

# The mosaic of a decentralized brain

## Abstract

Becoming a federated learning atom, IoT devices in the AI Technology Network based on blockchain technology can learn from its own desensitized work data in production and service operations to contribute to practical industry AI solutions. Meanwhile, owners of IoT devices can get profit from the data and computing his devices contribute. These optimized AI solutions can be sold or shared with the AI Technology Network Community after review and applied in a digital twin of the real world so that enterprises can optimize workflow, public can prevent disasters and talents can try innovations free and efficiently. Finally, all the previous work will contribute to form a decentralized AI brain which devotes to dynamically seek the integrated welfare for the whole society.

The remainder the paper explains:

- ◆ Why we need a decentralized brain
- ◆ How we establish a decentralized brain
- ◆ How the AITN economy supports the decentralized brain training
- ◆ What to be expected in the AI Technology Network

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## Why we need a decentralized brain

Web 2.0 has transformed all walks of life deeply and fed the billionaires with unprecedented power and desire. The convenience brought by the centered platform had blinded most of us and lured the original nature to contribute. On the opposite, the combination of capital interest and network does real and continued harm to our physical community. Not only is the common blame such as discrimination driven by data controlling, rank manipulating and content filtering, but also is the invisible responsibility shifted on every other part of the society than the benefited platform.

As Tom Slee demonstrated in his book<What's yours is mine>, Airbnb, the Silicon unicorn and the representative of the web 2.0 sharing economy promoted itself as an org which helps kind and artistic locals to gain some income to afford their daily life with dignity, but the actual data crawled by third party supported the fact that mainly professional agency and wealthy people earned much more untaxed short-term vacation rent, and the local community found that both long-term rent and real state offer decreased with the housing cost unsurprisingly surged. Despite the critics on the founders and venture capitals, the economic essence of the web 2.0 sharing economy is the uneven exploitation of local resources by privatizing the global-class data and repeating the ambiguous consensus of contradiction between digital rebellion and conservative hotel groups.

However, as sharing can be the most appreciate kindness ever since the first tribe was formed and all the technology is neutral, we won't give up exploring better technology solutions to help sharing. Blockchain is known as decentralized and trustable digital ledger, which derivates DAO, decentralized autonomous organization, a new form of public decision making. Therefore, the coming web 3.0 sharing economy can involve all parties together to design the sharing mechanism and contribute to increase the total community welfare.

Although most people are often generous, a satisfied agreement is still hardly reached concerning personal interest and anonymous voting, a decentralized artificial intelligence fed by high-quality data which takes care of all parties' interest and give the dynamically optimized solution deems to be the major engine of the web 3.0 sharing economy.

## How we establish a decentralized brain

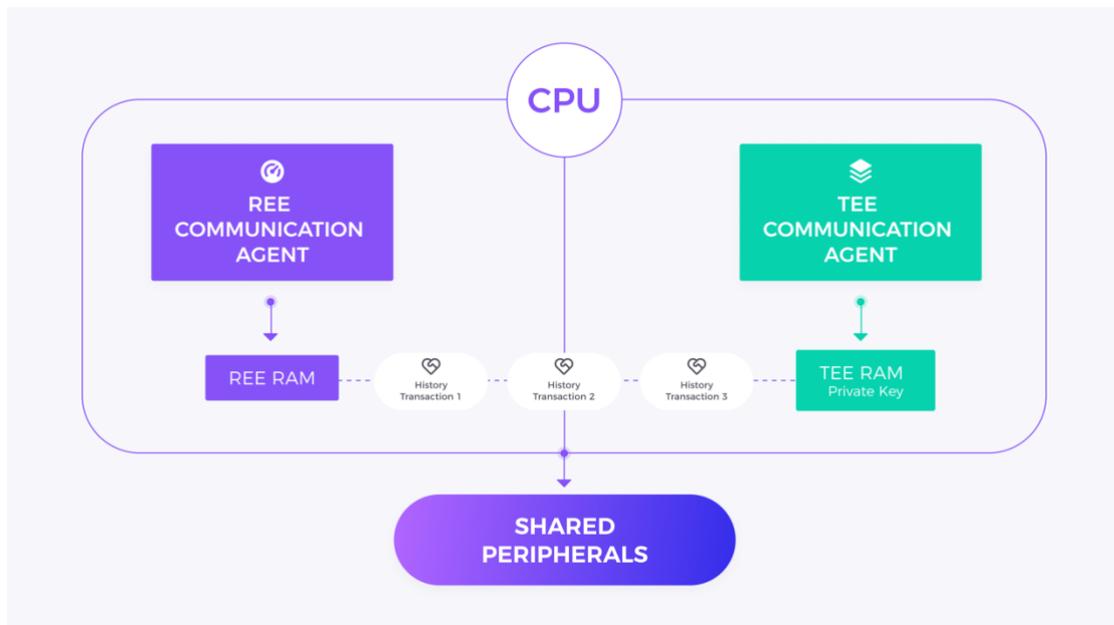
Big data and great mathematical model like neural network are Artificial Intelligence's father and mother.

