Grid - A multi-Chain parallel processing Blockchain framework

Grid Foundation

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Abstract

The Blockchain community has witnessed rapid development in the past few years. Firstly emerged as a secured decentralized P2P transfer mechanism, Satoshi's Bitcoin has proved the concept of decentralized crypto-currency. Ethereum then contributed the community with successful implementation of versatile "Smart Contracts". It unleashed great potential of Blockchain into numerous applications and industries. As a result, many alternative crypto assets have been built upon these Blockchains. This is only the dawn of Blockchain, as the boundary between Blockchain Community and business world are yet to be broken. We are at a turning point that the next phase of Blockchain will lead the integration between Blockchain and physical business world, and inevitably bring in much more solid digital assets.

In order to enter the new paradigm of Blockchain, there needs to be a versatile Operating System designed to meet commercial needs. This Chain has to possess:

1. High efficiency and scalability to handle transactions/ applications at commercial scale
2. High flexibility to customize Smart Contracts to meet the needs of different industries
3. High adaptability to new technology in the future
4. High compatibility to allow communication across public and private Chains

This white paper introduces a highly efficient Blockchain architecture which incorporated State-of-Art IT design principles and technologies to bring it up to commercial standard. We envision it creates a "Linux eco-system" for Blockchain. We focus on defining and providing the most basic, essential and time-consuming components of the system and making significant improvements based on existing Chains in the market. The system allows developers to customize it to meet their own needs, particularly commercial requirements for various industries. It will contain the below main features:

1. Introduces the concept of Main Chain and multi-layer Side Chains to handle various commercial scenarios. One chain is designed for one use case, distributing different tasks on multiple chains and improve processing efficiency
2. Enables Grid to communicate with external Blockchain systems via messaging, e.g. Bitcoin, Ethereum
3. Permits parallel processing for non-competing transactions and cloud-based service
4. Defines basic components of minimum viable Block and Genesis Smart Contract Collection for each Chain to reduce data complexity and achieve high customization
5. Permits stakeholders to approve amendments to the protocol, including redefining the Consensus Protocol; Permits Side Chains to join or exit from Main Chain dynamically based on Consensus Protocol, therefore introducing competition and incentive to improve each Side Chain

Contents

1. Current Blockchain systems

At present, the Blockchain technology and its application are developing exponentially. Many industries are experimenting how to migrate from traditional network architecture to Blockchain-based network architecture. However, current Blockchain systems are not yet capable and efficient of functioning as a versatile Operating System and supporting various applications on it. Bitcoin as the pioneering Blockchain design is more similar to an application. Ethereum has demonstrated some characteristics of an Operating System – developers can program applications as Smart Contracts on Ethereum, the Chain provides programming language and Adaptor in the form of Solidity, etc. However, from the perspective of modern Operating System, Ethereum still has several drawbacks, such as lack of decoupling between system components, lack of customization of most modules and insufficient system interfaces, etc.

This approach lacks of the holistic design of the system and not yet commercially viable for cross-industry application scenarios. It greatly limits the commercial application of Blockchain technology.

1.1. General Blockchain vs. complex business scenarios

The current challenge impeding large scale commercial adoption of Blockchain technology is its inability to meet the requirements of various complex business scenarios. These scenarios often have different characteristics in terms of process and execution logic, requiring distinctive solutions. Therefore a "one fits all" Blockchain faces tough dilemma to balance needs from different business scenarios. For example, ticket issuance is of high frequency which high TPS in the system is desirable; Digital legal contract on the other hand emphasizes high security and reliability.

There are two general solutions to meet these requirements:

i. Use Blockchain as solely a database and do not deal with business logic. This approach aims to handle any business scenario and maintain compatibility. Many Chains similar to Bitcoin use this approach. They record business-related data and hash, into a transaction output "OP_RETURN", stored in the Blockchain.

ii. Record various complex Smart Contracts onto one single Blockchain. These Smart Contracts are to serve pre-defined business models from various scenarios. Ethereum represents this type of Chains. Due to the fact that all Smart Contracts are written on one single Chain, the Blockchain becomes complex, requires high maintenance cost and lacks of effective structure to execute Smart Contracts.

1.2. Performance limitation of linear processing

As a Blockchain is more and more widely used, especially handling large scale transactions, its transaction processing capacity is under tremendous pressure using linear processing, resulting in the bottleneck of network performance. Current Blockchain systems face multiple challenges to improve its capacity, sometimes at the expense of transaction efficiency. For example, Bitcoin transaction fee is getting more expensive as transaction volume increases and a large backlog waits for confirmation for a long time. Ethereum faces increasing number of congestions during ICOs.

However, in traditional IT architecture, modern techniques such as partitioning, sharding and decentralized architecture, have been proven highly effective to improve system performance.

On the other hand, the concept of parallel task processing has not been adopted to increase efficiency. When a Block contains large amount of transaction data and complex Smart Contracts, linear transaction has hit its efficiency limitation of Block formation and verification.

1.3. Data complexity and redundancy

As described in Section 1.1, one universal Blockchain is used to meet the needs of different business scenarios. The drawback of universal Blockchain system is over-complex Smart Contracts and Consensus Protocol, lack of tailored solution to specific business scenarios and redundant data.

1.4. Dilemma of Protocol update

Despite the increasing adoption of Blockchains, it is still at nascent stage. Significant improvement and innovation are yet to come in the future. These updates are essential to evolve Blockchains and keep up with ever-changing environment and stakeholder's interest. The large variety of stakeholders within the eco-system is usually hard to reach Consensus without effective governance mechanism, leading most current Protocol updates into impasse or disputes. One vivid example is Bitcoin as the community found difficult to reach agreement for introduction of many new features in recent years.

1.5. Inflation of Block

The more successful a Blockchain system is, the higher its maintenance cost. Running through a Current Bitcoin full node requires over 130G space, and over 180G for Ethereum. This situation will not be improved in the future. As more users adopt Blockchain and conduct more transaction activities, the inflation of Block will accelerate and maintenance cost will grow even higher. Actions have to be taken to alleviate the vicious cycle.

1.6. Inefficient Point-to-Point communication support

Existing Blockchains are mainly communicated based on broadcast network. And the support for P2P communication is inefficient and insecure. One example is that if a certain data is only concerned by one group of users, these data should be communicated among finite nodes, instead of broadcasted to all nodes.

1.7. Pending breakthrough for Cross-Chain communication

Existing Blockchain systems have experimented cross-chain communication to process related business logics. However the outcomes are still unsatisfactory. Current cross-chain communication includes centralized mechanism and HTLC mechanism. Centralized mechanism deviates from the idea of Blockchain, leading to lack of trust, single node failure, single node bottleneck and only applicable to certain scenarios. The HTLC mechanism can only deal with specific scenarios such as asset exchange, and impose strict requirements on the protocols and Consensus Protocols of communicating chains. And implementation of such mechanism is usually complex. As a result, it is imperative to address the two critical issues, i.e. Protocol compatibility and data exchanging format compatibility.

