

Abstract

With the exponential development of GPU computing power, big data, Internet of things, sensors, and other fields over the past few years, artificial intelligence has begun to break out, in a way that futuristic technologies such as facial recognition and voice interaction are being integrated into our lives day by day. From 2012 to 2016, there was an increase of 5154 artificial intelligence startups in the whole world, the total financing amount reached \$22.4 billion, and many medium and large companies have set up artificial intelligence departments while the net investment in artificial intelligence world-wide became more than \$100 billion. It can be said that after the rise and fall several times in history, the era of artificial intelligence has finally arrived! In the past few years, the DeepBrain Chain core team has been deeply exploring the forefront of artificial intelligence. Upon exceeding over 30 domestic first-class academic and corporate AI teams, DeepBrain Chain team was awarded First Prize in Enterprise Sector, and Second Prize in Academic Sector & Enterprise Sector of SMP 2017 Chinese Man- Machine Dialogue Field Authority Evaluation Contest held by Artificial Intelligence Research Center of the Harbin Institute of Technology upon that participated in the competition.

We have been committed to artificial intelligence landing applications and services for a variety of Internet of things applications, so that ordinary appliances could have a brain, with dialogue, thinking, and reasoning abilities. In 2014, as a result, the world's first AI sound box Small Zhi was launched half a year earlier than the Amazon Echo. In 2017, the first national AI brain open platform DeepBrain was launched. When Artificial intelligence enterprises design AI products, it is estimated that nearly 10% to 30% of their budget will be spent on construction of AI's computing power. These include the purchase and maintenance of high computing performance hardware, which have become a heavy burden to enterprises, restricting investment in technology research and development. Is there a good way to completely solve this pain point, so that AI enterprises can navigate the technological revolution more smoothly? The answer is yes and This is where DeepBrain Chain enters. DeepBrain Chain is the first and only artificial intelligence platform in the world driven by blockchain technology to address this problem. By utilizing DeepBrain Chain's platform, artificial intelligence enterprises can save up to 70% of their hardware cost. In addition, potential privacy risk for enterprises when using data can be effectively avoided. This is because the algorithm of the platform is fixed by smart contract and thus cannot be changed.

Vision

DeepBrain Chain's vision is to build the infrastructure for the 5G + AIoT era which is aimed at providing all industries with low-cost, private and secure high-performance computing power.

DeepBrain Chain's mission is to accelerate the advancement of artificial intelligence in an era that is undergoing an explosion of smart devices, the data they acquire and their computational needs.

1. DeepBrain Chain allows the artificial intelligence neural network operation to be decentralized and distributed over the mass nodes of the whole world through blockchain technology. Thus, the cost can be just 30% of the user's self-built neural network server; and less than 50% of the traditional artificial intelligence centralization cloud computing platform.
2. Through smart contracts, data providers and data training parties will be physically separated, protecting data privacy. This successfully resolves the trust issue that often prevents data providers from willing to share the proprietary data for training, which is essential for developing AI products.
3. Using DBC token as the universal currency of the platform, DeepBrain Chain maximizes participation from various AI players in the ecosystem all around the world, including developers, universities, computing power providers, SMEs, financial institutes, Data providers etc.

Introduction

1.1 Problems of Artificial Intelligence Enterprises

1. Artificial intelligence products need to train models by neural network calculation, and the data model training process needs to consume a large amount of computing resources. Also, Artificial intelligence products want to achieve better product index, in addition to the algorithm. That is, there is a need for massive data to train, but more data, in the case of equal computing resources, means longer training, say over a week or even a month to several months. If there are incorrect parameters in the training process, repeated training is needed. Long training time is extremely disadvantageous to the enterprise product's iterative updating, increasing the product's likelihood to fail in the industry's competition. This leads to the fact that many manufacturers have to invest a lot of money to purchase GPU, FPGA, and other hardware resources, directly causing the artificial intelligence chip provider's, e.g. NVIDIA's, share price to rise rapidly. For most small and medium enterprises, more than one million of capital investment is a huge burden.
2. AI products still need to be decoded by a neural network after launching. The larger the number of users, the greater the amount of calculation required, hence pushing up the cost. Consequently, the user access frequency in different time periods will also change, and one-time purchase of a large number of computing resources will inevitably result in idle resources.
3. The three elements of artificial intelligence are computing power, algorithm, and data. The amount of data is an important factor affecting the index of any artificial intelligence product. Companies that design artificial intelligence products need to continually annotate low-quality data or directly purchase high-quality data, but most data usage involves the issue of user privacy, and data providers can only hope that the data won't be duplicated. They just sell the right to use the data, but not its ownership, which is almost impossible to do.

1.2 Brief Description of DeepBrain Chain

Using blockchain technology, we have developed a distributed, low-cost and privacy-protecting high-performance computing platform with comprehensive peripheral services and products. DeepBrain Chain's high-performance computing nodes can provide high-performance computing power for multiple industries, including AI trains and inference, cloud gaming, rendering, blockchain zero-knowledge computing, ETH 2.0 POS computing node etc. The AI computing nodes in our network can take multiple forms, including full-function nodes (permanent nodes) composed of large GPU or FPGA server clusters, independent nodes composed of idle GPU servers owned by small and medium-sized companies, and idle GPUs owned by individuals. Mining nodes earn their income from two sources: AI processing fees paid by AI companies in exchange for computing power and mining rewards from the system, calculated based on our reward algorithm.

Transactions are based on smart contracts, carried out using our crypto utility token, DBC. Mining nodes will be incentivized by a reward system based on smart contracts. We seek to ensure that the system is secure, safe, and that every participant in the system benefits. AI companies in particular will benefit from accessing neural network computing power at a competitive cost. We believe DeepBrain Chain will become one of the central platforms in the AI industry, with the capability to scale and provide enough computing resources to power tens of millions or even billions of AI instances, for use in both projects and products. Projects may be limited term or ongoing research using AI, but the network power can also be used to power processing for AI-based products, which requires cloud power for ongoing processing – an example might be a product for the home that uses cloud-AI power. Some cloud AI will move to dedicated chips, but the AI IoT (AI Internet of Things) will have an increasing demand for all kinds of processing, including flexible processing that exceeds the limitations of chips.

Our vast network potential will help to support the AI industry through providing cost effective, scalable and sustainable AI resources.

We believe that DeepBrain Chain will become one of the infrastructure platforms in the 5G + AI era. The DeepBrain Chain network will be able to carry the massive computing power demand of the 5G + AI era and push forward the development of the whole human society.

Design Concept of DeepBrain Chain

2.1 Design Thinking of DeepBrain Chain

Since 2016, we have been thinking about the application of blockchain in the field of artificial intelligence, in order to alleviate the pain faced by artificial intelligence enterprises. In April 2017, we released the DeepBrain platform and completed the underlying algorithm design and application of artificial intelligence operating systems. Currently, more than 100 manufacturers and 200,000 users have connected to more than 500 models of smart devices. In August 2017, we released a draft of DeepBrain Chain's white paper, studied, and solved the artificial intelligence problems related to blockchain with enthusiasts in the blockchain community. Together we are building the next generation artificial intelligence computing platform driven by blockchain. In October 2020, we expanded our service from just the AI industry to the cloud gaming, rendering and blockchain computing spaces.