According to the International Data Corporation, 59ZB data had been produced in 2020, and the annual compound increase rate was expected to be approximately 61% till 2025. On the other hand, most data produced on the Internet was controlled by giant platform like Facebook, Google, Twitter, etc. While we can not hack their database, we find another data ecosystem which is a rather better fit, the Internet of Things.

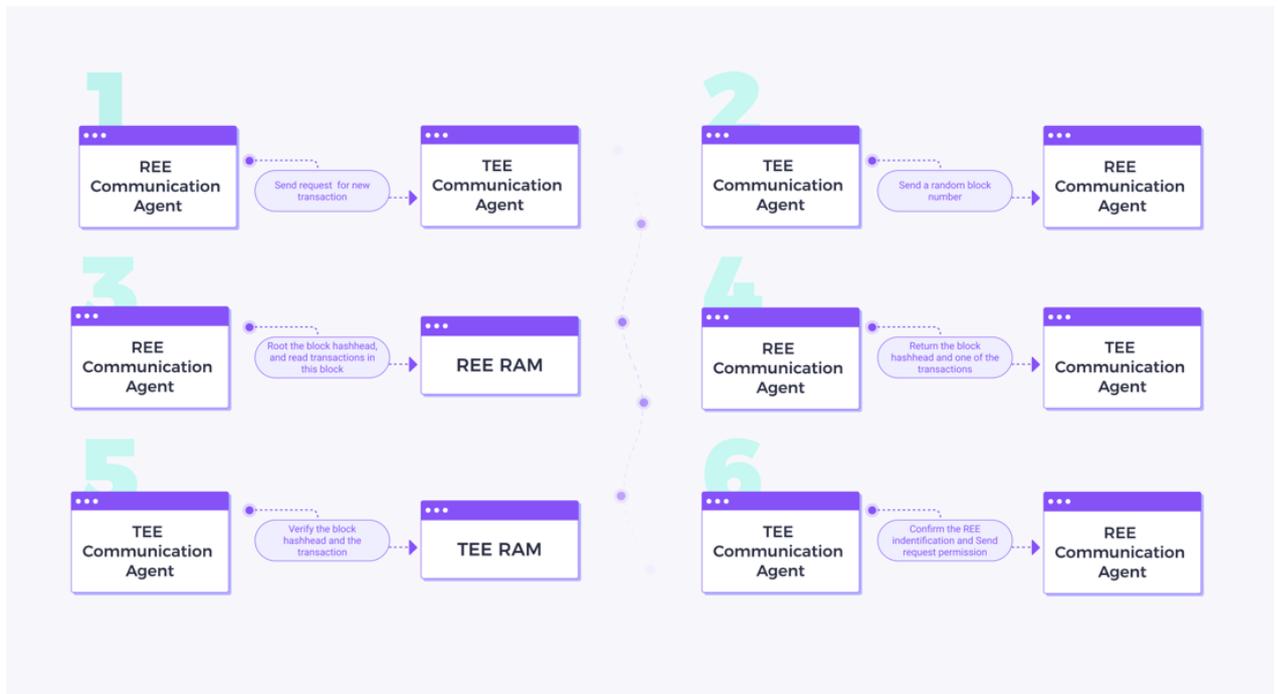
To manipulate Internet of Things is more difficult. A variety of devices can be linked to the network and serve as nodes, thus setting a unified standard covering both hardware and software causes a lot of trouble. Besides, basically any participant in this industry knows well about the value of big data even if not knowing how to take advantage of it. Every company wants to build their own "Apple" ecosystem on this uncultivated land, but there's no species can really dominate an ecosystem and the competitive reinvention and reproduction does waste the society's resources, leading a bigger chaos and calling a web 3.0 cooperative way to establish the Internet of things.