2. Key objectives of Grid

2.1. A highly customizable OS for commercial use

We envision Grid as a highly efficient and customizable OS and will become the "Linux system" in Blockchain community. Take Linux as an example, Linux Kernel and various Linux versions constitute the large and successful Linux family. Linux Kernel resolves the most fundamental, critical and time-consuming parts, allowing other developers to make customized systems based on application scenario and customer needs. This makes Linux the most popular server OS, supporting all kinds of industries.

The same idea has been incorporated into Grid design. Firstly, we define and implement the Grid Kernel which includes fundamental functions of a Blockchain system, namely the minimum viable Blockchain system. Secondly, we develop a "shell" as the basic interactive interface to the Core. Users can either use the complete Blockchain OS, or rapidly develop a customized OS based on the Core via redefining the Core through interfaces.

2.2. Cross-Chain interaction

Grid will interact with Bitcoin, Ethernet, and other Blockchain systems. Cross-chain interaction with mainstream Chains will be realized via messaging. And it will also form an endogenous multi-level cross-chain structure based on cross-Chain interaction, in order to share the digital assets, users and information.

2.3. Performance improvement

In traditional IT architecture, distributed structure is the popular solution to debottleneck capability limitation. Blockchain system should also support distributed parallel processing, e.g. parallel processing multiple transactions with non-competing data to improve transaction efficiency. In addition, when one chain has become too complex to be effectively processed, it should be split into parallel Chains to offload the traffic.

The initial design of an effective Blockchain should focus on solving specific business scenarios, rather than combining all Smart Contracts on one single Chain. In order to deliver optimal performance based on business requirement, the Chain has to provide effective and customized data structure, Smart Contract logic, and Consensus Protocol specifically for the targeted objective. By doing so, the components and data within the Chain will be much simpler and easy to manage.

In addition, Grid can define the mechanism to trigger snapshot in the system. Upon defined cycle, it takes a snapshot of current data and trims detailed transaction data. A new Genesis Block will include all subsequent transactions. This idea has been adopted in traditional IT database architecture to alleviate system inflation.

2.4. Protocol update

Upon the Genesis of Blockchain, the voting and update mechanism has to be clearly defined. With introduction of Consensus Protocol to include new features in the future, it avoids impasse and dispute over Protocol update.

2.5. Private Chain module

Considerable number of businesses is interested in Private Chain to leverage the advantage of Blockchain technology. These private Chains usually exist in isolation without any connection to external eco-system or other businesses. We provide a model similar to Amazon cloud service "AMI", where users can rapidly create an independent Chain using Private Chain module and obtain full ownership of it.

3. Grid system

3.1. Grid architecture

We introduce the Grid consisting of one Main Chain and multiple Side Chains attached to the Main Chain (Figure 1). The difference from traditional Single Chain system is that Grid is a "branched eco-system" where Main Chain works as the backbone of the system and connects to multiple Side Chains (can be even multiple layers).

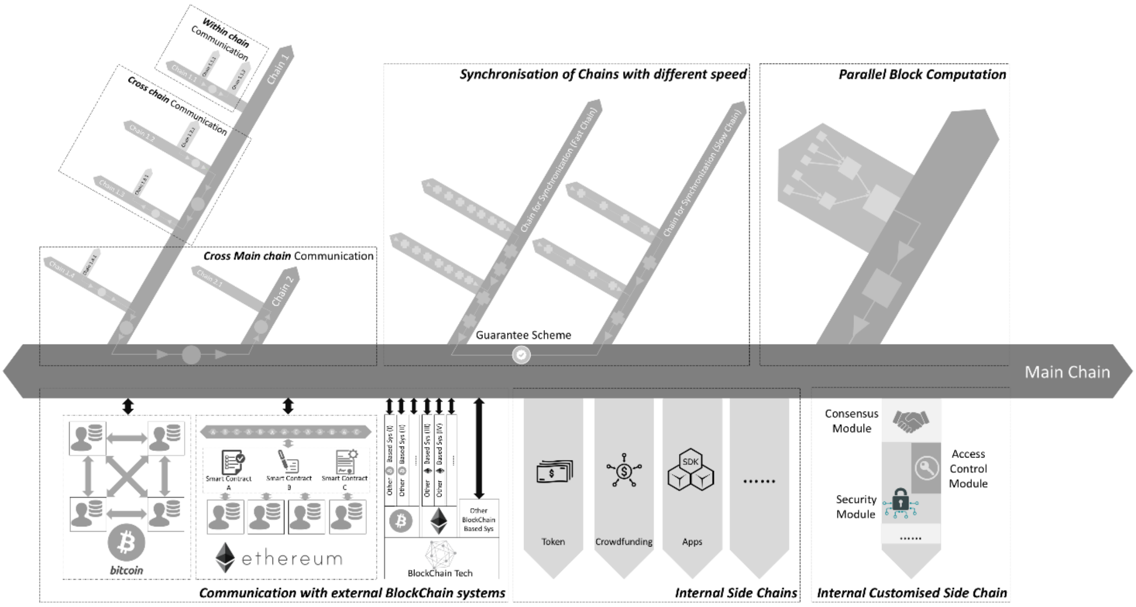
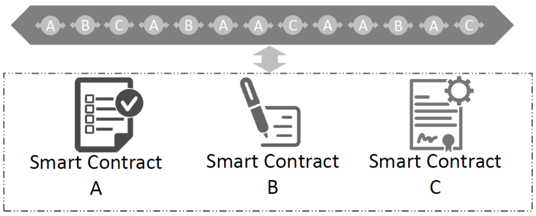


Figure 1: Overview of Grid structure

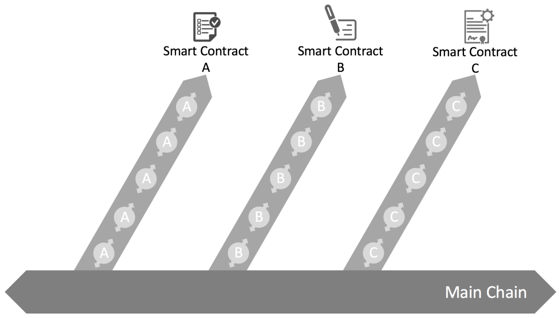
Grid connects with Bitcoin, Ethereum, and other Blockchain systems via adaptor, in order to be compatible with existing popular eco-systems. Grid Side Chains include System built-in Grid Side Chains and other chains generated based on the Grid operating system or Grid kernel. The Main Chain interacts with the Side Chains by Side Chain dynamic indexing.

3.1.1. One Chain One Contract

Compared with traditional structure of "one Chain to any types of Contracts", Grid imposes "one Chain to one type of Contract". As illustrated in Figure 2 (b), each Chain dedicates to one type of transaction and resolves one type of business problems. This makes the whole structure and data simpler and much more tailored to commercial requirements. By adding new Side Chains to Grid, Grid will be empowered with new functions, while maintaining an "easy to manage" structure.



(a) one Chain to any types of Contracts



(b) in Grid, one Chain to one type of Contract

Figure 2: A Blockchain with complex data structure

3.1.2. Side Chain dynamic indexing

Grid is a dynamic system, where all Side Chains are attached to the Main Chain. The Main Chain contains the index of the system boundaries (recording what are the Side Chains attached). They interact with each other via the Main Chain in the form of Merkle tree and verification through external information input. As such, Side Chains do not interact directly, allowing Side Chains to be added or excluded in Grid system.