As for DeepBrain Chain's design, we think about the following principles:

1. Extended principle: In DeepBrain Chain, each module should be loosely coupled. It should be easy to add new modules, and each module's own updates should not require other modules' interface changes.
2. Stretching principle: Customer access to DeepBrain Chain should be flexible. If there is a large number of users accessing a node, it will inevitably bring service breakdown to

the node, so the container of the node itself should be automatically deployed. When there is a pressure of user requests, it should realize the horizontal expansion quickly.

3. Privacy principle: the privacy of All participants of the DeepBrain Chain ecosystem like mining nodes, artificial intelligence manufacturers, and data providers.

2.2 Solutions from DeepBrain Chain

1. Low cost: one of the most important contributions that DeepBrain Chain can bring to AI companies is to solve their problem of high computing power cost, and this was the core issue that DeepBrain Chain was designed to solve from the very beginning. Because of our unique model, every node derives 70% of its income from mining and 30% from the training fees paid by AI companies. In other words, AI companies only pay 30% of the cost. Up to 2021, as DeepBrain Chain's products continue to improve and expand, Not only do we save money for AI companies, but also we are helping the cloud gaming, rendering, blockchain zero-knowledge proof computing and other fields making big savings on their computing cost.
2. Neural network computing performance optimization: DeepBrain Chain focuses on serving AI companies. All the current AI products are developed using deep neural networks as their core algorithm. DeepBrain Chain performs computing optimization on CUDA-based GPUs, and integrates mainstream deep learning frameworks such as TensorFlow (Google), Caffe (Facebook), CNTK (Microsoft), etc.
3. High concurrency: AI companies have a massive user base, which means DeepBrain Chain has to be able to provide high-performance computation for a huge number of users. We use a unique load balancing technique to make sure node containers cooperate and share the concurrent pressure.
4. Low latency: all user requests must be responded to in seconds, which means every module in DeepBrain Chain has to be able to respond immediately and consume as few resources as possible. The one exception is an ongoing neural network training.
5. Privacy protection: we should be able to protect the privacy of every participant in the ecosystem. The goal is that every participant can freely decide to what extent they want their information to be made public. We do this through encryption algorithms and sensible separation of data ownership and data usage rights.
6. Elastic supply: network demand for AI resources is variable. There are peak times when demand can be significantly higher than normal. Thus we have to be able to effectively handle a sudden spike in demand. Our roadmap includes elastic expansion technology that allows containers to be automatically and rapidly deployed to idle nodes as a method of load balancing.
7. Automatic maintenance: in order to maximize uptime for customers, the system will be able to issue alerts when there is something wrong with a node container and remove it from the system while adding a functional one in its place. It will also be capable of notifying the AI processing provider (the "AI miner") when there is an issue, to maximize revenue.

2.3 Building An Ecosystem that Surrounds DeepBrain Chain

DeepBrain Chain realizes the decentralized supply of GPU-based high-performance computing. DeepBrain Chain focuses on the IaaS layer in the era of 5G+ artificial intelligence, and all PaaS and SaaS layer services that require high-performance computing power can run on top of the DeepBrain Chain network.

The DeepBrain Chain Platform

3.1 Based on Polka Substrate

Polka Substrate is an open source, publicly maintained underlying blockchain system realized through blockchain technology. And supports others to very easily issue main chain mechanisms on top of it, the Polka community is very active and they have a well-functioning foundation. DeepBrain Chain foundation will issue DeepBrain Chain tokens on Substrate, and develop smart contracts based on the Substrate ecosystem.

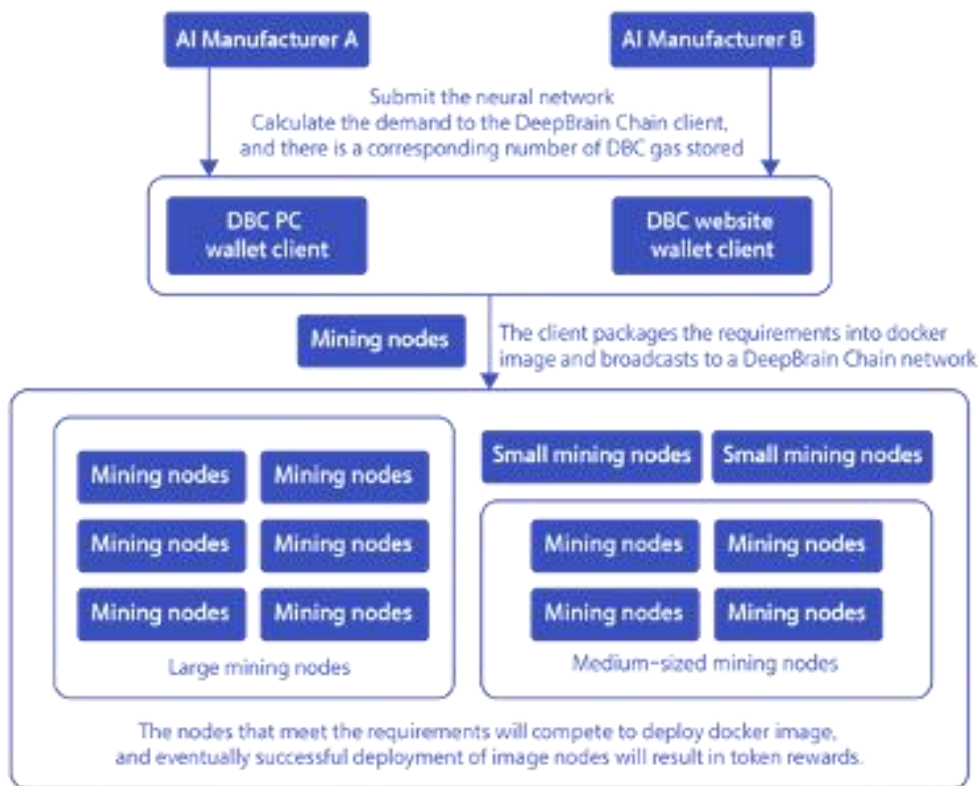
The DeepBrain Chain team will make DBC in a unified way on the blockchain application registration in order to ensure that once the asset is confirmed by the smart contract, all data would be open, transparent, and non-tamperable. Hence, DBC is a fully reliable data sharing asset allowing fully reliable transactions. There will be no false assets or sham transactions.