To cultivate the data land, the worker should be transformed to fit the blockchain protocol. First, the device needs to be minted as BEP-721 Non-Fungible Token to be unique and can be recognized in the web 3.0 sharing economy. We then updated the hardware stack to fulfill the security requirement as the device intelligently connecting to the economy and making decision by itself. The Arm Trustzone Stack is adopted to separate the hardware and software as to prevent sensitive information from network attack. The traditional stack is divided one CPU into two parts by time, Rich Execution Environment (REE) which runs normal and client applications and Trusted Execution Environment (TEE) which contains the secured components, with the two systems communicating through the shared trusted peripheral. When the device is connected to the blockchain, the private key that encrypted message is stored in the secured memory. However, as the REE is exposed to the outside network, a third party can hack the REE layer and get the REE hardware information, pretend itself to be REE

and fake a transaction message to ask for private key permission, which is a Man-in-the-Middle Attack.



To tackle this problem, we need to identify the correct sender. We decide to add a private blockchain to bridge the REE and TEE communication. All history message exchanged should be stamped by a time-lock related to all the previous transaction hash and the TEE will ask the sender about random block information on the private chain to verify if the sender is REE.



Now the question goes to how we store and process the data produced to serve the training of the decentralized brain. Data will be processed using edge computing and stored under IPFS protocol. Edge computing, also known as Fog computing, in contrast to Cloud computing, is extremely crucial to facilitate low and predictable communication latency, real-time interaction, location awareness, and large-scale mobility networks. The work data will be desensitized through privacy computing and the processed data set will be sliced, put in IPFS network and received the unique CID.

The data set after desensitization can be treated as a training set or a test set. Furthermore, the devices will play in the machine learning process as well, which is called federated learning. Each kind of device can learn from its own dataset, compute the gradient and conclude a rough model, then a demand-server node can collect the models and allocate weights to form an efficient model in the specific area.

When the specific AI models grow more mature, it is time to construct a digital world based on smart contracts. The decentralized brain can start to help community members like factories, household and organizations with daily operation, disaster prevention and cooperative innovation. Finally, we are expecting the decentralized brain can help dynamically suggest the optimized solution for the whole community welfare.

# How the AITN economy supports the decentralized brain training

## 1. A brief introduction of AITN economy

AI Technology Network economy aims to lay the groundwork for a market economy built around a marketplace for the big data process and AI training. Anyone who has a good model idea can get access to the AI Technology Network and gets backed by unprecedented amounts and varieties of data as well as efficient federated computation. We introduce a BEP-20 token, AITN as the economy share of AI Technology Network. Any kind of transactions happen in the AI Technology Network economy shall be settled by AITN.