3.1.3. "Tree branch" Side Chain extension

As illustrated in Figure 3, Grid defines a "Main Chain and Side Chain structure". Theoretically speaking, any Side Chain can also be connected with a few sub Chains underneath, acting as a "Main Chain" in one part of the system. This creates the branches structure in the system that allows Grid to extend both horizontally and vertically. This idea is similar to partitioning and sharding in database architecture. It allows each shard to perform specific functions and when one shard is too large to manage, it can be further broken down to multiple shards. In Grid, this corresponds to Side Chains.

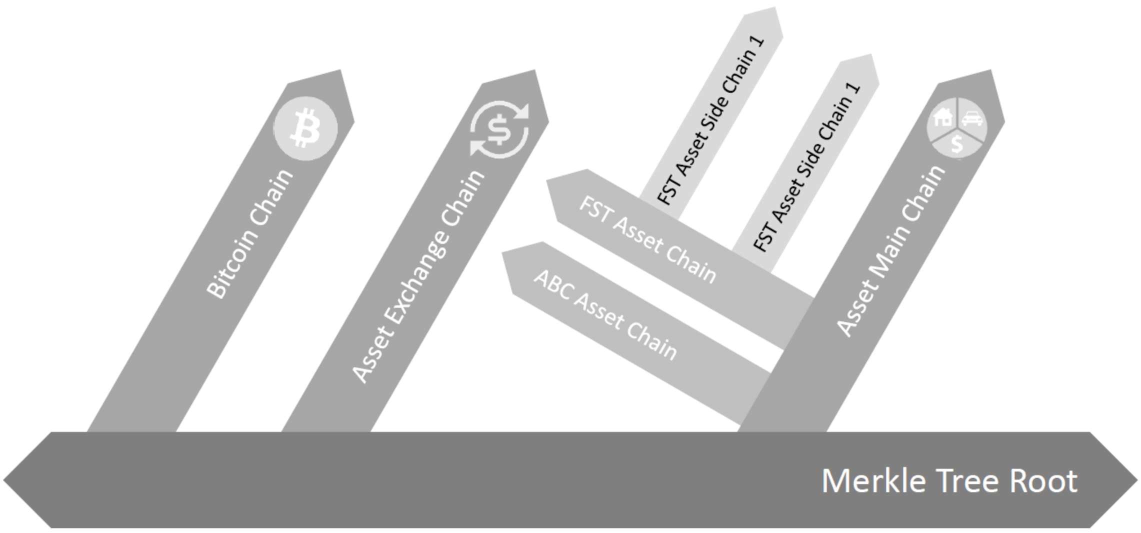


Figure 3: Multi-layer Side Chain structure

3.2. Grid Main Chain

Grid Main Chain is a Blockchain run by the Grid OS, acting as the backbone of the whole system. The Main Chain consists of a Side Chain index system, Token system, and DPoS Consensus Protocol.

3.2.1. Side Chain index system

Side Chain index system connects all Chains within Grid eco-system. Grid indexes two types of Chains:

- External Chains of high importance, can be used to expand the boundary of Grid, e.g. Bitcoin, Ethereum
- Internal Side Chains operating under Grid OS, which contributes to the economics of Grid system using Grid Token

Side Chain indexing works in following steps:

- Nodes of the Main Chain read information from Side Chains and form a Merkle Tree
- The header of the new Block records the Merkle Tree Root. As illustrated in Figure 4, if we want to confirm transaction TX1 on the 1000th Block of BTC, we only need to prove the existence of Merkle Tree of the 1000th Block of BTC as stored on the Merkle Tree Root of the Main Chain, and Merkle proof of TX1 on the 1000th Block of BTC via messaging. This approach also works for other Chains such as Ethereum as long as a Merkle Tree Root is formed

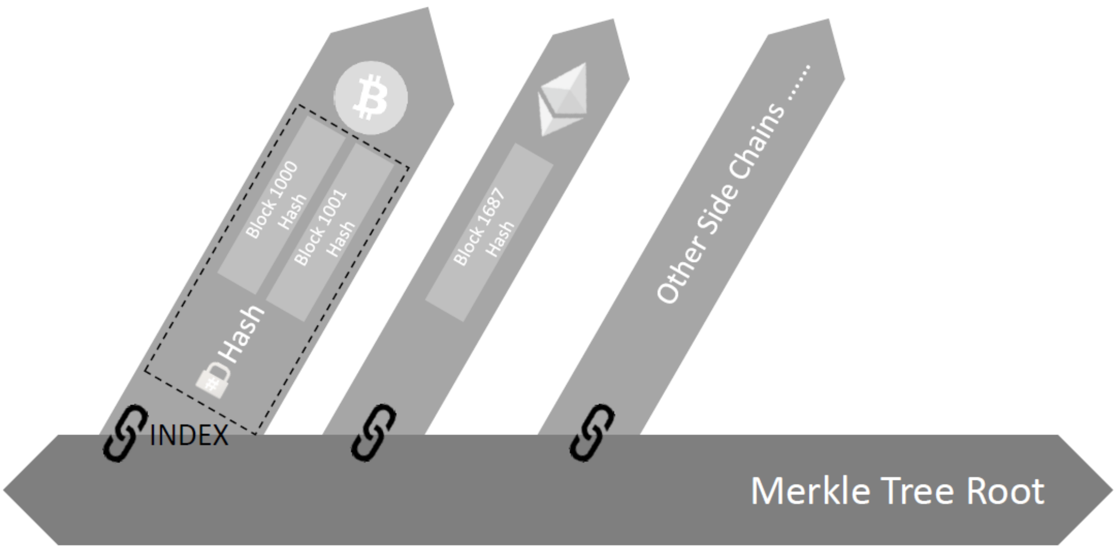


Figure 4: Side Chain indexing

In order to improve verification efficiency, we suggest expanding the structure of a Merkle Tree, including not only Block hashes as well as the Merkle Tree Root of transactions in Figure 5 and states in Figure 6.