3.2 DeepBrain Chain's Architecture

3.2.1 Overall Framework

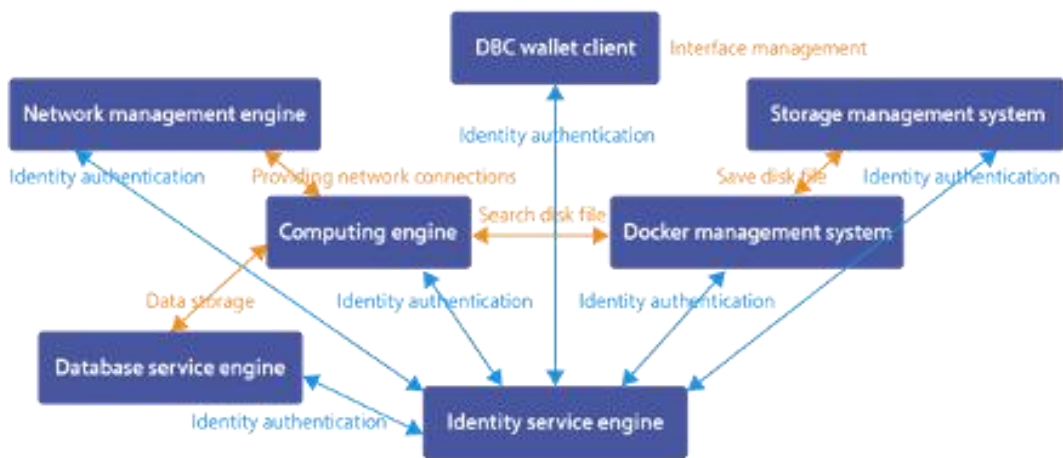
Nodes in the DeepBrain Chain network can be large nodes in the form of mining pools, medium-sized nodes or nodes mining using Azure or Aliyun (Alibaba Cloud), and high-performance home computers. Miners can join the system by installing our software and having the basic AI operating environment in place to mine DBC. AI companies upload data and models needed for neural network computation to our decentralized storage network, then submit neural network computing requests containing container image's name, data index and models index to DeepBrain Chain's client and make sure they have enough of the AI utility token, DBC. Qualified nodes will compete to deploy the images and nodes that have successfully deployed the images will get DBC rewards.

DeepBrain Chain Framework Layout



3.2.2 Mining Node Architecture

Mining Node Framework



1. Computing Engine

A computing engine is a set of controllers including a computational emitter and a container computing engine.

Computational emitter: After the container has been deployed successfully, the verification calculation is done, and the calculation is passed. The emitter will broadcast to the whole network, and the broadcast contains fields:

```
Struct{
    Timestamp: Total number of seconds from Greenwich time 00:00:00 January 01,
    1970 to now
    Address: Successfully deployed node wallet account
    Id:image ID number
}
```

Image computing engine DCEngine:for managing the entire lifecycle of container instances for a single user or a group of users, providing virtual services according to users needs , and the creation, pause, adjustment, migration, restart, destruction of and other operations to containers. When the user requests the calculation of the specific value of the distribution amount of container capacity (set by the user), the container calculation engine will start the alarm and will start to automate the deployment of container expansion into other normal nodes. First, the configuration file is read, the configuration parameters are read, the initialization message queue is configured according to the configuration, and then the internal message interaction is carried out with other components later. At the same time, the DB server according to the configuration item in the configuration file is started, and a server corresponding to each API in the configuration file is configured. According to the system GPU core number n, each DB server will have a process to deal with the request.

```
Def main():
    Config.parse_args(sys.argv)
    Logging.setup("DBEngine");
    Utils.monkey_patch()
    Gmr.textDBMediation.setup_autorun(version) Launcher=service.process_launcher()
    For api in CONF.enabled_apis:
        Should_use_ssl=api in CONF.enabled_ssl_apis
        If api == 'db2':
            Server
            =service.DBService(api,use_ssl=should_use_ssl,max_url_len=16384)
        Else:
            Server =service.DBService(api,use_ssl=should_use_ssl)
            Launcher.launch_service(server,workers=server.works or 1)
            Launcher.wait()
```

2. Image Management System

A virtual container image lookup and retrieval system has the functions of creating mirror image, uploading mirror image, deleting mirror image, and editing basic information of mirror image.

Docker Management System

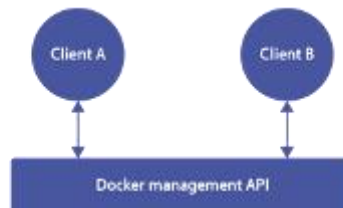
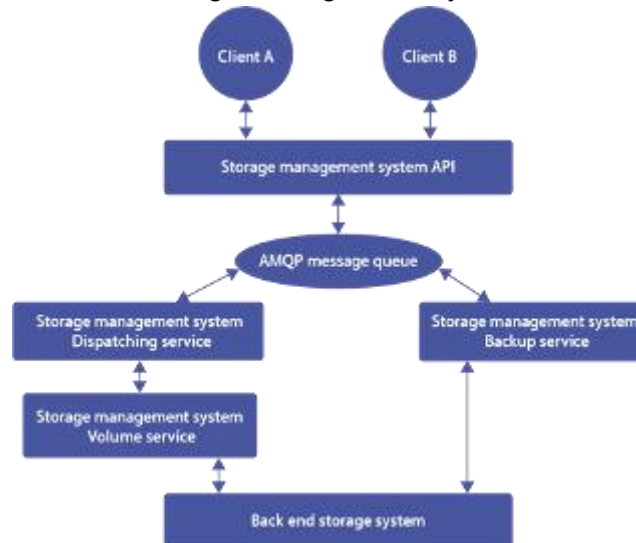


Image management system is mainly composed of an image management API and image management register. Image management API is the entrance of the image management system service, responsible for receiving the user's API request. The image management register deals with image metadata related requests. When the image management API receives the user's API request, if it is determined that the request is associated with metadata, the request is forwarded to the image management register service. Then the image management register parses the contents of the user metadata request, accesses, and updates the metadata of the image interactively with the database.

3. Storage Management System

A large scale extendable system for storing objects through built-in redundancy and high fault-tolerant mechanisms allows storage or retrieval of files, providing image storage of the image systems.

Storage Management System



Storage management system consists of four parts. API server: Storage management system API is the main service interface, which is responsible for receiving and processing the external API request, putting the request into the AMQP message queue, and then executing it by the back-end. Dispatching service: The task of the task queue is processed, and the appropriate volume service node is selected according to the predetermined policy to perform the task. Volume service: The service runs on the storage node, manages storage space, processes read and write requests of maintenance status of storage management system databases, and

interacts with other processes through the message queue and directly in the block storage device or software. Each storage node has a volume service, and several such storage nodes join together to form a storage resource pool. Backup service: This provides services to back up the volume of the storage management system to the backup storage device.

4. Identity Service Engine

This is to provide authentication, service rules, and service tokens to other modules of DeepBrain Chain and to manage commands, projects, users, groups, and roles.

5. Network Management Engine

This is to provide network virtualization technology and network connectivity services to other services in

DeepBrain Chain, providing interfaces to service users that can define networks, subnets, virtual IP addresses, load balancing, and so on.

6. Database Service Engine

This is to provide extensible and reliable relational and non-relational database service engines to users in the DeepBrain Chain environment.

DeepBrain Chain Mining and Privacy Protection

4.1 Machine Online Reward Smart Contract

4.1.1 Machine Online Reward

The main income of miners comes from online bonus DBC tokens and renting out GPU compute power. If miners want to get online bonus DBC tokens, they need to pledge DBC for each GPU, the equivalent value of DBC pledged for each GPU is between 300-500 USD.

