PCHAIN Network include:

1) The first native multi-chain architecture that supports EVM, with a consensus of POS based on multi-layer sharding mechanism that tremendously improves the performance of transactions.

2) A new Oracle mechanism based on the knowledge graph makes it easier to encapsulate smart contracts. The endogenous W3C-compliant smart data of the PCHAIN Network effectively addresses the issue of non-intelligence in smart contracts and can become a fundamental element of smart contracts, just like the market exchange rate data from the external.

3) The goal of PCHAIN Smart Data is to generate valuable data that filters out noise and make it an integral part of Oracle. These smart data can be used in various smart contracts and other cross-chain requests on the PCHAIN Network. Smart data, on the one hand, can serve as an intermediary between blockchain and artificial intelligence, and on the other hand, facilitates the integration of blockchain with big data.

Therefore, it has a vast application prospects, including decentralised question and answer, forecasting markets, the building of distributed knowledge graph ^[11], social networks, digital identities and others.

4) The trunked cross-chain solution makes the exchange of digital currency and digital assets more convenient. Various Tokens (eg BCH, ERC20) can be directly used to invoke smart contracts in the PCHAIN Network.

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CURRENT SITUATION OF SMART CONTRACT



Essentially, bitcoin completes the transition from the ledger state S_t to S_{t+1} via a series of transactions, which can be represented as triples $\langle \text{From}, \text{To}, \text{Value} \rangle$, occurring from time t to time $t+1$. While Ethereum expands the transaction into a six-tuple $\langle \text{From}, \text{To}, \text{Value}, \text{SmartContract}, \text{Function}, \text{Parameter} \rangle$ containing smart contract calls to complete the transition from state S_t to S_{t+1} .

Compared with the blockchain supporting digital currency, the main purpose of the blockchain supporting smart contracts is not only to record the flow of digital currency, but to convert the agreed rules in real life to a smart contract.

After smart contracts are deployed on the blockchain, no one can change the existing rules at will. And after triggering the stated conditions, the contracts will be automatically executed according to the rules, no one can intervene.

With the development of smart contracts do not just convert the previously human intermediated rules to machine code, blockchain applications in a variety of industries are beginning to deploy more sophisticated smart contracts to record data previously recorded in central databases to the blockchain so that the data cannot be modified; thus, blockchain data and its operations/transactions are becoming more and more complex, and the scale of their applications are is growing.

2.1 Solutions to Support Smart Contract

Commonly, the user uses a specific smart contract language to write the program, then deploys it on the blockchain. Then the blockchain will execute the contract in a virtual machine and return the result.

Now there are two ways to deal with the programming language and virtual machine:

One way is to define a new programming language and develop a virtual machine to run the application written in that language. For example, Ethereum uses the Solidity language and Ethereum Virtual Machine [3] [4].

Another way is to use existing programming languages and virtual machines, such as HyperLedger^[5], using the Java language and JVM. (HyperLedger is mainly used to build consortium chains and private chains; and the aim of the PCHAIN team is to build a public chain, so for the time being HyperLedger is not the focus of the discussion here.)

2.2 Existing Problems

From a practical point of view, the blockchains supporting smart contracts have the following problems:

Insufficient support for large-scale transactions

Taking Ethereum as an example, Ethereum currently deals with about 13 transactions per second, While Facebook handles about 175,000 transactions per second. In terms of the size of the transactions, the current blockchain is still far from the most mainstream social applications.

In terms of the transaction mechanism, the support for large-scale transactions is also not strong enough. Currently, all DApp transactions are put together and packaged into the same block. When a DApp is very busy, sending too many transactions, and cannot form a new block in time, other DApp's transaction cannot enter the block too, and then all DApps cannot response in time. The status ICO event^[6] some time ago is an example that a DApp congestion causes the system not to work properly.

> **All DApps exist on one blockchain, browsing and restoring transactions are complex**

When there are many DApps deployed on the main chain, each DApp's data including transaction data, is spread across blocks of the blockchain. Tracing and restoring operations on a particular DApp on the blockchain will require traversal of the entire chain, which is less efficient.

> **Lack of a unified and effective Oracle method**

The Bitcoin system itself is a complete closed loop from the generation, distribution and transfer of digital currencies. When expanding to smart contracts, the entire system is often an open-loop state, requiring an intermediary node to inform the blockchain of external information in the form of an Oracle prophet.

> **POW with single chain at present is a waste of calculation power ^[7]**

At present, most of the public chains that support smart contracts use the POW mechanism to reach a consensus. When miners compete to generate a new block, each block consumes the calculation power of all miners. This mechanism causes tremendous waste of calculation of the blockchain network.

And POW is easy to bring a fork, this will bring some barriers to make transactions confirmed immediately. While POS avoids the waste of calculation power, the publicly released POS systems do not effectively solve the classic problem Sybil attack.

> **Smart contract data compatibility issues, inconvenient to upgrade**

Since the data saved on the blockchain (including the codes of smart contracts) cannot be modified, in theory, the smart contracts that have been deployed are immutable. In this way, if there is a bug in the existing smart contract, it will be very difficult to fix it. Although there are various options to solve this problem, it is not easy. For example, export all the original smart contract data, and write them in the new smart contract. In this scenario, if the amount of data is huge, it takes a lot of time, and the transaction-related data of the original smart contract is likely to be lost.

As software development (including smart contracts) inevitably leads to bugs, how to ensure that smart contracts can be upgraded in a way that ensures data is immutable is already a more urgent requirement.

2.3 Related Work

Multi-chains technology effectively divides the original structure of single-chain into different sharding through the way of the structural reconstruction, which makes the whole block chain structure no longer show the processing power of a single computer. As the number of multi-chains increases, its computing power and storage capabilities increase linearly. A number of related efforts have been made in this field, such as LISK [18], Asch [19] and Ardor [20]. However, none of these multi-chained structures provide direct and effective support for EVM. When the smart contract encounters problems, it easily falls into an endless loop due to non-Turing completion or without considering the gas limit. Its improved BFT algorithm has a strong centralised tendency. the PCHAIN Network is the first blockchain project to support EVM on a multi-chains structure.

Cross-chain considers the transactions between multiple chains or within the native multi-chains. Early work is usually based on BTC, such as BTC Relay[21], BlockStream[22] and RootStock[15]. RootStock is a secondary chain attached to the Bitcoin blockchain, and provides intelligent contract function through the exchange between BTC and its endogenous SBTC. However, its secondary chain is still single-stranded so that it also faces serious performance bottlenecks like Ethereum. Polkadot[13] further defines cross-chain as Parachain, Relaychain and Bridge. The PCHAIN Network supports the smart contract call of non-native Tokens, which differs from universal cross-chain targeting for One Size fits All as Polkadot expected. Cosmos[16] proposes a structure called ABCI to link different heterogeneous

chain. However, its current improved BFT Consensus algorithm is costly to communicate and does not support the dynamic joining and exiting of Validate.

A number of performance-enhancing efforts are designed from the perspective of improving Transaction Processing and stochastic consensus, such as Dfinity[17], Zilliqa[12] and Aelf[14]. Different from these work, the PCHAIN Network improves the overall performance of the blockchain from the perspective of Data Processing and Sharding through a multi-chain structure, and designs a new consensus approach based on multi-chain structure.