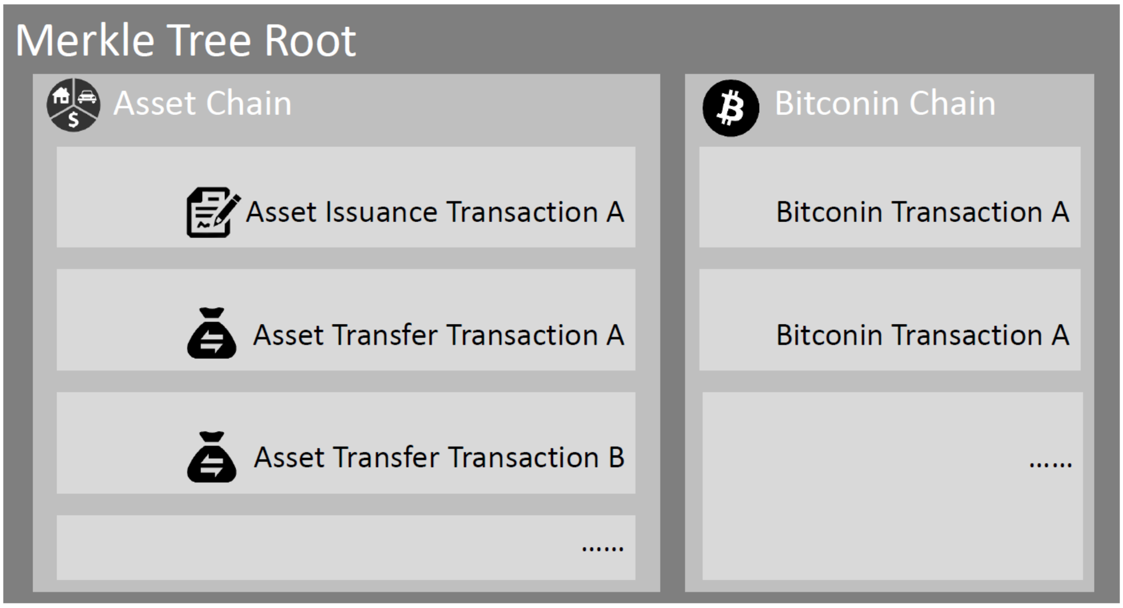


Figure 5: Transaction indexing

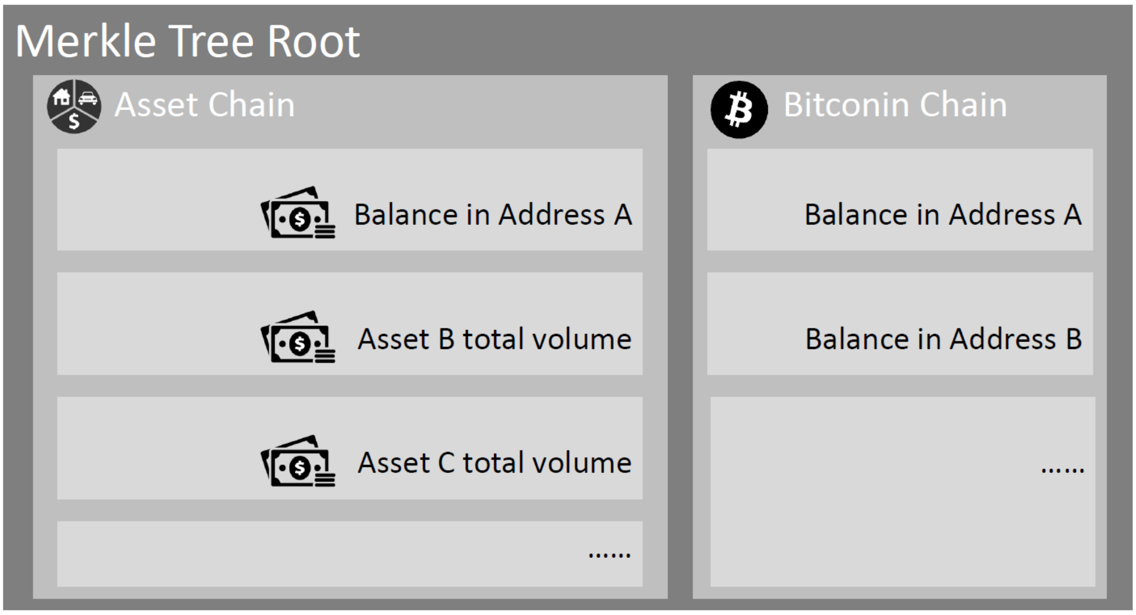


Figure 6: State indexing

One key issue to be discussed is the timing of Side Chain indexing by the Main Chain. If the Main Chain frequently indexes a Side Chain with high probability of fork, it wastes efforts to index Orphaned Bocks. Therefore we suggest different indexing strategy for each Side Chain based on its characteristics and this can be defined in the system. Indexing strategy for Blockchain similar to Bitcoin can be after one minute of a Block is formed. This has been proven statistically as a Block can be confirmed not an orphan after one minute of formation. Within Grid, if a Side Chain and the Main Chain adopt merge mining, real-time indexing can be conducted due to the same miners.

3.2.2. Grid Token system

Grid token incentivizes honest behavior in the system. All Grid Side Chains accept Grid Token as storage of value and means of value transfer. It can be transferred across Chains that accepts Grid Token.

When a Side Chain applies to be indexed by the Main Chain, it receives some locked-in Tokens from the Main Chain. When the Side Chain receives transaction fees, it shares partially with the miners of the Main Chain. When the Main Chain finds indexing a Side Chain is economically unfavorable to its benefit, the Main Chain has the right to terminate indexing, or permitting competition of two Side Chains providing the same services.

3.2.3. Consensus Protocol

A stable and efficient Block formation mechanism is the foundation for Grid system. The operation and maintenance of Grid is more complicated than Bitcoin and Ethereum. This is due to the fact that Grid Block formation requires the Main Chain to record information from Side Chains, and Grid is designed to provide cloud-based enterprise services in a more complex structure. In addition, miners need to update information from multiple Chains in parallel. The Main Chain will adopt DPoS to ensure high frequency and predictability of Block formation, in order to improve user experience.

3.3. Grid Side Chain

Chains that are indexed by the Grid Main Chain are considered as Side Chains. As mentioned before, it is recommended that each Side Chain to be designed to handle one specific type of transaction (Figure 7).

When a new Side Chain is created via Grid OS, it is recommended to merge mining with the Main Chain and establish its own Consensus Protocols. To contribute to the Grid eco-system, Side Chains should reserve certain amount of Grid Token and share partial transaction fees with the Main Chain.

When a Side Chain needs to verify information from another Side Chain, it has to include the Block header information of the Grid Main Chain. Side Chains do not interact directly with each other. Verification is done through Merkle Tree Root provided by the Main Chain.

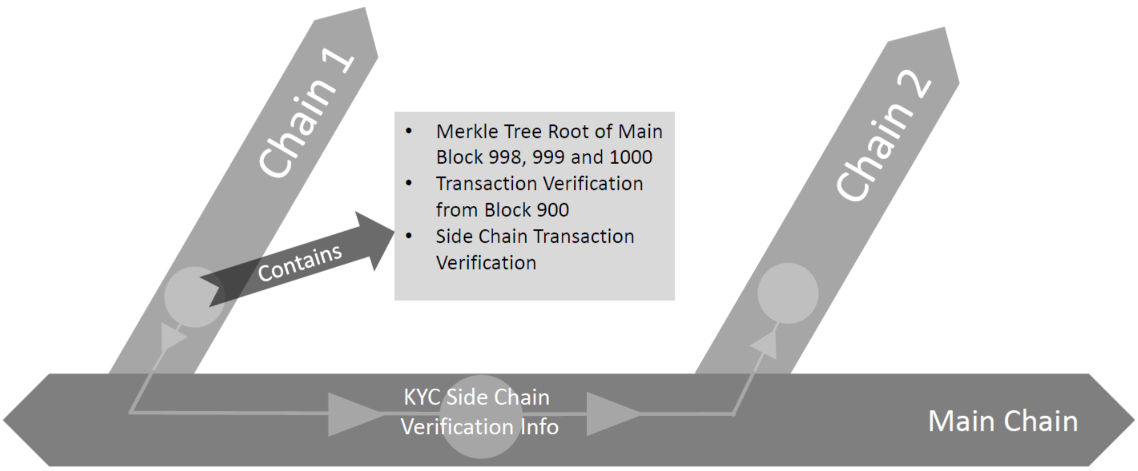


Figure 7: Messaging interaction between two Side Chains

It is highly complicated to obtain state information from UTXO systems such as Bitcoin, for example the available balance from an address. Across-Chain communication can be addressed via a Blockchain Adaptor, where it creates a compatible Block header including Merkle Tree with Bitcoin. Grid adopts such Adaptor and intends to establish a fully compatible Bitcoin Side Chain using Grid OS to cooperate with the widely used Bitcoin and interact with its assets.