The reward is based on the whole network according to the ratio of contribution value, and the DBC is rewarded once every 1 hour, only if the machine is continuously online and no cheating is detected, will the reward be given. If the system detects cheating, the pledged DBCs will be confiscated into the treasury after 28 days of appeal time.

New nodes that successfully deploy images for the first time will have a 1%*95%probability to get rewards and nodes that exit in the midst of training will not get rewards. Instead, they will be punished and their probability of getting rewards in the next 100 hours will be reduced to 1%*1%. Probability of existing nodes that successfully deploy images to get rewards is 99%*99%. Nodes that exit in the midst of training will not get rewards. Instead, they will be punished and their probability of getting rewards in the next 100 hours will be reduced to 99%*1%;

Actual reward Count = probability * computing power contribution/ sum of computing power of all nodes

1. DeepBrain Chain DBC token mining mechanism

The total number of DBCs generated by DeepBrain Chain mining is 5 billion, of which 1 billion are awarded to GPU miners who participated in early contributions before the mainnet goes online. The remaining 4 billion will be mined after the mainnet goes online. 500 million DBCs per year for the first three years, and the number of DBCs mined is halved every five years thereafter. Miners rent out GPUs to get earnings of which 10% is immediately destroyed, 5% goes into the treasury, and is locked for 8 years, after 8 years these tokens automatically go into the mining reward pool. After 8 years of the mainnet being online, the total number of DBCs in the total mining pool is: 1.25 billion + 8 years of accumulated rental GPU proceeds * 5%. Such a mechanism ensures that the main mining pool can be continuously replenished with DBCs to achieve permanent operation.

4.1.2 Mining Algorithm

I. Release of model algorithm

Researchers have developed a new model for an AI applications, open source and packaged into a DeepBrain Chain (Resource A: model algorithm), provided operating environment and input and output data format standard (Resource B: json description file), and can choose to submit training / testing tasks with public datasets (Resource C: pre-trained model / Resource D: evaluation reference). When the released model is used by others, the publisher can share the token (basic fee).

II. The release of training / testing tasks

Select published model algorithms, publish data, and publish training / test tasks after packing data. These can be displayed before submission:

- a. Estimated price = Model algorithm training or testing unit cost * Run steps (upper limit can be set) + Basic cost of model algorithm
- b. Available nodes + expected queuing time

Unit cost = $\frac{\text{Average}_i (\text{Average}_j (\text{Model J unit cost} * \text{the speed of node } i \text{ running model J}))}{\text{Current model running speed}}$

The unit costs of all model algorithms are adjusted dynamically, which makes all nodes get the same overall returns throughout running different models.

After the completion of the task, the transaction gets recorded on the block.

III. Automatically receive and run training / test tasks

Receiving the broadcast of the task in DeepBrain Chain and other nodes running state, the node will create a block every other time and select the task to run according to the algorithm.

For the final reward, in addition to the cost paid by the task publisher, the total “amount of calculation” in the current block = $\sum \text{Model algorithm training or testing unit cost} * \text{running steps}$ will be summed after completion of the task. The total pool of each block is fixed and assigned to each node according to the proportion. Node allocation algorithm: Task publishers hope that the task will be completed as soon as possible; the people

running task nodes want to maximize revenue.

Therefore, we use reinforcement learning to maximize the expected revenue of all nodes:

$$R = \sum_i R^i = \sum_i r_t^i + \gamma r_{t+1}^i + \gamma^2 r_{t+2}^i = \sum_j \gamma^t R_j$$

r_t^i = Returns obtained at node i at moment t

γ is discount factor

R_j is the reward for mission J

t_j is the time point for the completion of task j The algorithm is divided into two parts: The Q function $Q(S, A)$ is constructed to predict the expected revenue of nodes to take action A under the state S .

- a. State S contains the hardware and historical performance of the node as well as the current running state of the node.
- b. Action A includes running one of the currently available model algorithms and not running any task to remain idle.

Deep Q learning is used to train the parameters in the Q function. For all nodes taking action in time t , the global optimal solution is found by beam search approximation.

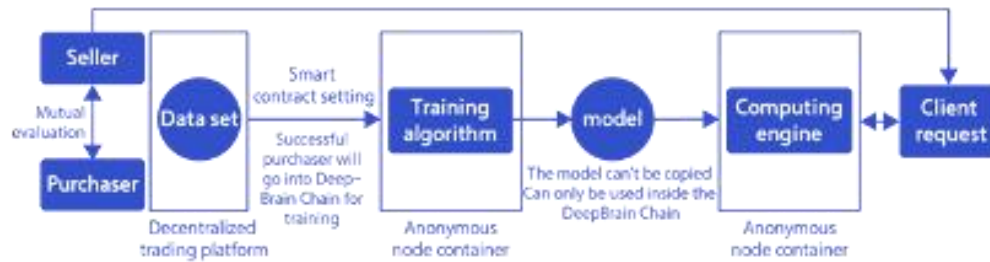
Design logic:

- The publishers of driver model algorithms publish more models that people will use to get more returns. Task publishers will spontaneously choose better model algorithms and at the same time use unit cost to punish model algorithms with unnecessarily large computation.
- Miners will optimize hardware to get higher returns based on current popular model algorithms and their unit costs.
- Within the unit time, the total return of mining is fixed.

4.2 User Payment Mechanism

The DBC fee to be paid is calculated according to the number of FLOPS, the number of neural network units occupied, the storage space occupied, the memory space used per unit of time, and the traffic consumed per unit of time, and the actual fee to be paid is freely set by both the vendor and the miner, but must not be lower than a specific threshold. The fee paid will not increase proportionally with the appreciation of DBC, it is kept stable with the reference value of the fiat currency exchange rate at the time of signing.

4.3 Data Privacy Protection



If a data seller wants to make revenue from selling data, they don't need to reveal the user's privacy to the purchaser who bought the data or sell it to others. While it is possible to trade in the DeepBrain Chain's built-in decentralized data trading platform, the data buyers on the trading platform cannot receive directly; instead, the data are sent directly to the anonymous node container of DeepBrain Chain to be trained, and the trained model will also be sent directly to the anonymous node container that the computing engine is working on. Data buyers cannot copy data from the node to the outside in the process of training data and using the model. On the flip side, the seller can verify whether the anonymous node container cheats to output raw data or variant data of the original data by client request. Finally, the seller and the buyer can rate each other which will eventually contribute to the betterment of the whole network.

4.4 DeepBrain Chain's Bottom Layer Blockchain

DeepBrain Chain, as a distributed high-performance computing network, is essentially an infrastructure for building the 5G+AI era.

Key features of the bottom-layer blockchain:

1. Using the Matrix platform and the software architecture characteristic of Topic
2. subscription+event-driven+processor, aided by high-performance asynchronous architecture to support the outstanding performance of the blockchain;
3. The multi-chain framework is composed of one main blockchain and several working chains. The main blockchain contains the scheme definition of all working chains and there is no limit on the number of working chains. Working chains comprise of sharding blockchains and support unlimited sharding;
4. Block data is defined based on scheme, block size supports elastic definition, block data supports compressed storage;
5. DeepBrain Chain's communication transmission uses a self-encoded two-layer transport protocol or two-layer encrypted transport protocol to reduce network bandwidth. This coded-based protocol of different message packages on the same link can change freely, making transport more secure;
6. Multi-layer network: on the basis of the P2P network, we are building a multi-layer network and introducing SN relay nodes. Message routing uses a multi-layer network

message routing mechanism to speed up the dissemination of messages. SN nodes are geographically dispersed and the network topology changes dynamically to improve the robustness of the network against DDoS attacks to reduce security risks;

7. Network consensus mechanism: we use DPOS (Delegated Proof of Stake) mechanism, meaning both users' stake and their contribution to the network will be taken into account when making assessments.