3

FRAMEWORK AND KEY TECHNOLOGIES OF THE PCHAIN NETWORK

PCHAIN

In response to the defect of child-chain method which supports smart contracts, a multi-chain approach is proposed to improve the support for DApp. The multi-chain approach has a new structure of a main chain and multiple side chains (as shown in Fig.1). The main chain with the two adjacent child chains looks like the Greek letter π , so it has been named PCHAIN.

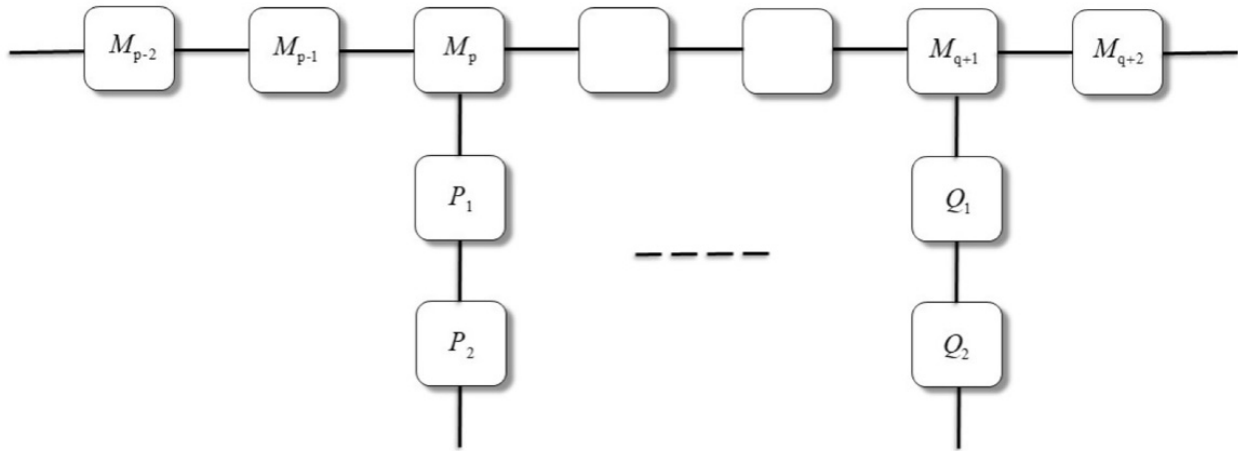


Fig.1 The Structure of Main Chain and Child Chains

The characteristics of the PCHAIN Network will be introduced in detail below.

1. The growth of the PCHAIN Network

As shown in Fig.1, the blockchain in the horizontal direction is the main chain and the vertical chains are the child chains.

When one creates a new DApp (e.g. a new smart contract), a child chain will be created. Taking Fig.1 as an example, the current block in the main chain is M_{p-1} , and now a request for creating a smart contract is received. The main chain will execute the request and generate a block M_p . Meanwhile, a new child chain P will be generated and the first node P_1 of P points to the block M_p . P_1 contains the binary code of the smart contract. When a request calling the smart contract on the the PCHAIN Network is coming, it will be processed by the PCHAIN Network. And the PCHAIN Network will generate a new block P_2 . The child chain P is growing in the way that deals with the smart contract.

Besides, child chain also has a growth way (i.e. upgrading the smart contract). When upgrading the smart contract on the chain, the binary code of the latest smart contract will be placed in the newly generated block.

2. The duty of the main chain and the child chain

As described in the above section, the main chain stores various account information and transfers digital currency among accounts. It is also responsible for interacting with other existing external public or consortium blockchain and providing interfaces to provide the corresponding service for the child chain. The child chain mainly records the data related to the specific smart contract.

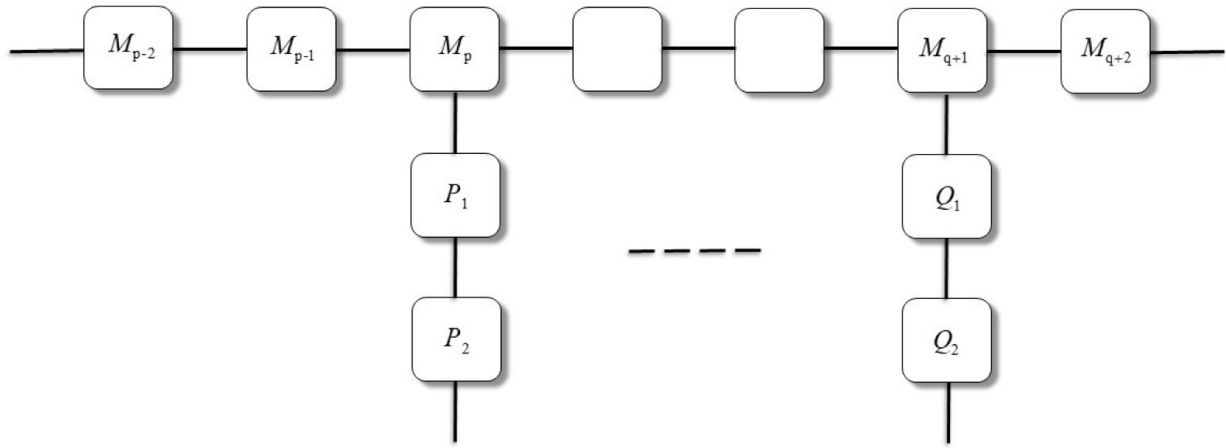


Fig. 1 The Structure of Main Chain and Child Chains

3.1 Key Technologies of the PCHAIN Network

3.1.1 Invocation of Smart Contract for Non-native Tokens

The PCHAIN Network supports cross-chain calls. With the toolkit provided by the PCHAIN Network, the smart contract on the PCHAIN Network can be invoked using non-native Tokens of other chains. The toolkit currently supports BCH and Tokens following the ERC20 protocol.

The principle is as follows. When the toolkit provided by the PCHAIN Network, which is used on other blockchains, invokes the smart contract of the PCHAIN Network with a certain number of Tokens in this blockchain, the exchange rate between the Token and PI (Token of the PCHAIN Network) will be acquired by the toolkit firstly through the smart data in Knowledge Graph. When the convertible PI is enough to run the called smart contract, the toolkit will transfer the corresponding number of Tokens to the PCHAIN Network and consume the corresponding quantity of PI of the PCHAIN Network to invoke the smart contract.

Taking BCH as an example, the calling process is as follows. Before calling, the caller tells the PCHAIN Network the name, functions and parameters of the smart contract that he needs to invoke through the toolkit. The PCHAIN Network will calculate the PI to be consumed according to the call, then use the exchange rate between BCH and PI to calculate the corresponding number of BCH and return them to the caller. The caller fills in the toolkit with the number of BCHs returned in the previous step and imports the name, functions and parameters of smart contract again. After signing the smart contract, the caller will send the request. While the PCHAIN Network receives the request, it will consume the corresponding PI, then call the corresponding smart contract and return the result.