3.4. The economics of Grid

A virtuous economy lays the foundation of a sustainable Grid eco-system.

For PoS and DPoS, any stakeholder can sell their Tokens and exit from the eco-system in a short timeframe (PoS has a certain lock-up period). One challenge that PoS and DPoS are facing is the fact that Exchanges hold large amount of Tokens in the system, therefore earning interest at almost zero cost.

For PoW, miners face more complex consideration before exiting. Exit is constrained by external factors such as electricity cost, mining machine depreciation, land lease, and human resources.

Grid will use DPoS on the Main Chain to incentivize large Stakeholders to maintain a stable system and will deploy PoW for the Side Chain where mining creates Grid Token. In Grid system, Consensus Protocol on each Chain can be customized to achieve specific objectives.

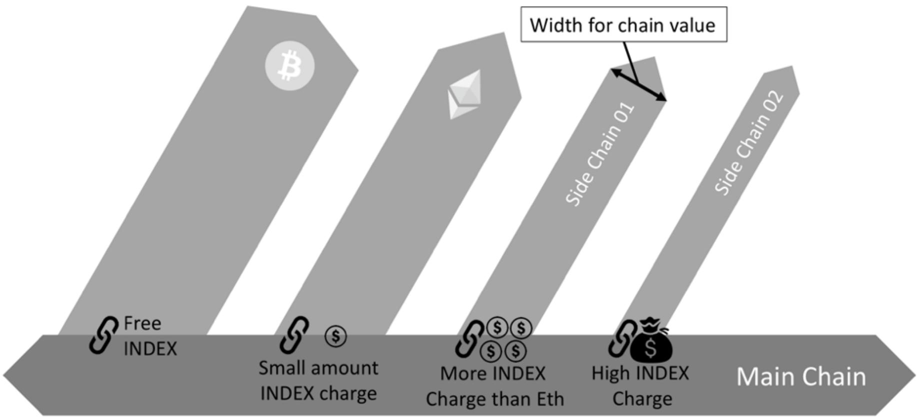


Figure 8: Fee mechanism of indexing Grid Side Chains

After a Side Chain is included by the Grid eco-system, it will pay a certain amount of transaction fee to the Main Chain for indexing. Grid adopts a dynamic transaction fee strategy to reflect the different contribution level of each Side Chain to Grid eco-system. For instance, Grid will charge less transaction fee for a Side Chain with high contribution (e.g. No fee charged on indexing BitCoin for its wide adoption and associated assets. On the other hand, a Side Chain with little value to the eco-system and consuming resources from other Chains will be charge high transaction fee).

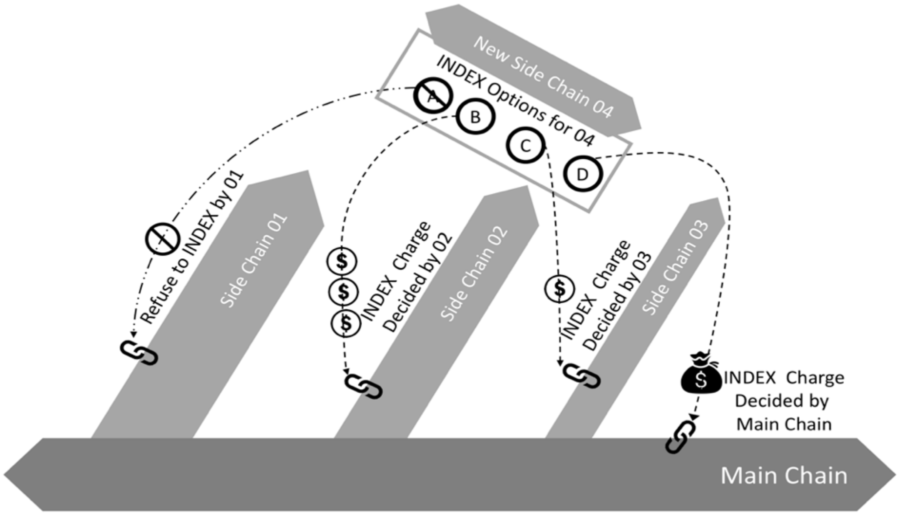


Figure 9: Sub-Chain indexing

The Eco-system of each Side Chain votes to determine its indexing strategy for Sub-Chains independent of the Main Chain. Its own strategy includes but not limited to the business scope (e.g. An insurance Chain will only include sub-Chains that are also in Insurance business) and fee scheme of Sub-Chains. Any Chain can also decide not to include any Sub-Chain or actively invite a Chain to become a Sub-Chain, as a means to enrich its Eco-system. Within the Grid Eco-system, any Chain can apply to become a Sub-Chain of another Chain or even multiple Chains.

3.5. Security mechanism

The security mechanism is designed from the aspects of application, protocol logic, network communication, data and rights management. And a distributed security monitoring and early warning system based on big data is provided.

3.6. System built-in Grid Side Chains

Grid Node Topology consists of an interlinking P2P network between Full Nodes of the Main Chain, light nodes and Nodes of Side Chains. Non-ledger nodes are usually Light Nodes. Similarly, ledger Nodes are Full nodes. Nodes of Side Chains are distributed in Grid Node Topology based on its indexing relationship with Main Chain.

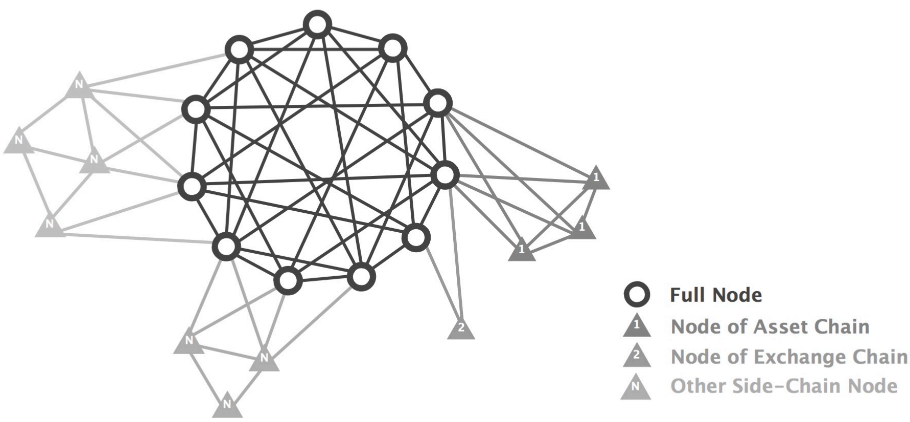


Figure 10: Illustration of Grid Node Topology

3.6.1. Information registration and authentication Side Chain

Information registration and authentication Side Chain creates great value to industries both online and offline. Currently it has been widely adopted in O2O businesses, such as e-commerce, car hailing and delivery. Huge opportunities are yet to be unleashed in businesses such as supply chain finance, logistics, credit scoring etc, where their large information assets can be migrated to this Side Chain in the future.