4.4.1 DeepBrain Chain's Network Structure

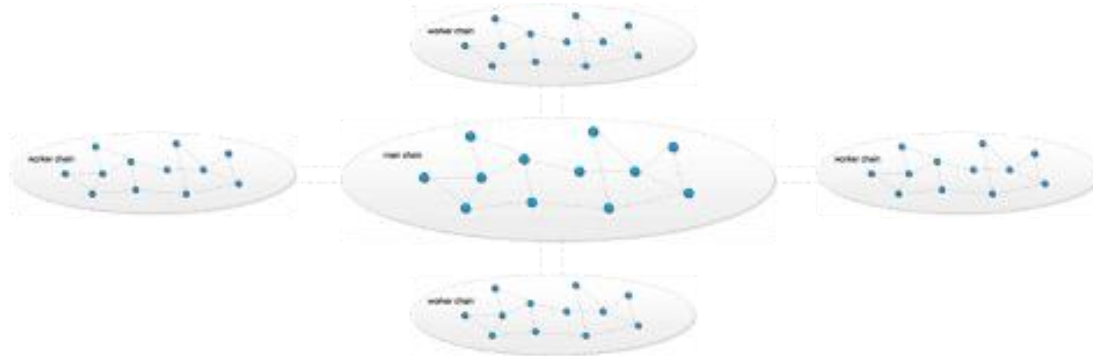
There are currently two mainstream proposals in the industry for solving the scalability issues of blockchain: vertical and horizontal scaling. A classic vertical scaling proposal includes: optimizing consensus algorithms, storage using bigger blocks, and enhancing system performance. For example: block scaling, EOS, DPOS, VRF+POS+PBFT. A classical horizontal scaling proposal includes: Lightning network, multi-chain structure, and sharding network. All of these are an attempt at solving blockchain's scalability and flexibility issues.

Blockchain 4.0 needs to build a high-performance distributed commercial system on top of a large-scale decentralized network. Blockchain 4.0 is about commercialization. Any improvement on just one aspect of the technology will not be sufficient for solving the overall scalability issue. Any overall structure design of a blockchain needs to consider the following four important factors: P2P network structure, bottom-layer storage structure, computing/consensus structure and the design of commercial-use procedures. Moreover, in the world of blockchain, we must consider the three design elements of the blockchain: decentralization, scalability and security. Only two of the three can be perfected at most and all scalability designs are based on these principles.

DeepBrain Chain uses a multi-chain structure that is beneficial to enhancing the entire network's flexibility in regards to its performance. By using the isolation nature of multi-chain to carry out security isolation on DAPP data, alongside the simultaneous execution of multi-chain, the system's performance can achieve linear growth. However, each single chain under the multi chain structure still faces limitations with its performance. Therefore, through a technical structure of sharding, it can improve the performance of a single block further and facilitate horizontal scaling. Using a cross-chain router amongst multi-chains, cross-chain for the relay layer, supporting the relay of isomorphic sub-chain and heterogeneous side-chain, through sub-chain and side-chain

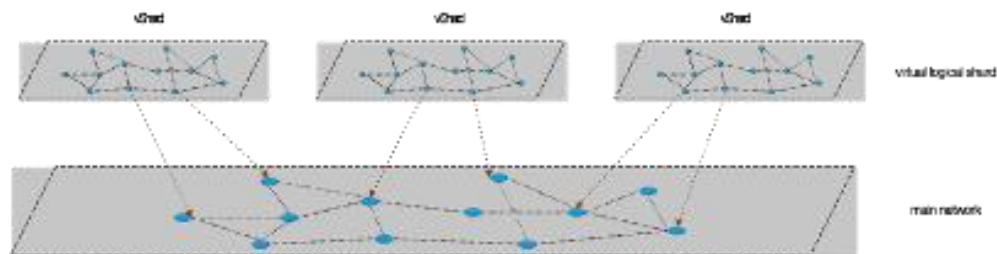
anchoring parent blockchain, we can communicate between different chains and connect them to build a indefinitely flexible blockchain structure.

DeepBrain Chain's multi-chain network structure:



1. The entire network structure is divided into Parent Blockchain (DeepBrain Chain) + Relay Nodes + Worker Chain / Side Chain;
2. DeepBrain Chain, as the Parent Chain, will be responsible for all the transfers (crossing chain) to all Worker Chain/Side Chain;
3. Relay Nodes are responsible for connecting Parent Blockchain with Worker Chain/Side Chain;
4. Worker Chain/Side Chain will be responsible for their own business applications and commercial needs independent from each other. Through Relay Nodes, Parent Blockchain and Worker Chain/Side Chain can realize two-direction anchoring and conversion.

4.4.2 DBC's Scalable Sharding Structure



The main goal of sharding is to enhance a single blockchain's performance and the scalability of the entire network. Each shard will process different subsets' transactions in parallel, reaching consensus within the shard for transactions to be able to run simultaneously.

DBC's sharding structure is main shard (main network) + programmable virtual sharding structure.

Key Design Elements

1. The complete sharding structure includes three parts: network sharding, compute sharding (transaction/consensus) and storage sharding (status sharding).
 - First, we divide the nodes in the network according to sharding rules into different virtual shards (i.e grouping); here we need to guarantee the network connectivity within shards and the network connectivity between nodes and the main network within the shards; transactions within shards are only broadcasted within shards to reduce bandwidth cost.

- Secondly, all nodes that need to take part in consensus need to pay a deposit and register on a smart contract; we can conduct sharding on consensus nodes according to sharding rules, transactions happening within different shards should be packaged and verified by consensus nodes in each respective shard; as different shard transactions are verified within different shards in parallel, the performance of consensus allows linear growth.
- If all nodes on the entire network stored complete data of the ledger, as the performance of the network improves, say that the entire network's performance is at 1 million TPS, a single node's daily storage space for the ledger's data is > 20TB, it would therefore be impossible for a single node to store the data of the whole ledger. DBC will separate the storage layer and the computing layer. Ledger storing will be carried out by the Ledger File System. The entire DBC network will keep the data of the ledger together.

2. Programmable Virtual Sharding (vShard)

- Every node has an independent Peer ID in the P2P network, together they form a non-structured and structured P2P network.
- According to different business needs, we will conduct virtual sharding on network nodes through smart contracts on the basis of a P2P physical network; each node will calculate its vShard ID according to a programmable smart contract. Nodes with the same vShard ID will form a network shared with independent logic.
- All network shards comes from the same P2P network physically; but logically they can also be isolated, the independence logic-wise fulfills the scalability design of the network; each independent P2P network node can belong to several virtual shards logically;
- We need to build network connectivity between shard nodes to achieve area autonomy in the sharding network.
- Sharding is dynamic and flexible; the network can add sharding flexibly.
- Mainnet can still build non-structured and structured P2P networks.