In the toolkit provided for BCH, the information of the called smart contract is carried by OP_RETURN. In view of the limited amount of information carried by this instruction, it will be considered to propose BUIP to add new instructions for carrying more information in the future.

For the Tokens that follow ERC20 protocol, after obtaining the entitlement of a certain number of the Token, the PCHAIN Network can use the ERC20 interface to make the Token withdrawals and consume corresponding PI internally according to the exchange rate to invoke the smart contract

In addition, since the PCHAIN Network itself supports EVM, it also certainly supports the issuance of Token that follows the ERC20 protocol. The PCHAIN Network can access a variety of external public blockchain and consortium blockchains, as shown in Fig.2.

3.1.2 Consensus of Sharding

The PCHAIN Network supports Shardings at different levels and offers a choice of POS consensus mechanisms to improve the efficiency of operation and storage and support chain expansion.

As far as the current consensus mechanism is concerned, all transactions ultimately can only be executed and verified serially, no matter in POS or POW consensus mechanism. For the current popular POW-based public blockchain, whether it is the Bitcoin network or the Ethereum network, the time consumption of mining even goes far beyond the time consumed by the execution and verification of transactions. The ultimate result is that the entire network can only exploit the power of one node, which causes the situation that it is difficult to improve the performance and expand the structure.

The PCHAIN Network supports expansion of chain and improves operational efficiency by introducing Sharding mechanisms at different levels and supporting POS consensus mechanism.

The PCHAIN Network executes Sharding in two ways:

> Hierarchical structure of Main chain and child chain

The main chain provides registration, search, storage, deposit and other services for child chains and supports cross-chain transactions. One can create a child chain to complete a specific business logic. This eliminates the need for all business transactions to be done on one chain, greatly reducing the operation and storage pressure on the main chain, while the child chain also eliminates the interference of other services under the original single-chain model.

> For specific chains with more nodes, use transaction-level Sharding.

The PCHAIN Network automatically enables this Sharding mechanism inside the chain when there are more nodes and too many transactions in the chain. Specific implementation is as follows:

> Mark the current time point as the beginning of a new epoch.

> **The PCHAIN Network first separates all the nodes in chains by verifiable random functions**, and sequentially divides them into different groups called the execution group. Through the same process, select some of the 'qualified' nodes to form a separate group called the governance group.

Note: The word 'qualified' means that there is enough PIs and applies to become a member of the Governance Group.

> **The incoming transactions are classified, for example**, by sending transactions to a specific execution group, depending on the different categories of users who initiated the request. The execution group performs and verifies the transaction internally and reaches a consensus at the transaction-level.

> **After a certain time interval, all the execution groups will package and submit the transaction list that has been verified to the governance group.** The governance group collects these transaction lists from different execution groups to reach a consensus on the block-level for forming a block and broadcasting the new block to the whole network.

> **At the end of each epoch, make sure all nodes are synchronised** to the newest block in a consistent state; then enter a new epoch.

In this way, the transaction really has a parallel implementation of the verification, and gets rid of the single-node drawbacks in a single chain. Figure 3 and Figure 4 show transactions entering different

execution groups, respectively, as well as the governance group packaging process:

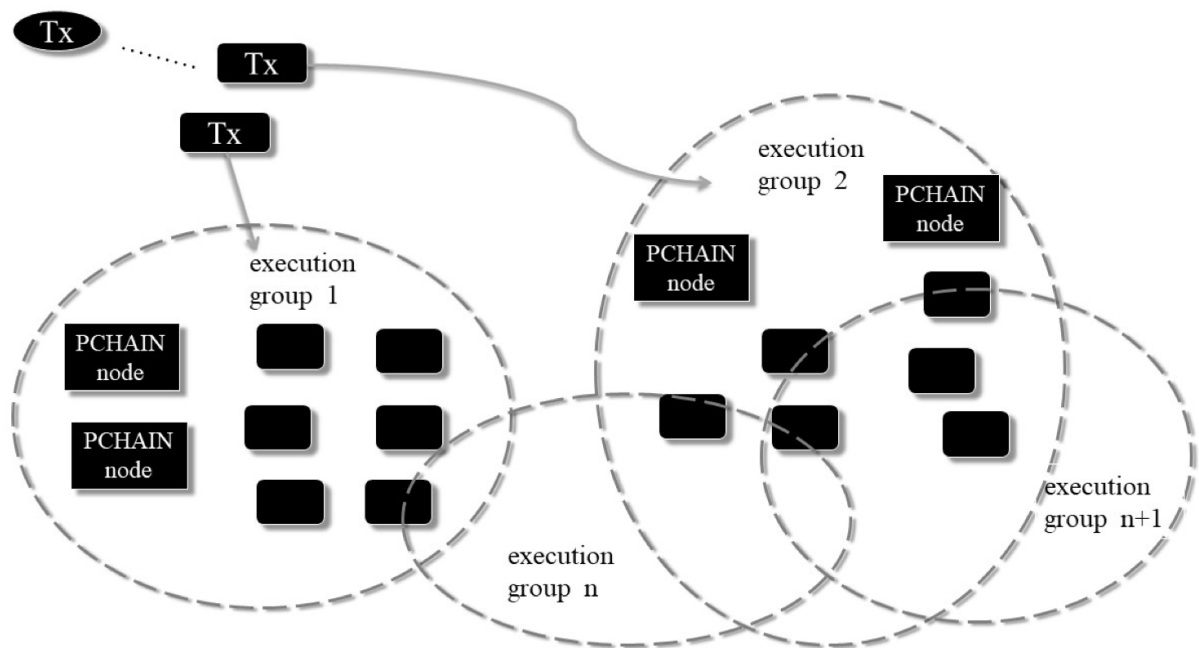


Fig.3 Distributed Transaction Execution

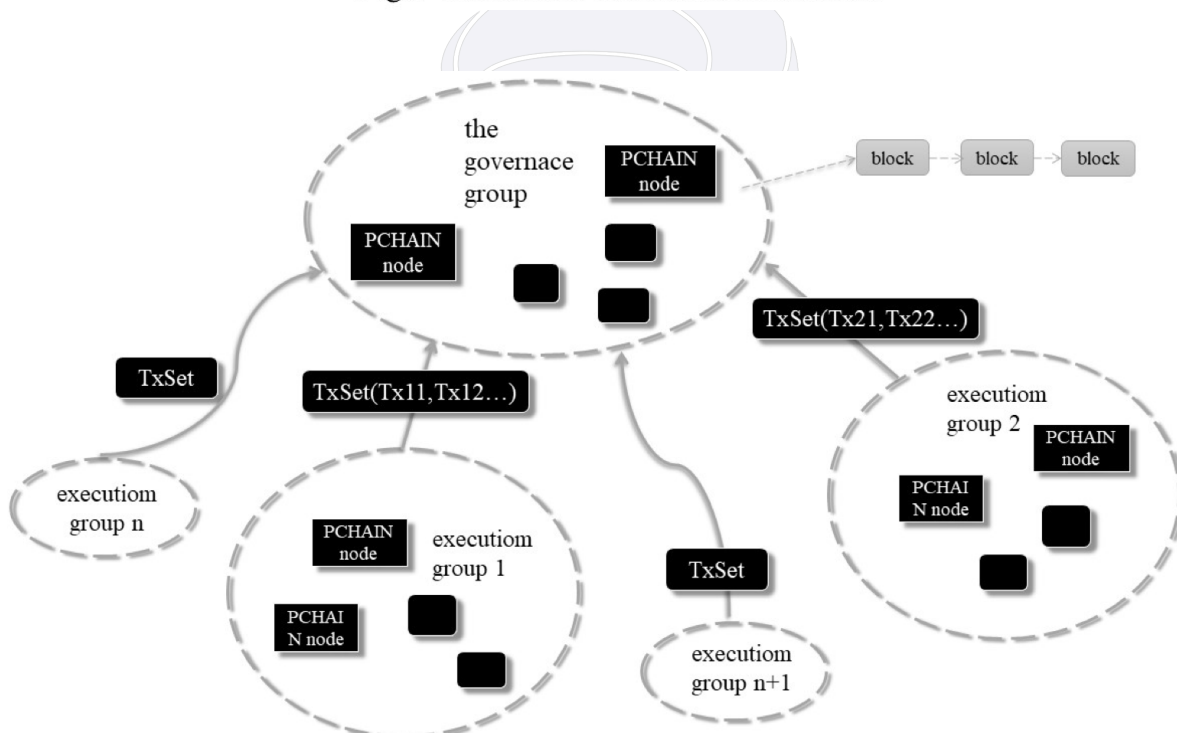


Figure4. Transaction Aggregation and Packing

The PCHAIN Network offers a POS mechanism for each chain:

Currently every chain uses POS as a consensus mechanism in the initialisation by default. POS as a consensus mechanism can greatly reduce the time needed to reach a consensus and package transactions very quickly to form blocks. This is to avoid the consumption of mining time and improve the operation efficiency.

3.1.3 Knowledge Graph and Smart Data

The current development of smart contracts is subject to the acquisition of valid external data. There is a lot of information which needs to be obtained from outside the blockchain, such as weather forecast, traffic information, stock price, exchange rate, etc. In Ethereum, there is a solution like Oracle (Prediction Machine) and smart contracts deployed in the blockchain can obtain the corresponding external information from Oracle. However, there is no standard for the Oracle mechanism at present, so it is difficult to realise the cooperation and exchange among different blockchains.

Knowledge Graph, called Ontology Around 2007, evolves constantly under the impetus of Tim Berners-Lee, the father of the Internet. RDF (Resource Description Framework) is a markup language for describing web resources, and an XML (a subset of the standard general-purpose markup language) application that describes metadata as a data model by using XML syntax and RDF Schema (RDFS). An RDF file contains multiple resource descriptions, where a resource description is composed of multiple statements, and a statement is a triple consisting of resources, attribute types, and attribute values, indicating a property of the resource. The statement in resource description corresponds to the statement of natural language. The resource corresponds to the subject in natural language, the attribute type corresponds to the predicate, and the attribute value corresponds to the object. In the RDF terminology, it is called SPO (Subject, Predicate, Object). SPO includes two forms: entity - attribute - value, entity - relation - entity. These triples combine to form a linked digraph called Knowledge Graph.

The PCHAIN Network writes standard RDF triples into the built-in blockchain knowledge base to form Smart Data. The goal of PCHAIN Smart Data is to generate valuable data, filter the noise of the data, and become an element of the smart contracts Oracle. Smart Data can be widely used in various smart contracts of the PCHAIN Network, as well as other cross chain requests. Smart Data can be an intermediate layer combining blockchain and artificial intelligence, and can facilitate the combination of blockchain and external big data. Therefore, it has broad application prospects, including decentralised distributed Q&A, market forecast, distributed Knowledge Graph building ^[11], social networking, digital identity and so on.

As shown in Figure 5, the node of the PCHAIN Network has built-in the corresponding modules of Knowledge Graph. The PCHAIN Knowledge Graph module consists of a series of endogenous APIs. The main chain of the PCHAIN Network takes the initiative to access a variety of public trust structures, obtains knowledge of related fields, records in a specific form to fill in the Knowledge Graph module and provides APIs internally; Other smart contracts can invoke the services of the Knowledge Graph module to obtain relevant information. At the same time, the Knowledge Graph module will be open to the outside world and maintain the audit system. The access of knowledge providers will be welcome, and the PCHAIN Network will have a certain review of the access service. With the increase in the number of knowledge providers, access to external information will become more and more convenient. Smart Data can support the application of a variety of Knowledge Graph, such as community incentive mechanisms based on blockchains ^[11].

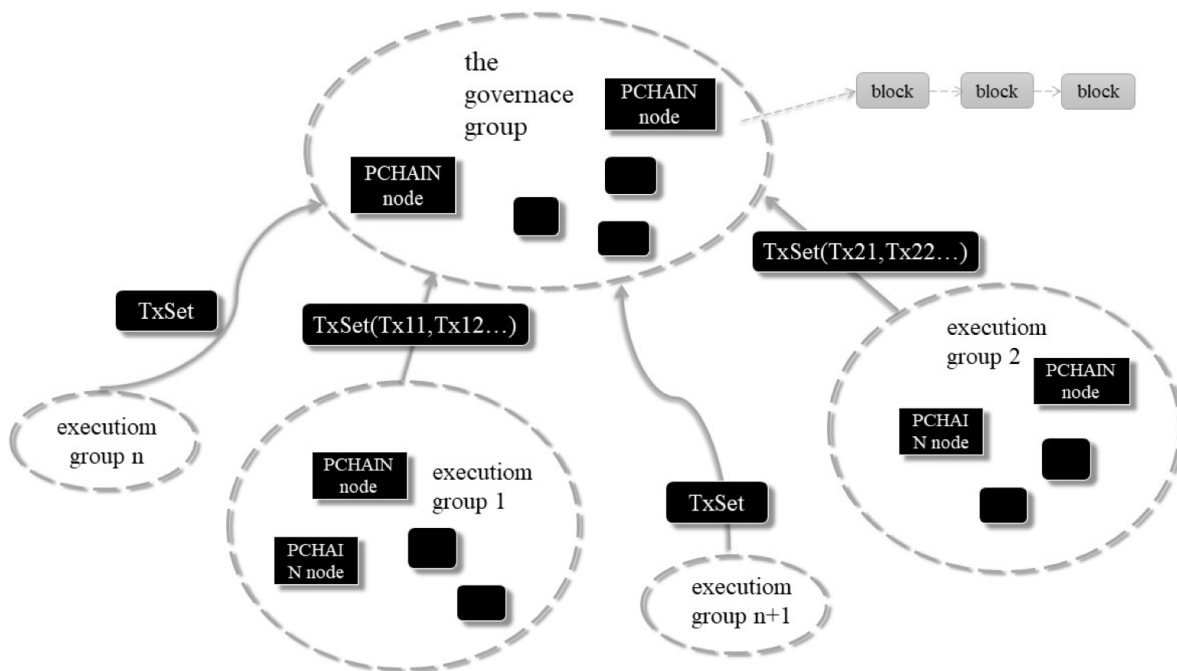


Figure4. Transaction Aggregation and Packing

3.1.4 Supporting EVM

From the implementation of Non-Turing-complete script language to Java, Go and Nodejs, popular blockchains basically support the smart contract; there are many ways which can well meet the needs of their fields. Differently, EVM supports a new language called Solidity. EVM completes the logic of business and takes control of all instructions and thus to resist malicious code logic (such as Infinite Gas), While making reasonable and transparent calculations of the costs of calling smart contracts (through the execution of instructions and memory consumption) by implementing Turing complete Solidity.