3.6.2. Digital asset ownership Side Chain

The main function of this Side Chain is to store digital assets and wallet ownership information.

3.6.3. Asset initial distribution Side Chain

The main function of this Side Chain is to facilitate asset initiation (First Coin Sales). Once the distribution has been completed, assets will be moved to the Digital asset ownership Side Chain. The advantage is that normal transactions will not be interrupted during a large scale First Coin Sales.

3.6.4. Decentralized Exchange Side Chain

A decentralized transaction Side Chain functions as an Exchange. It enables KYC, asset transfer, order placement/ withdrawal and execution.

3.7. Grid Cross-Chain optimization

Cross-chain transactions need to be optimized to match the block formation speed between different chains. We design two mechanisms to solve this problem. First, hierarchical side chain mechanism. We categorize chains into different levels in accordance with the block formation speed of the chain, and provide a dedicated adapting side chain or adapter module to carry out the same level of cross-chain transactions for each level of the chain. Second, cross-level guarantee mechanism. For cross-chain transactions at different levels, the main chain provides a guarantee for the slower chain. This is only an optional mechanism if required. These two mechanisms can be an effective solution to enhance the Grid cross-chain transaction speed.

4. Grid Operating System

4.1. Definition of Minimum Viable Blockchain system

Grid system creates highly specialized and efficient Chain structure to handle all kinds of business scenarios. It also enables "Chain split" to address capacity issue when demand increases. To further enhance its commercial potential, it is essential to lay out the most fundamental block and infrastructure of the system for developers and the community. The following Chapters discuss the minimum viable Blockchain system and Grid Operating System as the foundation for achieve high customization and efficiency.

Block: A Block is used to record a state in the system. The transition from last Block to current Block is defined by the transactions included in current Block.

Transaction: Transaction logic is defined as Smart Contract. Smart Contract is essentially a Protocol. It always gives the same output with the same input.

Account: An account is used to distinguish the boundaries of data storage. It consists of public key and private key systems.

P2P network communication: Data transmission between nodes is through the underlying P2P network.

Consensus Protocol: A Consensus Protocol defines the rules and authority to update a state within the Blockchain.

4.2. Grid Kernel

4.2.1. Built-in minimum viable Blockchain system

These are the foundational components of the Blockchain system operating within the Grid Kernel. They are linked with relevant interfaces to define the customizable parts of Smart Contract, Consensus Protocol, and customizable area of Blockchain header.

4.2.2. Unified account system

Bitcoin system introduces public and private keys into the concept of account. The Pay to Script Hash gives transaction authority to a Smart Contract. Ethereum defines externally owned account and contract account. Grid Kernel defines both types of accounts as Smart Contracts.

4.2.3. Parallel transactions processing within a Block

Grid analyzes the static state of transactions and assesses the impacted data range of each transaction. As illustrated in Figure 8 Multiple transactions without read/ write conflicts can then be processed in parallel, without affecting the output of each transaction. During the process of Block formation, nodes assign transactions to different groups based on mutex of the transactions. Transactions within a group will be processed in linear sequence, while all groups will be processed simultaneously.

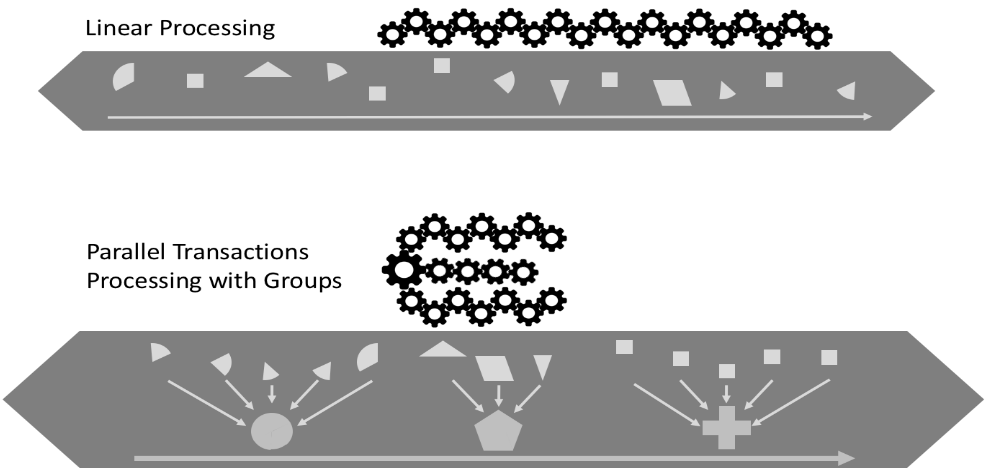


Figure 11: Parallel transactions processing within a block

There are special transactions that cannot be processed in parallel due to the fact that its impacted data range changes while other transactions are being processed. Under such circumstance, nodes will prioritize transactions that can be processed in parallel. With sufficient transaction fee, these special transactions in a non-parallel group will be processed in linear sequence. Otherwise nodes can reject to process these transactions. It is to be noted that, when an evil node accepts a transaction that cannot be processed in parallel and time-consuming, the probability that other nodes reject this Block will increase.

4.2.4. Smart Contract Collection

The Grid Chain Contract has a collection of Smart Contracts that are defined during the Genesis. This collection is name as Genesis Smart Contract Collection, in honor of Satoshi. The essence of Smart Contract Collection is a class that defines the main functions, Consensus Protocol of the chain and the update mechanism of the collection.

4.2.5. Smart Contract Update

The functions of Grid are defined by the Smart Contract Collection. Therefore updating the Collection will impact the functions of the whole Chain. The update mechanism of the collection is defined by the previous collection. For example, we define that if 80% votes for a new Smart Contract Collection in the most recent 100th Block, it is confirmed by the consequent 2000 Blocks, new collection will replace the original one. Nodes that do not update the collection will be terminated for work.

4.2.6. Customizable Consensus Protocol

For specific business scenario, Consensus Protocol has major impact on participants' decision. For a private chain with high trust level, PBFT is a popular Consensus Protocol. It creates high performance with small number of pre-assigned miners. In an environment with low trust, the stability of a Blockchain is maintained via Consensus Protocols such as PoW, PoS and DPoS.

Grid defines Consensus Protocols as part of the Smart Contract collection and can implement any type of Consensus Protocol based on business scenario. We use

Bitcoin and Peercoin as an example to illustrate the considerations of choosing Consensus Protocol.