3. Wallet Address Account Design

- Using a wallet address as an account, divided into main account and shared sub-account, the sharded sub-account's address will be: main account address +vShard ID. It is similar to a bank account system, only one client owns a specific account but under that account there can be several sub-accounts; transactions can be carried out agilely between sub-accounts.
- Using only one private key, users can control the main account and all shared subaccounts.

4. Compute (consensus) Sharding Design

- Consensus nodes: consensus nodes are divided into whole-network consensus nodes and consensus nodes within shards. For whole-network consensus nodes,

they are responsible for the consensus of the main network; consensus nodes within shards are responsible for the consensus within shards;

- The consensus can use a plugin mechanism. Different shards can support different consensus mechanisms;
- Distributed and randomly forming new protocols: random protocols need to be just and fair without prejudice, as well as holding unpredictability, verifiable by a third party and scalability
- Main shard consensus nodes are sharded using VRF algorithm, responsible for the consensus of different sharding by random chance; consensus nodes for different sharding are responsible for the transactions of different sharding;
- Choosing witness nodes: witness nodes are chosen from sharded consensus nodes by random as the nodes that actually participate in the process of reaching consensus
- Consensus nodes will hold elections periodically to avoid malicious attack;
- The consensus nodes of each shard can increase the number of shard consensus nodes flexibly

5. Transaction Sharding

- Transactions can be divided into two types: transactions within sharding and crosssharding transactions. Shard transaction address is: transaction address +vShard ID. If the address initiating the transaction and the address of the transaction recipient belong to the same shard then this is a transaction within sharding; if the address initiating the transaction and the address of the transaction recipient belong to a different shard then this is a cross-harding transaction.
- Transaction within sharding: transactions are only broadcasted with vShard, shard consensus nodes are responsible for packaging and verifying;
- Cross-hard transaction: Main shard consensus nodes are responsible for packaging and verifying;

6. Storage Shard (Status sharding)

- The simplest way to store data is for one single node to store all the data of the entire ledger, but this will inevitably encounter scalability and performance issues. Under the immense pressure to perform, normal nodes cannot withstand the massive bandwidth and storage room requirements and will inevitably regress into Light node;
- Single shard Light nodes are responsible for storing and verifying the shard ledger's block header that they belong to. Decentralized ledger file system will acquire ledger data to conduct verification;
- Single shard complete nodes are responsible for downloading the ledger data of the shard they belong to completely and verifying the content of the shard completely;
- Dechained complete nodes are responsible for downloading all shards' ledger data, verifying the content of all shards completely;

- Decentralized ledger file system: ledger data is sent to a decentralized file system and this distributed storage layer will provide the visits of data and verification mechanism;

7. Security Concerns

1/N single shard taking-over attack; cross-fragmented-shard contamination risk; attacker sending cross-hard transactions to shard x from different shards simultaneously; fraud detection; verifying nodes work together to carry out malicious actions; double-spending attack; Eclipse attack and so on.

8. Consideration on Decentralization

Consensus nodes will integrate the VRF mechanism based on AI to ensure the randomness and unpredictability of consensus nodes.

DBC Token

5.1 Token Issuing

The total number of DBCs issued is 10 billion, of which mining generates 40%. The founding team believe that DeepBrain Chain is a project that has been verified by the market, has huge market scale and significant application value, lets the process and economic value be associated, and is gradually issued with the core business sharing storage and the mechanism of computation capacity of mining.

5.2 Token Allocation

As more AI devices adopt DeepBrain Chain and users use more services running on top of DeepBrain Chain, the value of each individual coin increases, thus rapidly boosting the revenue of backers who participate in token sales and purchases.

Purpose	Proportion	Quantity	Remarks
Early Sales	15%	1.5 billion DBC	Crowd sales of DeepBrain Chain's ecosystem services to professional investors or artificial intelligence vendors.
DeepBrain Chain foundation and ecosystem	25%	2.5 billion DBC	Unlock 10% in the first month after launching in the market, and unlock the remaining 10% each year, total lock-period of 10 years.
DeepBrain Chain team	10%	1 billion DBC	Unlock 10% in the first month after launching in the market, and unlock the remaining 10% each year, total lock-period of 10 years.
Rewards for Miners Before Mainnet Launches	10%	1 billion DBC	Used to incentivize miners to add GPUs to DeepBrain Chain's network before the mainnet goes online.

Produced from Mining	40%	4 billion DBC	The first 3 years of mining generates 500 million DBCs per year, then the later 5 years of mining generate 250 million DBCs per year, and then every 5 years the mining production is reduced by half.
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Development History and Roadmap

Time	Event / milestone
August 2017	DeepBrain Chain Token Sale white paper 1.0 was released
September 2017	<ol style="list-style-type: none"> 1. R & D team moved to a new office in Hongqiao Tian Street in the Hongqiao business circles of Shanghai. 2. Was invited to participate in China's AI 30 people closed door forum and interpretation of the State Council's notice of new generation of artificial intelligence development planning " internal seminar in Beijing 3. Was invited to participate in the "Digital Asset Summit"
2017 Q4	<ol style="list-style-type: none"> 1. In October DBC was invited to participate in the "First Global Financial Technology and BlockChain China Summit 2017" 2. The first phase of the DeepBrain Chain is completed based on the NEO contract, and the tokens are issued 3. Support to charge and withdraw tokens, DBC assets to be launched on the third party exchange 4. Project quarterly key information disclosure 5. DeepBrain Chain promotion and vendor access

2018 Q1	<ol style="list-style-type: none"> 1. Completion of development of core layer architecture and key components, completion of development of the DBC AI TestNet, and building internal testing environment 2. Support test users' submission of AI training requests to DBC AI TestNet and finishing training in the TestNet 3. Development of the community contribution & reward system on the official website of DeepBrain Chain 4. Completion of the first round of global meetup (Dublin, Hamburg, Amsterdam and San Francisco)
2018 Q2	<ol style="list-style-type: none"> 1. Finishing development of features including AI users management, group management, role management and authorization management 2. Finishing integration of DBC AI TestNet with blockchain 3. Finishing development and testing of the internal DBC network environment 4. June 30th Launch of Skynet TestNet 5. Established DBC's Silicon Valley R&D center
2018 Q3	<ol style="list-style-type: none"> 1. Further improvement on and testing of the blockchain network and conducted internal test by key users 2. Support integration and deployment of various deep learning engine frameworks 3. Support release of new model algorithms and selection amongst existing algorithms, packaging data and putting out training/testing assignments 4. Support monitoring and statistics analysis of the DBC network 5. Support AI users performing AI computations on DBC network 6. Support DBC network security 7. On August 8th officially launched the SkyNet, users can now use DBC tokens to purchase GPU compute power