In addition, EVM + Solidity has established a complete RPC mechanism which can be accessed through http. EVM + Solidity gets quite perfect support of Nodejs Truffle framework; thus, the Nodejs Truffle framework can used to access it and this provides a great deal of convenience for application programming. These are the reasons why the EVM is popular and has received a great deal of support. With these factors, the PCHAIN Network now uses Solidity + EVM for smart contracts in both its main chain and side chain so that existing EVM users can quickly build new or migrate existing DApp applications on the PCHAIN Network.

3.2 Other Technologies

> Account mechanism

The mechanism of current blockchain account is divided into UTXO and balance. UTXO (Unspent Transaction Output) which is used by bitcoin mainly uses the address to identify related accounts. If counting the available balance of an address is required, the relevant UTXO statistics will have to be collected. Ethereum is based on the balance. The balance becomes an attribute of the account, and the transaction causing the change of amount is recorded separately.

The main purpose of the PCHAIN Network is to deploy and execute DApps, so the PCHAIN Network uses a balance mechanism to directly deduct or increase the balance when transactions occur.

> Multilink consensus

Based on the unique multi-chain structure, transaction requests from multiple chains will enter the system at the same time. All request processing is done on a client which means a client participates in all chain consensus and transaction storage. The process of reaching consensus here is mainly divided into three stages.

1 Choose chains to participate in the consensus

As shown in Figure 6, a client receives requests from each chain and prepares a corresponding set of

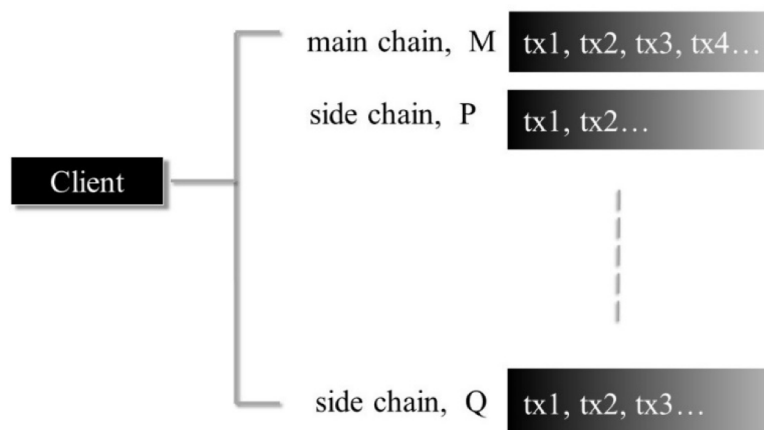


Fig.6 Chain transaction set schematic

transactions for each chain. The main chain M has transactions txm1, txm2, etc., the child chain P contains txp1, txp2, txp3, etc., and the child chain Q includes txq1, txq2, txq3, etc. These transactions are ready to participate in consensus.

Considering the simplest case, where the client participates in the consensus of one chain at some point. The client knows the speed of the block generated by each chain in the previous period and the number of pending transactions of each chain. When the incentive of generating blocks and processing transactions has been determined, the client can determine which chain is most favourable to generate blocks. Participating the chain which generates blocks slowly will have higher success rate. The incentive mechanism described next may prompt the client to participate in the chain of more pending transactions at present. These mechanisms achieve the requirement that each chain should be duly processed according to the number of transactions included in it.

If the client wants to participate in multiple chains consensus, the process is similar to a single chain but needs to start multiple threads to handle respectively. Note that the number of chains that the client can participate in depends on the hardware and software performance of this client.

2) Generating the master node randomly

If there are enough clients expressing the need for building consensus for a certain chain (assuming is P), they form a set of nodes the next operations are in this set. First, selecting a node from the clients in this set randomly to act as the master node.

3) Using BFT to generate blocks and broadcasting to the entire network

After generating the main node, it will enter the BFT protocol and begin to negotiate the transactions of the block chain P that needs to be processed. Then it verifies the vote and finally forms a block. After generating the block, it will be broadcasted to the entire network. The consensus mechanism and other multi-block generation mechanisms all can generate multiple blocks at a same time, but there are differences in the growth mechanism of chains ^{[8][9]}.

> The incentive mechanism of PI

In the PCHAIN Network, PI is used to measure the work of the generated blocks. When blocks are generated, PI incentives will be given to the accounts of all nodes participating in the consensus. When a user invokes the smart contract, statistics are made on the resources required for the command to be invoked to calculate the PI that the user needs to pay. This part of PI will also be given to the accounts participating in the consensus.

> Storage mechanism

The blockchain includes account balance and public key; transactions between accounts; the address and binary code of the contract; the storage and call records of the contract; etc. These transactions will make use of Merkle Tree as the hash tree to verify and are stored in the underlying database (e.g. LevelDB).

> Smart contract upgrade

The Ethereum EVM and Solidity language have been relatively mature and go through a long test at present. As a result, this project chooses to upgrade on the basis of EVM to support smart contracts and upgrade of smart contracts. The solutions for supporting smart contract upgrading are as follows:

- 1) The original smart contract C, its publisher is A, its original storage is S, all calls / transactions are T, and all of these are recorded in the side chain P.
- 2) The new smart contract C1 should be released by A, and C1 will also be deployed in the side chain P. The C1 can increase the storage field, but can not reduce the field, besides, it can add new methods, but can not reduce the method.
- 3) One can choose whether original contract C still can be invoked when the new contract C1 has been deployed. If permitted, C and C1 provide services. Otherwise, all invocations of C will return a prompt, "Version is deprecated, please use the new version". By extension, the subsequent new contract C2 can decide whether C and C1 will be deprecated. The version cannot be reopened to provide services when it has been deprecated.

The underlying mechanism manages different versions of the smart contract. When the smart contract is called, it matches the version of the contract according to the address and select corresponding code to execute on the virtual machine.

> External interface

The PCHAIN Network provides an RPC external service similar to the Ethereum ^[10], which provides a variety of management and query functions, for example, account query, transfer, block and transaction query, contract storage query, etc. REST API based on HTTP is supported currently.

4

ADVANTAGES OF PCHAIN NETWORK



PCHAIN

The PCHAIN Network is the first blockchain that supports Smart Data, based on which knowledge graph is formed and smart contract can be executed within a closed loop. It is the goal for the PCHAIN Network to include well-established tools for the blockchain community and developers to design and build applications and products within the ecosystem thereon.

Every DApp has its own chain that makes it easy to browse and restore transactions

For the DApps of interest, all the relevant data can be obtained through traversing corresponding side chain from origin block to latest block and thus transactions can be restored to provide browsing, which is different from the single chain that still needs to scan all unrelated blocks. In this way, efficiency can be greatly improved.