PoW used by Bitcoin authenticates the Blockchain solely based on information from the Block header without any forms of input. On the other hand, PoS used by Peercoin requires data from stake transaction within the Block, its own authentication of the transaction besides Block header. We recommend future users to pursue Consensus Protocol that only requires Block header information, in order to achieve timely authentication. In addition, for specific scenarios, customized Consensus Protocol shall be implemented.

4.2.7. Customizable Block header

To facilitate the recommendation that Consensus Protocol to only use Block header information, we introduce customizable block header. The Block header of Peercoin does not contain information that verifies the legitimacy of the Block, therefore a stake Block cannot verify the Block legitimacy by itself. Grid Kernel allows customizing Block header structure during the creation of a Chain. Self-proof based on Block header can be done by verifying unspent transaction Merkle Tree with Hash (TxID + N + Value), calculate the stored Root, to obtain TxID, N and Value and Merkle Tree verification.

4.3. Grid Operating System customer interface

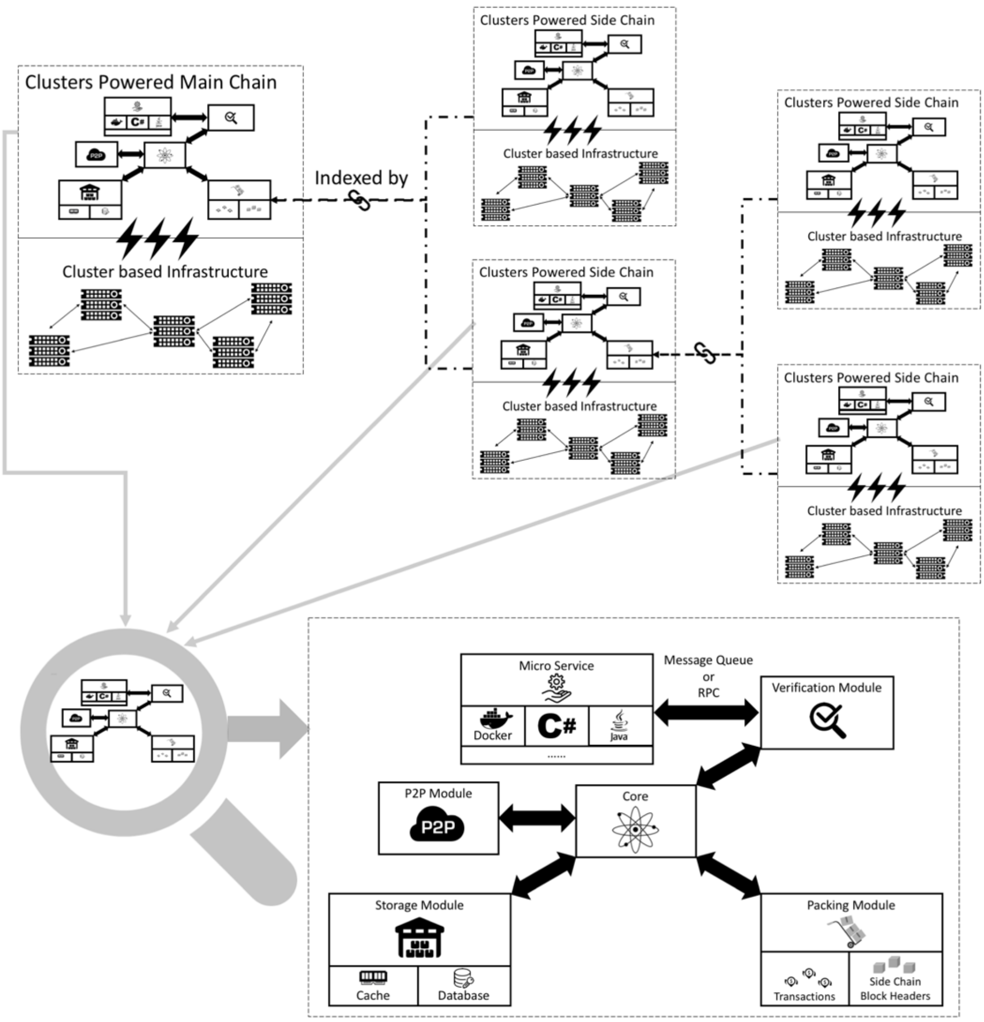


Figure 12: Grid operating system interface

4.3.1. Smart Contract execution

Grid Operating System defines Smart Contracts as Protocols. It can be executed in any forms of service realization.

Grid Operating System prefers Docker and also supports native programming languages such as JAVA, C#, Go, JAVASCRIPT, LUA.

For Docker, Grid provides internal RPC services to grant access to read variables and user accounts during Smart Contract realization. For native programming language, Grid provides respective SDKs to execution functions.

4.3.2. Micro-service

Smart Contracts are defined as micro-service in Grid. This makes Smart Contracts independent of specific programming language. Consensus Protocol essentially becomes a service as it is defined in Smart Contract.

4.3.3. Cloud-based

Through the micro-service approach, Grid Kernel extends parallel processing to a cloud, thus enables cloud-based contract execution.

Grid Kernel has defined data structure and standards, therefore hot data can be stored in RAM. By utilizing mature decentralized database service, it can effectively improve IO performance of the system.

4.3.4. Light node

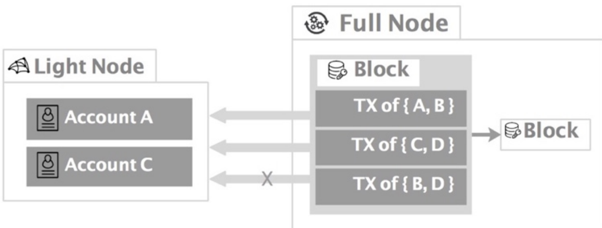


Figure 13: Illustration of light node data structure

Through customization and internal Merkle Tree verification mechanism, each node within Grid only handles relevant information within the system. This enables nodes to be lighter and significantly increase compatibility with light desktop and mobile terminals.

4.3.5. Optional Modules

4.3.5.1. Data cleansing mechanism

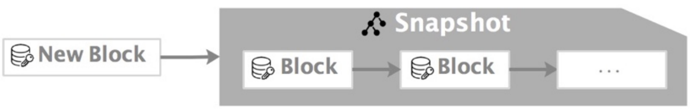


Figure 14: Illustration of Data cleansing mechanism

Grid system adopts a snapshot mechanism and resets the Block formation, with addition of the original data to the new Genesis Block.

4.3.5.2. Data tunnel

Data tunnel is one mechanism to execute P2P transfer. These data will not be recorded in the Block. Data tunneling is only applicable to encrypted P2P data transfer. For example, if A purchases data from B, B transfers data to A while A transfers asset to B, both through the data tunnel.

4.3.5.3. Rapid confirmation model

Grid permits rapid transaction confirmation if the recipient has been authorized by the sender. The authorization is only valid for a certain type of transaction during a certain period and between assigned addresses. For example, A wants to initiate a rapid confirmation model with B during an asset transfer. A needs to initiate a transaction with certain amount of asset reserved for this transaction, and specify B to be the counterparty. During the actual transaction process, A will send the signed transaction to B via Data Tunnel. B instantly confirms the transaction when it receives the transaction. Affected assets will then be transferred to B after B signs on the transaction with its address. A will receive the remaining assets. Data Tunnel is terminated after the transaction.