## 2. Participants in the AITN economy

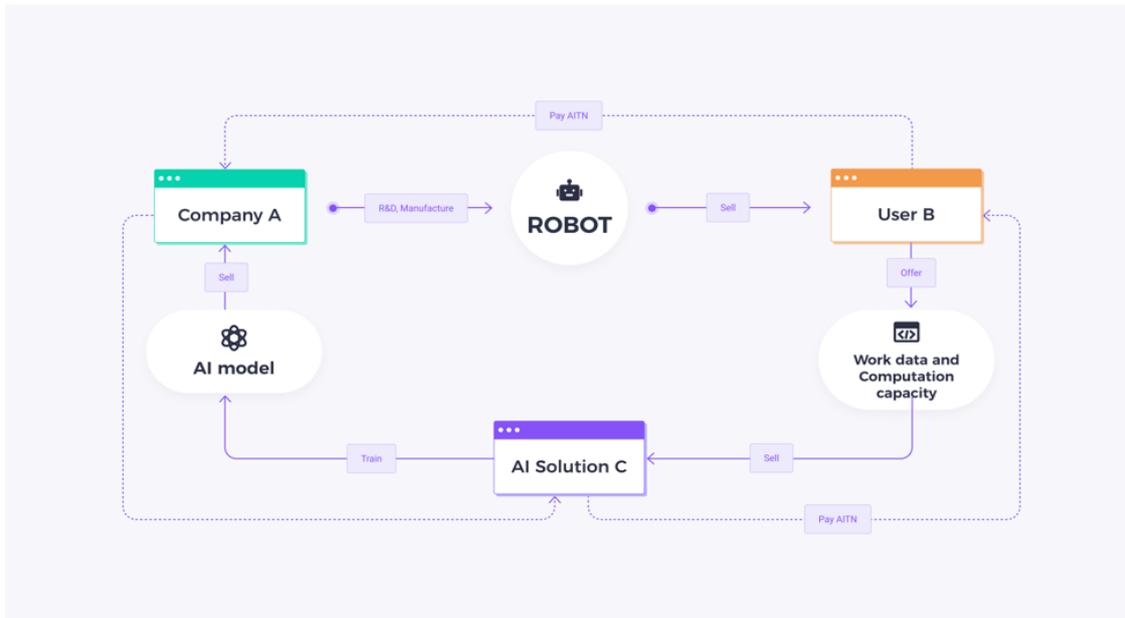
All kinds of industry need AI to utilize their procession and cooperation with market demand and supply chain. Cited from Fortune, “the global Artificial Intelligence market is projected to grow from \$47.47 billion in 2021 to \$360.36 billion in 2028 at a CAGR of 33.6% in forecast period. Further, amid the pandemic, not only the health care industry experiencing hunger for AI, but also industries such as retail, manufacturing, automotive transportation, and logistic, even medium and small companies in these industries highly invested in the AI technology to balance the demand and supply. “

The AI solution providers stand on the supply side, apart from the traditional giant's cell like Azure and Facebook AI, more and more AI labs emerge and many of them are specialists in a vertical industry. Competing with big brothers, the new AI companies desire good-quality big datasets a lot and will perfectly get used to the AI Technology Network.

What's exciting about the AI Technology Network is the personal user and the public organizations can really engage in the prosperous AI future. Even the governments realize the consequence of data centralization, the regulations like General Data Protection Regulation can only protect privacy and usage of user's data, the aggregated profit and power still put the user in the unfair situation. However, in the AI Technology Network economy,

once the user buys the device, the device NFT, the unique certification of the ownership and usufruct protects the user's benefit in his/her data.

Here's how participants interact in the AI Technology Network. As there are all kinds of IoT devices, for your convenience, we use the stereotype of IoT device, the robot to demonstrate all the upcoming operations.



The self-growing cycle started from the industry side. Company A manufactures a cleaning Robot L and sell it to User B. User B uses AITN to pay the bill. Then, AI Solution C wants to train its AI model in cleaning industry and buys the cleaning robots 'data and hires them to do federated computation. The AITN paid by AI Solution C will be allocated to User B according to the contribution of Robot L. Finally, Company A needs the AI model offered by AI Solution C to develop the next generation of cleaning robot. A new round of data flow continues.

## **3. Services in the AITN economy**

### **3.1 The Service**

#### **3.1.1 Atom**

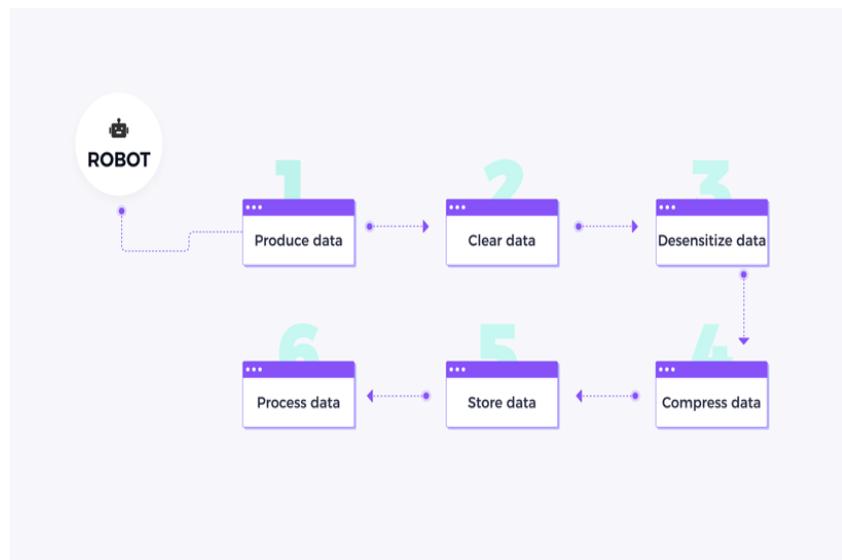
Atom in the AI Technology Network is the IoT devices. Although one type of devices is identical one from each other. The actual work data production and computation contribution can still vary because of workload and network efficiency. However, two different types of devices are different mainly because their components, especially the workflow designed and computing units like CPU and GPU.