Supporting large-scale transactions

When the accumulation of transactions of multiple DApp results in a large overall scale, the scale of the corresponding side chain is relatively small. Now every side chain grows itself without affecting the main chain and other side chains.

When the scale of transactions of single DApp is large, the computing power of the whole network focus on the chain because of incentive mechanism to ensure blocks can be produced in time and transactions can be completed as soon as possible.

If there are many DApps and many transactions in each DApps, the system will be busy, and it is hard to avoid congestion. However, this situation is less likely to happen.

New consensus makes computing parallelism

Under the original POW mechanism of the public blockchain, every node is involved in mining and thus there is a high probability to produce new blocks at same time. However, the probability of fork also is high. Under the new consensus mechanism, a group is formed for consensus and the probability of fork is reduced. Meanwhile, with the new mechanism, when a group reaches a consensus, intensive CPU operation is not needed anymore, which can save a lot of power. All nodes can be divided into many small groups and each group has a consensus on one chain, which is concurrent consensus. Besides, groups have intersection, i.e., a node may join the consensus of many chains. Therefore, the computing power is fully utilised and the growing of the PCHAIN Network is smooth.

Supporting smart contract upgrade

The PCHAIN Network supports the upgrade of smart contracts through the methods above.

High fault tolerance

In building the PCHAIN Network, main chain just records, and errors will not occur in theory. When some error happens in a child chain, main chain and other child chains are not affected and only corresponding child chain needs to be corrected.

Expansibility

It is easy to deploy a new DApp with expanding a new side chain. Under the consensus mechanism, the growing of new chain does not cause much burden.

5

APPLICATION SCENARIOS OF THE PCHAIN NETWORK



5.1 Application Scenarios of the PCHAIN Network

The PCHAIN Network is the first native multi-chain system which supports EVM which makes it possible to apply blockchain at large scale.

5.2 Application Scenarios

The PCHAIN Network can be applied to many scenarios based on smart contracts:

> Distributed artificial intelligence, distributed question and answer, big data transaction.

> Digital asset transaction - provide reliable records of digital asset transactions. Digital assets include digitised certificate of asset, or they are digital network virtual assets (various game props, token, etc.) Smart contracts can record every operation such as login, transfer and sale in blockchain. These records are open and transparent to all participants which offer convenience for censorship.

> Game – Set rules for the game to prohibit cheating

Here are mainly refers to the games of chance. After the rules are established, the game process and the results will be carried out strictly in accordance with the rules, thus avoiding the artificial influence on the results. (e.g. the lottery game and the dice game).

> Notary system - Provide a promise with a basis that cannot be tampered with.

In the notary system, the authenticity of the basis is very important. There will not be any questions on the authenticity of the basis if it is recorded in the blockchain.

> Trace sociality – record all the words that have been said.

Most of the existing social records will be cleared after a long time. There are also some social scenarios that support the system of 'burn after reading'. However, as for some serious discussions, there may be a purpose to store them forever and view them whenever needed which can be achieved with the smart contracts combined with blockchain.

> Full-cycle collaboration system – it works on the whole process, from planting, harvest to entering market.

This system tracks the whole Green ecosystem chain, from farming, to slaughter, to transportation and finally to sales. In the field of logistics supply chain, the whole process will also be tracked from product production to transportation to shelf and finally to the hands of consumers. These full - cycle collaboration systems enable the participants in each part to share data and increase collaboration and trust in them.

6

DEVELOPMENT PLAN



PCHAIN

6.1 Token sale and Management of sale proceeds

6.1.1 PI Token

The native digital cryptographically-secured utility token of the PCHAIN Network (PI) is a major component of the ecosystem on the PCHAIN Network, and is designed to be used solely as the primary token on the network. PI will initially be issued by the Distributor as ERC-20 standard compliant digital tokens on the Ethereum blockchain, and these will be migrated to tokens on the PCHAIN native chain when the same is eventually launched.

PI is a non-refundable functional utility token which will be used as the unit of exchange between participants on the PCHAIN Network. The goal of introducing PI is to provide a convenient and secure mode of payment and settlement between participants who interact within the ecosystem on the PCHAIN Network. PI does not in any way represent any shareholding, participation, right, title, or interest in the Foundation, its affiliates, or any other company, enterprise or undertaking, nor will PI entitle token holders to any promise of fees, dividends, revenue, profits or investment returns, and are not intended to constitute securities in Singapore or any relevant jurisdiction. PI may only be utilised on the PCHAIN Network, and ownership of PI carries no rights, express or implied, other than the right to use PI as a means to enable usage of and interaction with the PCHAIN Network.

PI is required as virtual crypto “fuel” for using certain designed functions on the PCHAIN Network, providing the economic incentives which will be consumed to encourage participants to contribute and maintain the ecosystem on the PCHAIN Network. Computational resources are required for running various applications and executing transactions on the PCHAIN Network, as well as the validation and verification of additional blocks / information on the blockchain, thus providers of these services / resources would require payment for the consumption of these resources (i.e. “mining” on the PCHAIN Network) to maintain network integrity, and PI will be used as the unit of exchange to quantify and pay the costs of the consumed computational resources. When blocks are generated, PI incentives will be given to the accounts of all nodes participating in the consensus. When a user invokes the smart contract, statistics are made on the resources required for the command to be invoked to calculate the PI that the user needs to pay. This part of PI will also be given to the accounts participating in the consensus.

PI is an integral and indispensable part of the PCHAIN Network, because without PI, there would be no incentive for users to expend resources to participate in activities or provide services for the benefit of the entire ecosystem on the PCHAIN Network. Users of the PCHAIN Network and/or holders of PI which did not actively participate will not receive any PI incentives.

6.1.2 Token sale

The sale proceeds of the private and public token sale of PI will be applied towards the development of the PCHAIN Network.

(1) The Distributor of PI shall be an affiliate of the Foundation.

The Distributor shall issue a total of 2,100,000,000 (2.10 billion) PI will be issued, and sell 35% of these tokens.

(2) Sale and Distribution.

Among all PI, 32.62% is used for private sale. 2.38% is used for crowd sale. 25% is reserved for the core team and early contributors. 25% is used for community development. The remaining 15% is used for POS mining.

Proportion	Amount (million)	Use	Illustration
32.62%	685	Private sale	To develop and operate projects; staff salaries, development of hardware and software procurement, office expenses, legal / tax and other expenses
2.38%	50	Crowd sale	To develop and operate projects; staff salaries, development of hardware and software procurement, office expenses, legal / tax and other expenses
25%	525	Team and early contributors	Incentives for the members of the team and the early contributors
25%	525	Community building	To build the PCHAIN foundation and the PCHAIN community
15%	315	POS mining	To motivate the proof of stake

Token sale phase consists of private sale stage and crowd sale stage. Crowd sale is only offered to the citizens of countries and regions permitted by relevant laws and regulations. The contributions in the token sale will be held by the Distributor (or its affiliate) after the token sale, and contributors will have no economic or legal right over or beneficial interest in these contributions or the assets of that entity after the token sale. The start time of private sale depends on the development and operation of the first round.