4.3.5.4. Token Module

The Token module defines all logics and algorithms for the value carrier (Token). It specifically serves scenarios such as payment for resource allocation, or reward to maintaining the stability of Grid.

4.3.5.5. Customization

Grid enables developers to rapidly customize the system via redefining parameters in each module. Grid follows the principle that "one chain serves one specific business scenario", and establishes a highly abstract and modular architecture. For enterprise users and entrepreneurs, this accelerated the process to implement their business ideas. For sophisticated users, it permits high customization for their own Chains, and unleashes the full operation of Blockchain.

4.4. Grid Operating System performance

Grid Operating System runs efficiently in a P2P network. We describe Grid Operating System performance in terms of Response Time, Concurrent Visits, Throughput and Think Time.

The Grid OS optimizes the system service response by deploying the Grid kernel through the distributed micro service, reducing the network transmission risk during the same confirmation period, and reducing the request blocking time by the distributed load balancing. Grid customizes side-chain system with business characteristics, so the Concurrent Visits of the main chain depends on the side chain. The Concurrent Visits of the side chain can be optimized through a special consensus mechanism, such that the Concurrent Visits of the whole network is upgraded. In the view of network, throughput is described by bits per second. Grid improves transaction efficiency by parallel processing multiple transactions with non-competing data. The Think Time of the whole system can be significantly improved based on the above optimization strategies.

5. Grid Eco-system development

Any new technology does not succeed without commercial adoption and a sustainable eco-system. Grid has proposed a technical blueprint with commercial application instilled throughout the whole design. It is crucial to establish a Grid eco-system, including internal and external resources. We will pursue the goal by concurrently striving in three dimensions: technology, business, and capital

5.1. Technology

The chapters above have laid out the key technical features of Grid. The Grid team has several years of Blockchain development experience, particularly involved in a few commercial-focused enterprise projects. The proposed Grid technical solution intends to resolve the most pressing obstacles for commercial adoption of Blockchain, such as scalability, security, customization, and interoperability. It provides a highly efficient infrastructure to adopt new protocols and support all kinds of commercial scenarios in the future.

5.2. Business applications

Grid is intended to ultimately become the new "internet infrastructure" to support the next generation of "digital businesses". The team and its advisors have been advising numerous Blockchain projects in the past and we see a few industries will be the "early adaptors" and "Blockchain stars" on Grid:

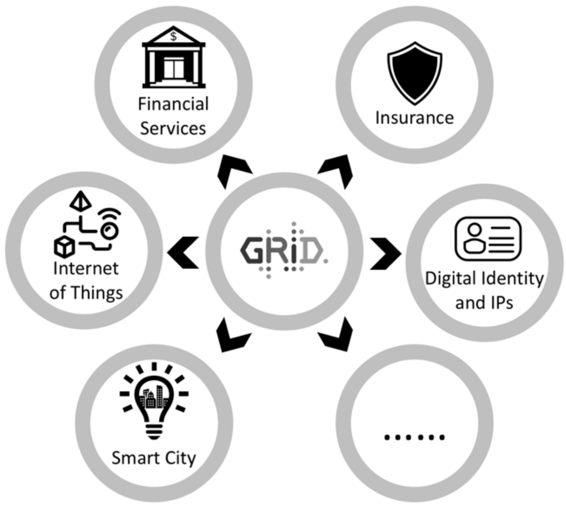


Figure 15: Illustration of Grid business applications

1) Financial services

   Blockchain has drawn a lot of attention in financial services industry as it significantly reduces intermediaries and ensures secure transactions. It is highly likely that multiple chains on Grid will be developed specifically for financial services, such as cross-border payment, trade finance, supply chain financing, etc. The parallel processing feature is capable of handling business transactions at international scale and the inter-chain communication feature allows smooth coordination from asset registration, account management, real-time transaction.

2) Insurance

Insurance is another highly attractive field to be disrupted by Blockchain. A dedicated Grid side chain for insurance will integrate various DAPPs for insurance, transforming the whole industry value chain, starting from user identity, to insurance contract execution, to claim handling.

3) Digital identity and IPs

   Grid's multi-chain structure has a built-in chain for digital identity. This ensures the performance of such side chain if another side chain is busy, e.g. a new token is issued on the other side chain.

   Within Grid, digital identity can be used by other side Chains via "messaging". Using adaptor, Grid is also capable of retrieving information and data from other established chains, such as Bitcoin and Ethernet.

4) Smart City

   Governments will also be interested in Grid as it allows them to securely and conveniently to run certain administrative tasks on Grid. Government or organization can customize the consensus protocol to meet national security requirement. Activities, such as utility recording, citizen identities, government agency information disclosure and polling can be realized on Grid with great transparency and efficiency. A few countries are experimenting in this field, including Estonia, Singapore, China, etc.

5) Internet of things

   Grid supports light node and cloud service, which reduces the computational requirement for devices connected to it, while maintaining high performance. This is critical in order to manage billions of devices and enables micro-payment across them to link internet of things.

Grid has laid out strong foundation for the above industries and more to strive on it, we will actively identify new business opportunities and DAPPS to be part of Grid eco-system.

1) Interoperate with existing DAPPs on existing chains

   There are already some proven DAAPs on existing Chains, such as on Bitcoin and Ethernet. Grid will leverage its interoperability feature to connect with these DAPPs in order to allow asset exchange and also capture the transaction data coming from those DAPPs

2) Nurture new start-ups ideas

   The development team and its advisors are deeply involved in new idea formation and commercialization in the global Blockchain community. New start-up ideas have approached us for technical and commercial advice. We will leverage this strong connection to nurture new start-up ideas and include them in Grid eco-system. Together with VCs, we are confident to identify and bring the most promising projects to be launched on Grid.

3) Transform established companies to "Blockchain savvy"

   Established companies pose another opportunity to be part of Grid eco-system. They already possess large customer base and proven value for their current business. Grid can transform them into even more powerful models with strong incentives and rewards to customers, resolving certain pain points within the industry as described above. The grid team has been in discussion with a few Internet companies and traditional corporates on disruptive business model on Grid. We foresee a few exciting announcements will be made in near future. In addition, the team intends to collaborate with global strategy consulting firms to push the boundary of next generation business models on Grid eco-system.

5.3. Capital

Building an eco-system requires undoubtedly large amount of capital. Besides leveraging the fund raised during ICO, the team and its advisors have established strong alliance with leading crypto funds globally. The team and its advisors have been advising numerous ICO projects internationally to successfully raise fund and develop their solutions. The international capital network and reputation ensures a strong financing capability to support future pipeline with long-term view.

6. Future Development

This White Paper lays out the initial idea of Grid and how it will work as an open Operating System for various Stakeholders, including the community and industry adopters. With self-evolving as one of the key objectives of Grid, the future development of Grid will be guided by the community and industry experts. A list of potential directions is as below:

i. Zero-knowledge Succinct Non-Interactive Arguments of Knowledge
ii. Quantum resistant ledger
iii. New Consensus Protocol, such as virtual mining machine

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