2018 Q4	<ol style="list-style-type: none"> 1. Further improve and test the blockchain network, activate network public test 2. Support better integration and deployment of deep learning engine frameworks 3. Support AI users to rate AI task execution results 4. Support API open to third party users 5. Further improvement on DBC network security
2019 Q1	<ol style="list-style-type: none"> 1. Further improve and test the blockchain network and update based on user feedback and community requests 2. Support AI data transaction and rating 3. Support AI data encryption and privacy protection
2019 Q2	<ol style="list-style-type: none"> 1. Complete the GPU isolation function; 2. Design and develop new DBC message encryption function and refactor DBC message signing function; 3. Use ECDH algorithm to generate one-time share secret, and then use share secret to encrypt log messages with CBC-AES transmission; 4. Integrate DBC message encryption and DBC message signing. 5. Designing and developing offline authentication for training tasks, solving the problem of miners being used without compensation in case of auth WEB failure. 6. Designing and optimizing the DBC matrix protocol, adding the enable_fast_forward option.
2019 Q3	<ol style="list-style-type: none"> 1. Support for transparent forwarding of optional parameters, where the current DBC intermediate node discards fields it does not recognize when forwarding messages. 2. Support for transparent forwarding of messages of unknown types. 3. Reconstructing DBC source code and preparing open source documentation. 4. Supplementing the internal design documentation of the restful API

2019 Q4	<ol style="list-style-type: none"> 1. A standard template for creating a GPU Server is provided, corresponding to the following scenarios: <ol style="list-style-type: none"> a. GPU Server uses the public IP that comes with Computing Node b. GPU Server using ngrok proxy 2. Optimize GPU Server creation: The GPU Server creation time is reduced from several minutes to tens of seconds by <ol style="list-style-type: none"> a. installing the standard template startup code mentioned in 2.2 into the computing node and copying it to each GPU Server b. Using the standard template will skip the IPFS installation, startup and code download 3. Completed development of memory management, CPU management, and hard disk management functions for the container 4. Completed GPU adding and unloading functions for the container
2020 Q1	<ol style="list-style-type: none"> 1. The GPU container and CPU container functions are officially online. 2. The automatic verification function of adding machines is online, after miners add machines, the system will automatically verify the availability of the machines, and automatically launch the machine online if it passes the verification, so that the whole link from DeepBrain Chain payment network to AI computing network to cloud platform can be verified fully automatically without any human intervention. 3. The container image supporting TensorFlow2.0 is online, so users can use it directly without installing TensorFlow2.0 by themselves. 4. The private cloud storage function is officially online, which facilitates most white users to upload files to GPU servers. 5. The image supporting drug molecular dynamics simulation is online, which is convenient for most drug R&D workers to use GPU computing power.

2020 Q2

1. added tensorboard support to facilitate visualization for AI users during training.
2. Added SSH verification mechanism for miners to go online.
3. security reinforcement done on the cloud platform server to prevent data loss.
4. Upgraded the GPU machine classification mechanism to classify machines based on memory space and hard disk space.
5. Improved the machine rental notification message display, making it easy for miners to view machine revenue.
6. added a payment verification mechanism to prevent payment failures caused by network problems.
7. automatic acquisition of the development completion image and production of a new version of the image.
8. added a limit on the absolute value of CPU cores of CPU containers to prevent malicious mining by wasting own resources.
9. improved the mechanism for bringing machines online and offline.
10. added the hard disk full restart limit and the hard disk space shortage alert mechanism.
11. Improved the switching mechanism of GPU container and CPU container, which no longer depends on the size of data in the container and greatly improves the usage experience.
12. Originally 100g of data takes 1 hour to start the container, but the new version only takes 3 minutes to start the container.
13. Addition of a scripted startup mechanism to the distributed computing network layer.
14. produced a new version of the image, unified python execution environment, unified jupyter and private cloud storage file directory.

2020 Q3

1. Added the automatic recovery mechanism in case of GPU container and CPU container switching failure.
2. Added the automatic recovery mechanism for disconnection of jupyter and private cloud storage ngrok.
3. Added the automatic recovery mechanism for abnormal termination of ssh, jupyter and private cloud storage processes.
4. developed and produced brand new images of tensorflow2.1, tensorflow2.0, tensorflow1.14, pytorch1.2, pytorch1.4, pytorch1.5, mxnet1.5, mxnet1.6.
5. A new upgrade of the deep learning mirror, removing a lot of useless content and making the mirror more lightweight.
6. added support for mxnet1.5, mxnet1.6, tensorflow2.1, pytorch1.5, and the latest molecular dynamics environment.
7. the addition of the corresponding version of the ipykernel kernel for each mirror to facilitate the use of jupyter.
8. automatic activation of the mirror corresponding version of the virtual environment, more convenient to use.
9. unification of python versions under jupyter and terminal access for virtual environments.
10. mirror Ubuntu version upgraded to version 18.04.
11. pre-installed opencv compiled version of the mirror, which greatly improves the experience of using opencv.
12. added docker auto-detection and restart functions.
13. added detailed server usage documentation and help documentation.
14. optimized the response mechanism of the AI computing network.
15. upgraded the deep learning image and DBC network, and the image is pre-installed with the opencv compiled version, which greatly improves the experience of using opencv.
16. added pip to regard the default download source as the Tsinghua source.
17. optimized the response mechanism of the AI computing network.
18. added support for cuda9 by default.
19. added support for filecoin snark computation mirror and API interface access for computation support of c1 and c2 of filecoin seal.
20. Added support for Filecoin snark GPU computation.

2020 Q4

1. Added the discount function for monthly, quarterly and annual packages.
2. added the function of supporting whole rentals.
3. added the AI inferring area, renting machines in this area grants users' the use of additional open APIs.
4. the website interface layout was reworked with clearer classification.
5. Added the DBC supernode rental function. If you want to participate in the DBC supernode, you do not need to buy the machine yourself, you only need to pledge a certain number of DBCs to rent the machine inside the DBC network to participate in becoming a node that generates blocks.
6. Added the pledge function. In order to enter the highly stable AI training area, you need to have a machine running stably for at least 144 hours and pledge DBCs.
7. added the function of launching machines online and moving machines offline.
8. Optimized the GPU acceleration algorithm.
9. optimized the cloud platform wallet and added the gas function.
10. studying the combination of privacy computing and DBC network.
11. optimized the node dynamic scaling function of the DBC network.
12. upgraded the deep learning mirrors that support deepshare courses and papers.
13. further optimizing the dynamic scaling function of DBC nodes in order to cope with the continuous increase of machines in the DBC network.
14. Upgrading the AIM machines, all of which are now fully online and ready for delivery to AIM buyers.
15. further optimizing the DBC network node message forwarding function.
16. developing a scheduling engine based on GPU virtual machines for the needs of cloud gaming and rendering users.
17. ongoing modification of the substrate based web wallet.
18. Supporting the launch of nearly 30 GPU cloud platforms based on DeepBrain Chain network.