In particular, you understand and accept that PI:

- i. is non-refundable and cannot be exchanged for cash (or its equivalent value in any other virtual currency) or any payment obligation by the Foundation or any affiliate;
- ii. does not represent or confer on the token holder any right of any form with respect to the Foundation (or any of its affiliates) or its revenues or assets, including without limitation any right to receive future dividends, revenue, shares, ownership right or stake, share or security, any voting, distribution, redemption, liquidation, proprietary (including all forms of intellectual property), or other financial or legal rights or equivalent rights, or intellectual property rights or any other form of participation in or relating to the PCHAIN Network, the Foundation, the Distributor and/or their service providers;
- iii. is not intended to represent any rights under a contract for differences or under any other contract the purpose or pretended purpose of which is to secure a profit or avoid a loss;
- iv. is not intended to be a representation of money (including electronic money), security, commodity, bond, debt instrument or any other kind of financial instrument or investment;
- v. is not a loan to the Foundation or any of its affiliates, is not intended to represent a debt owed by the Foundation or any of its affiliates, and there is no expectation of profit; and
- vi. does not provide the token holder with any ownership or other interest in the Foundation or any of its affiliates.

6.1.3 The Use of Sale proceeds

The sale proceeds will be allocated as follows:

- > **65%** - The PCHAIN Network system research and development, including wages, software and hardware procurement, etc.
- > **20%** - Carrying out the marketing campaign, including wages, promotion expenses, etc.
- > **10%** - Carrying out operations, including holding all kinds of activities, etc.
- > **5%** - Conducting legal compliance, including the payment of counsel fees, etc.

6.1.4 PCHAIN Foundation

PCHAIN Foundation Ltd. (the **Foundation**) is a non-profit organisation. Through the establishment of relevant departments, the Foundation is committed to managing the project to develop the PCHAIN Network, development of the open source community, and the feature recommendations of the PCHAIN Network. At the same time, it is committed to the finance management, team building and external relations of the project to make the project run better. The ultimate decision making body of the Foundation would be the Board of Directors.

The Foundation plans to establish the following departments which would report to the Board of Directors:

General Executive Department

The Foundation will set up the general executive department, which is responsible for the normal operation of the Foundation, including departmental establishment, function adjustment, personnel recruitment and external communication.

DApp Management Department

DApp management department is responsible for tracking and managing all the DApp added to the PCHAIN Network, and communicating with DApp developers (companies or individuals), so as to ensure the PCHAIN Network can provide the best service for DApp development and deployment.

Code Review Department

Due to the attack of hackers, even very large blockchain projects encounter a large number of asset loss incidents. Here, learning from other communities, a code review committee is set up to review all the code submitted to the open source community, especially the part involved in the circulation of PI.

Administration and Public Relations Department

Responsible for financial and personnel management, that is, to coordinate and master the expenditure of the project and the change of personnel. When the project has a major release, or an influential event happens, it is responsible for advocacy and response.

6.1.5 System Use

There are two main uses of the system of the PCHAIN Network:

Promoting the combination of smart contract and blockchain

After the establishment of the PCHAIN Network, a certain amount of cost is required to pay while combining smart contract with blockchain and invoking smart contract, which is settled in PI. After the PCHAIN Network is built, it is envisaged that there will be an increasing number of applications on the chain; as more and more transactions will be carried out on the chain, accordingly there would also be increased demand for PI. In addition to mining, PI can also be obtained in the secondary market (however, to the extent a secondary market or exchange for trading PI does develop, it would be run and operated wholly independently of the Foundation, the Distributor, the sale of PI and the PCHAIN Network. Neither the Foundation nor the Distributor will create such secondary markets nor will either entity act as an exchange for PI).

Providing PCHAIN Network-based services

As the provider of the platform of the PCHAIN Network, the Foundation has the leading power to the core technology and application development interface of the PCHAIN Network. The Foundation can provide convenient products based on the PCHAIN Network, such as query platform, and also provide technical solutions for the DApp demand side which makes the development of DApp smoother, for example, the upgrade of smart contracts.

For now, 3 international well-known large blockchain application projects have been planned to be established based on the PCHAIN Network. For example, cultural blockchain project built by international famous music producer has been recognised by Japan's Blockchain Association and reported by Japan's rich television, Phoenix, People's Network, Sina, Sohu, Tencent, Netease and many other media; the research of anti-quantum blockchain in cooperation with State Key Laboratory of Tsinghua University has been recognised by many academicians. In addition, a number of blockchain application projects are underway.

6.1.6 Risks

You acknowledge and agree that there are numerous risks associated with purchasing PI, holding PI, and using PI for participation in the PCHAIN Network. In the worst scenario, this could lead to the loss of all or part of the PI which had been purchased.

Uncertain Regulations and Enforcement Actions

The regulatory status of PI and distributed ledger technology is unclear or unsettled in many jurisdictions. The regulation of virtual currencies has become a primary target of regulation in all major countries in the world. It is impossible to predict how, when or whether regulatory agencies may apply existing regulations or create new regulations with respect to such technology and its applications, including PI and/or the PCHAIN Network. Regulatory actions could negatively impact PI and/or the PCHAIN Network in various ways. The Foundation (or its affiliates) may cease operations in a jurisdiction in the event that regulatory actions, or changes to law or regulation, make it illegal to operate in such jurisdiction, or commercially undesirable to obtain the necessary regulatory approval(s) to operate in such jurisdiction. After consulting with a wide range of legal advisors and continuous analysis of the development and legal structure of virtual currencies, the Foundation will apply a cautious approach towards the sale of PI. Therefore, for the token sale, the Foundation may constantly adjust the sale strategy in order to avoid relevant legal risks as much as possible. For the token sale the Foundation is working with Tzedek Law LLC, a boutique corporate law firm in Singapore with a good reputation in the blockchain space.

Inadequate disclosure of information

As at the date hereof, the PCHAIN Network is still under development and its design concepts, consensus mechanisms, algorithms, codes, and other technical details and parameters may be constantly and frequently updated and changed. Although this white paper contains the most current

information relating to the PCHAIN Network, it is not absolutely complete and may still be adjusted and updated by the PCHAIN team from time to time. The PCHAIN team has no ability and obligation to keep holders of PI informed of every detail (including development progress and expected milestones) regarding the project to develop the PCHAIN Network, hence insufficient information disclosure is inevitable and reasonable.

Competitors

Various types of decentralised applications are emerging at a rapid rate, and the industry is increasingly competitive. It is possible that alternative networks could be established that utilise the same or similar code and protocol underlying PI and/or the PCHAIN Network and attempt to re-create similar facilities. The PCHAIN Network may be required to compete with these alternative networks, which could negatively impact PI and/or the PCHAIN Network.

Loss of Talent

The development of the PCHAIN Network depends on the continued co-operation of the existing technical team and expert consultants, who are highly knowledgeable and experienced in their respective sectors. The loss of any member may adversely affect the PCHAIN Network or its future development. Further, stability and cohesion within the team is critical to the overall development of the PCHAIN Network. There is the possibility that conflict within the team and/or departure of core personnel may occur, resulting in negative influence on the project in the future.