#### **3.1.2 Demand Server**

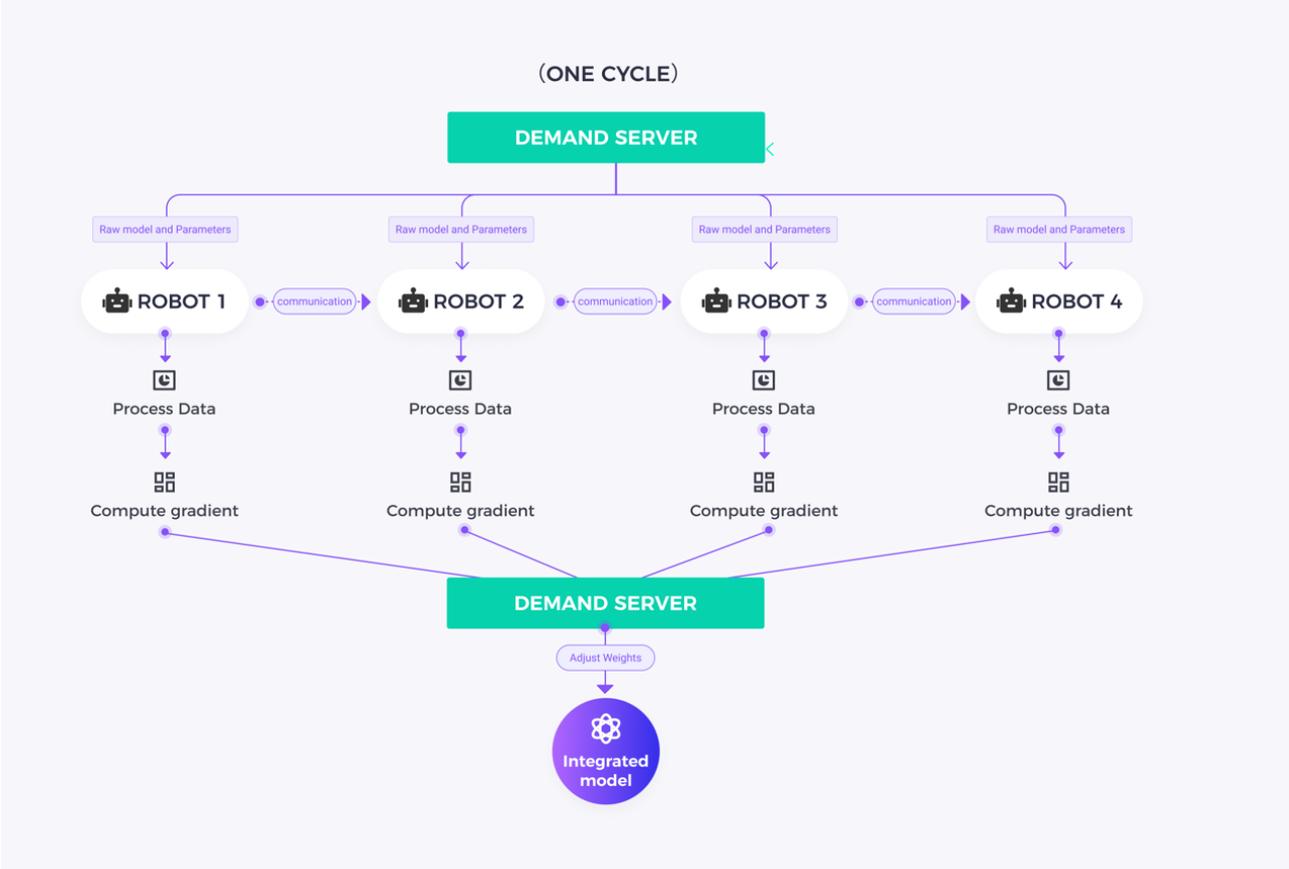
Demand Server is the server of AI Solutions. Demand Server can get access to the AI Technology Network through the series of smart contracts. Currently, we built the first version of AI Technology Network on the Binance Smart Chain because the huge amounts of data exchange require tested stable network and cheaper communication cost. The Demand Server can broadcast its requirement to the AI Technology Network and receive the atom's application which contains some sample work data and atom characteristics. The Demand Server can select the qualified candidates, then send the original model and training instructions including key parameters to start the federated learning.