2021 Q1	<ol style="list-style-type: none"> 1. DBC mainnet public test phase one launched 2. Development of online reward smart contract for computing nodes 3. Development of computing node rental and destruction contracts
2021 Q2	<ol style="list-style-type: none"> 1. DBC mainnet public test phase II started 2. Testing phase one of online reward smart contract for compute nodes 3. DBC mainnet officially launched and token swap starts 4. Online reward smart contract for compute nodes officially launched
2021 Q3	<ol style="list-style-type: none"> 1. Compute node rental and destruction smart contract officially launches, DBC starts to enter the deflationary era 2. Upgrade and improve the smart contract
2021 Q4	<ol style="list-style-type: none"> 1. Support AI training and inferring, cloud gaming, graphic rendering, ETH2.0 and other advanced customization needs from customers in multiple scenarios
2022-2025	<ol style="list-style-type: none"> 1. The scale of DeepBrain Chain's network exceeds 500,000 GPUs, making it the world's largest distributed performance computing power network

Fund Usage

As the world's first blockchain based high-performance distributed computing network, we are both the founder of the new model, but also the industry benchmark. The purpose of this Token Sale sale is mainly to:

1. Consolidate the first brand position of DeepBrain Chain in the industry
Optimize DeepBrain Chain system performance, promote marketing, network at home and abroad so that more manufacturers know DeepBrain Chain, and support the use of artificial intelligence business global Token Sale of DeepBrain Chain.
2. Harness blockchain technology to create more valuable assets
Our goal is to redefine the artificial intelligence operating system with blockchain

technology, and to enhance the belief that blockchain and artificial intelligence are in line with the technology and scale expectations of the future development of the project. Blockchain + artificial intelligence will change all aspects of our lives.

3. More efficient return to mining nodes contributors and Token Sale sale supporters The project team will set up a DeepBrain Chain fund for Token Sale public funds for earmarking, and develop a public disclosure mechanism by cycle, with timely disclosure of details of uses.

7.1 Token Sale Capital Use Plan

Category	Proportion	Illustration
Technology research and development	55%	Employ advanced technical personnel; Set up blockchain laboratory with international first-class universities; Performance optimization and upgrade of DeepBrain Chain system; DeepBrain Chain ecological strategic investment, and create the first specific application case of DeepBrain Chain To push the commercialization of DeepBrain Chain.
Market promotion	25%	Media advertising investment and brand promotion; With users, factories, and developers, promote the interpretation and widespread use of DeepBrain Chain.
Daily operation	10%	Office expenses, travel expenses, transportation fees, conference fees, business entertainment expenses, fees of office equipment, servers, and so on
Community incentive	8%	Encourage supporters to spontaneously establish regional DeepBrain Chain applications and communicate with communities, and continue to maintain the community's activity, collect suggestions of the majority of supporters to promote the healthy development of the DeepBrain Chain platform

Intellectual property right	2%	Patent fees, trademark fees, copyright fees, high and new technology certification and expert exchange at home and abroad
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Investment Institutions, Investors and Consultants

8.1 Investment Institutions



Gobi Partners has offices in Shanghai, Beijing, and Southeast Asia, and is a professional venture capital company focusing on investing in China's early science and technology projects. Gobi fund's strategic investors include IBM, Sierra Ventures, The McGraw-Hill

Companies, and Steamboat Ventures (Disney's venture capital sector), etc. It has invested in Tuniu, Camera360, CloudCare, and other famous start-ups, and is a veteran investment fund.



GBIC (Global Blockchain Innovation Center) is a global hub for blockchain technology that provides investment, human capital, and resources for the development, acceleration and launch of blockchain projects. We utilize our global network of resources & investors from China, Russia, Europe & Korea to provide investment and services including Marketing & PR, community building, exchange listings, white paper and token analysis.



Founded in October 2017, Hong Kong Bite International Capital focuses on venture investment in and cooperation with companies engaged in blockchain and cryptocurrency. It has incubated more than 15 good projects, in areas ranging from blockchain bottom protocol technology to AI distributed computing technology.

Voting and Community Governance

9.1 Operating Body

DeepBrain Chain set up the DeepBrain Chain foundation in Singapore. The main task of the foundation is to run DeepBrain Chain platform openly, fairly, transparently, without a profitable purpose, and deeply support the development team. The foundation is a legally established organization that supports or participates in the public or private interests without any commercial interests. The profit earned by the fund is called surplus and will be retained as funds for other activities without allocating profits among its members.

9.2 Governance Structure and Voting

In order to let the DeepBrain Chain foundation make use of the funds and resources in an open, fair, and transparent way, to constantly promote the rapid development of DeepBrain Chain, to expand the application scenarios of DeepBrain Chain, and to absorb more institutions, companies, and organizations into the DeepBrain Chain ecosystem, the foundation sets up the organizational structure as follows:

Decision Committee

The decision committee is the highest decision-making body of the DeepBrain Chain foundation, which bears the final decision-making function. Members of the decision-making committee are responsible for review and approval of strategic planning, annual plan, budget, and other important matters, and on behalf of the foundation vote on the DeepBrain Chain ecological issues. Members of the decision committee and the chairman of the foundation are in office for two years.

Executive principal

The executive principal is elected by the decision committee and is responsible for the decision committee. The executive principal will comprehensively implement the relevant resolutions and provisions of the decision committee, will be responsible for the daily operation of the DeepBrain Chain, will complete the indicators issued by the company, and will regularly report the implementation to the organization. The executive principal has the right to set up the necessary functional departments and to recruit the management personnel, responsible for coordinating five departments (technology research and development, product design and manufacture, ecological operation, marketing, and financial personnel) to form an organization and management system centered on it.

Technology R & D Committee

The technology research and development department is responsible for the development and audit of the underlying technology. It is the basic department of the foundation. In order to

ensure smooth internal sharing of information, the technology research and development department should exchange information with other departments (especially product design department), timely adjust the communication project details, and determine the direction of research and development of the next stage.

Product Design Committee

The product design department is responsible for enriching and perfecting the product framework provided by the technical department. The department establishes a sustainable concrete development strategy, such as conducting market research, coordinating product functions, and undertaking UI design and image design of DeepBrain Chain. Members need to keep abreast of community dynamics, hot spots, and feedback. Members also need to actively communicate with token holders and irregularly organize technical exchanges and other activities.

Ecological Operations Committee

On the basis of the technical and product sectors, the eco-operations department is responsible for "one outside one inside." First, the work will be extended to the depths, and the partners will be actively explored. DeepBrain Chain, end users, and partners will be closely linked to create an open and distributed global ecosystem of privacy protection.

Second, the department will strive to build a community within the ecological circle, form a user community with benign interaction, and let fully symmetrical information flow freely.

Marketing Committee

The marketing department is responsible for promoting the core or derivative products and services of DeepBrain Chain. Responsibilities include, but are not limited to, communication with the media, advertising, design, user interaction, and so on. The department will work closely with the ecological operations department and, according to the requirements of partners and end users, develop the most appropriate publicity program.

Financial Personnel Committee

The financial personnel department is responsible for the management of the company's financial affairs and personnel matters, such as capital management, accounting, cost control, and other aspects of the work. At the same time, due to the high risk of digital assets projects, the department is also responsible for risk management business, cooperating with other departments for project management, financial risk analysis, and evaluation. In auditing, the existing system is difficult to supervise effectively, because of the particularity of digital assets and token itself. The decision committee will hire professional auditors with relevant experience to ensure transparency and openness of DBC use.