Failure to develop

There is the risk that the development of the PCHAIN Network will not be executed or implemented as planned, for a variety of reasons, including without limitation the event of a decline in the prices of any digital asset, virtual currency or PI, unforeseen technical difficulties, and shortage of development funds for activities.

Security weaknesses

Hackers or other malicious groups or organisations may attempt to interfere with PI and/or the PCHAIN Network in a variety of ways, including, but not limited to, malware attacks, denial of service attacks, consensus-based attacks, Sybil attacks, smurfing and spoofing. Furthermore, there is a risk that a third party or a member of the Foundation or its affiliates may intentionally or unintentionally introduce weaknesses into the core infrastructure of PI and/or the PCHAIN Network, which could negatively affect PI and/or the PCHAIN Network. Further, the future of cryptography and security innovations are highly unpredictable and advances in cryptography, or technical advances (including without limitation development of quantum computing), could present unknown risks to PI and/or the PCHAIN Network by rendering ineffective the cryptographic consensus mechanism that underpins that blockchain protocol.

Other risks

In addition, the potential risks briefly mentioned above are not exhaustive and there are other risks (as more particularly set out in the Terms and Conditions) associated with your purchase, holding and use of PI, including those that the Foundation cannot anticipate. Such risks may further materialise as unanticipated variations or combinations of the aforementioned risks. You should conduct full due diligence on the Foundation, its affiliates and the PCHAIN team, as well as understand the overall framework, mission and vision for the PCHAIN Network prior to purchasing PI.

6.2 Team Members

A global team of internationally recognised experts with years of experiences in the blockchain industry will oversee the research, development and management of the project to develop the PCHAIN Network. Their roles and relevant experiences are introduced in below.

Feng Cao (Vision & Algorithm)

Dr. Feng Cao graduated from Fudan University in Computer Science. He is the inventor of the 1st International Blockchain patent from China, the Co-Founder of ChinaLedger, the most influential blockchain alliance of China, the Chief Scientist of Blockchain Application Committee in China Federation of Logistic and Purchasing (The 1st Gov Association in Industry), and a Senior Fellow of the China Blockchain Research Alliance. Dr. Feng Cao and his team successfully accomplished the 1st blockchain-based assets earning rights transfer in the world in September 2016, which is also the 1st Financial Blockchain Transaction in China. He is a bold player in financial blockchain industry in China. He found several blockchain startups that attracted investment from top funds and received a few financial blockchain innovation grand awards. He was the Chief Scientist of Internet Finance and co-chair of the patent review board in IBM Research-China. Dr. Feng's innovative achievements have been successfully adopted in China, US and other 150 countries. He won IBM Global Technical Achievement Awards three times. He published 22 papers in ACM/IEEE top conference and 30+ international patents.

Haojin Lv (Architecture)

Haojin is a Master of Computer Science with Tsinghua University. He is a blockchain technology pioneer of China and responsible for a few global blockchain projects as team leader. He has worked for several leading international company such as SAP Shanghai Lab, with rich commercial experiences in product optimisation and innovation, system level software design and implementation, distributed cluster deployment, big data storage, mining and visualisation, large-scale software development process and quality control.

Zhanfeng Ma (Blockchain Storage and Optimisation)

Zhanfeng is a Master of Computer Science with Xi'an Jiaotong University. He is a senior software engineer and expert of core blockchain technologies. He has over 10 years working experiences at Global Top 500 companies with focus on database systems and distributed systems. He holds a few US patents in database area and has rich experiences in system development and performance optimisation.

Kai Zheng (In-memory Data Management)

Dr. Kai Zheng is a Full Professor of Computer Science with University of Electronic Science and Technology of China. He received his PhD degree in Computer Science from The University of Queensland in 2012. He has been working in the area of spatial-temporal databases, uncertain databases, social-media analysis, in-memory computing and blockchain technologies. He has published over 100 papers in prestigious journals and conferences in data management field such as SIGMOD, ICDE, VLDB Journal, ACM Transactions and IEEE Transactions. He is authoring the book "Blockchain Technology and Practices". His Google Scholar citation is over 1400 with H-index = 21. He was the recipient of Australian Discovery Early Career Research Award in 2013, and Best Paper Award of International Conference on Data Engineering (2015). He was the Program Committee Co-chair of the 18th APWeb Conference and General Co-chair of the 22nd DASFAA Conference. He is a PC member of over 10 top conferences and invited reviewer for the most prestigious journals.

Zhihong Chong (Knowledge Graph)

Dr. Zhihong Chong is an associate professor in the college of computer science and engineering at Southeast University. He was visiting scholars of University of New South Wales in Australia and University of Illinois Research Center in Singapore. He has focused on theoretical and applied research and development of blockchain, big data, knowledge graph and deep learning. He has led and participated in the National Natural Science Foundation, National 863, the national key defence projects, and more than 10 enterprise cooperation projects such as HUAWEI, China Electronics Group and Focus Technology Co. Ltd. He has published more than 10 papers in major conferences and journals in the field of database and artificial intelligence.

Zhenjie Zhang (Query Speedup and Indexing)

Dr. Zhenjie Zhang received PhD degree of computer science from National University of Singapore and is now a senior research scientist at the University of Illinois Advanced Digital Science Center. His research areas include database query, indexing of high dimensional data mining and causality analysis, data mining and machine learning in privacy protection, high-speed data stream processing, and elastic cloud computing technology. He has published over 50 prestigious papers in databases, data mining and machine learning fields, including SIGMOD, VLDB, ICML, VLDB Journal and IEEE TKDE, which have more than 1800 Google Scholar citations. He was the PC co-chair of International Data Privacy Seminar (2013) and Asia-Pacific Web Conference (2015), and program committee at over 10 top international conferences. He won President Award of National University of Singapore in 2008, Early Career Research Award of the IEEE Data Engineering Technology Committee (TCDE) in 2015, and the best paper award at the IEEE International Conference on Cloud Computing in 2013.

Ruosong Xu (CMO)

Ruosong is the former chief marketing officer of GXS (Gong Xin Bao). He received the Bachelor of physics at Fudan University. He has worked for HUAWEI, China Mobile and Tong Dun Technology with extensive experience in the field of big data, credit risk control, communication and IoT.

6.3 Road Map

- ◆PCHAIN Position Paper completed -- T
- ◆Dewdrop stage -- T + 7 months
- ◆Complete the development of the PCHAIN Network core system which supports account system and deployment of smart contract, publish technical white paper, conduct a test online.
- ◆River Stage -- T + 12 months
- ◆Publish the product on the major network, complete document of external API and wiki.
- ◆Sea Stage - -T + 15 months
- ◆Expand the capabilities of knowledge graph and Smart Data Blockchain and support external development interfaces.
- ◆Ocean stage -- T + 18 months
- ◆Introduce several blockchain application projects to form Knowledge Graph Blockchain Alliance.

After examining the results of the 18-month milestone, a new plan will be made for the specific development, so that the PCHAIN Network can maintain the correct R & D and service direction and maintain the leading position in technology and market.

7

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PCHAIN