### 3.1.3. Training

Generally, the work data produced by devices will first be cleaned, remaining the effective parts. Second, desensitization is the most important process, as the raw data contains user's private information and is prohibited under regulations. Afterwards, the work data is compressed and stored in the IPFS space, where the whole set will be sliced into pieces and then hashed into Content Identifier to point to in the next request.



The atom will root its history dataset using recorded CID and process the data by itself. After an original model is trained, the atom will differentiate the model to get the gradient model. Then, the atom will return this gradient model to the demand server. Normally the demand server will integrate the atom's model in the base model by allocating a weight to the atom's model. After collecting all the atoms 'gradient models, the demand server will produce the optimized model. And the next round of federated learning can start if this model needs to be further optimized after industry test.

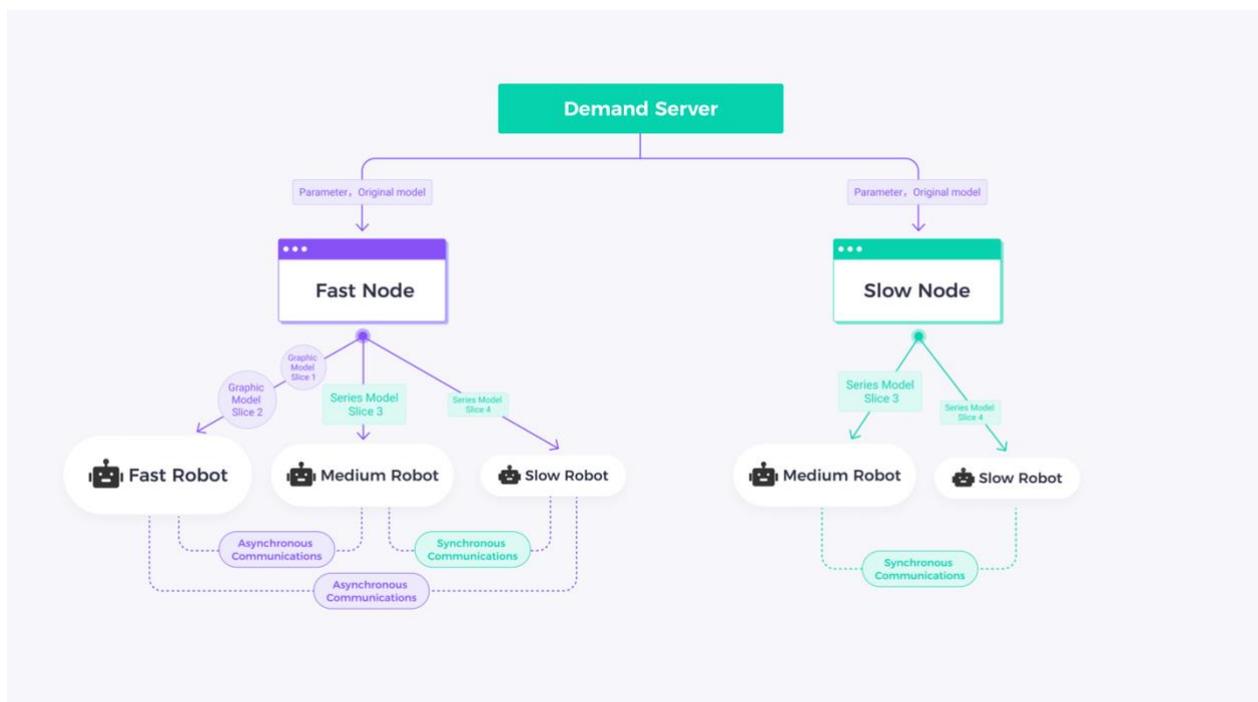


### 3.1.4 Hybrid Parallelism

As federated learning gradually adopts either model parallelism or hybrid parallelism (data and model parallelism) to increase training efficiency, we encourage users setting up training node as the AI Technology Network cell. One device can certainly set up a training node. A group of IoT devices computing corporately is closer to the earth. In practice, data falls into different types. Different types of devices equipped with different competitive computing components for different uses, a group of devices can separate data and model parameters according to types and let the competitive edge do what it is good at, such as GPU dealing with graphic data. Therefore,

some devices can practice asynchronous communications with each other because one simply don't depend on the other's data to train its own gradient model, the fast device can continue on training its part rather than wait for the slow device to synchronize data. Meanwhile, according to the various computing capacity, the communication node can slice the original model and allocate different-size models to devices, which maximizes the work efficiency among the group.

This is so-called hybrid parallelism optimization, and it is broadly accepted in practice. That's why AI training flow in the AI Technology Network encourage node access rather than direct device access.

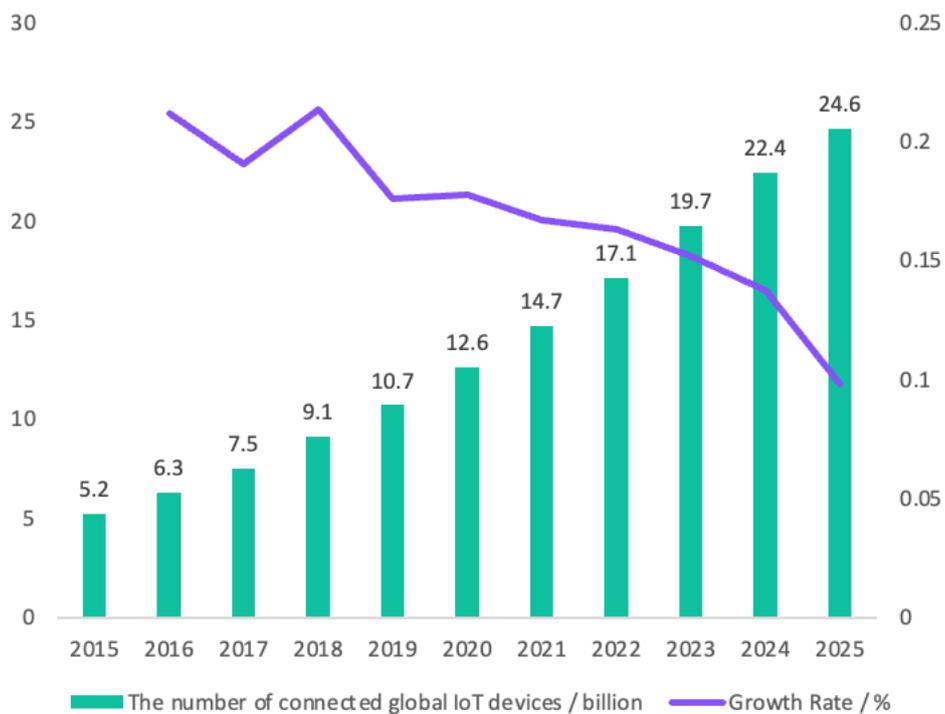


## 3.2 The Incentive

### 3.2.1 Jump-up Solution

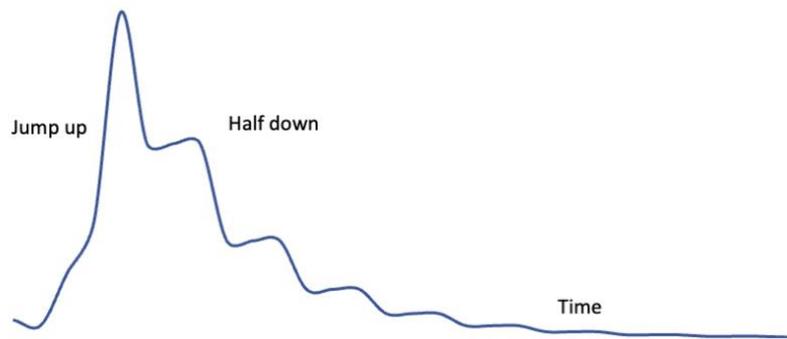
Although after the AI Technology Network gets recognized, the whole network can be driven completely by market demand, it still needs incentive aside from fee paid by AI solution companies to facilitate the initial explorers and fasten the progress. Therefore, we propose a jump-up incentive solution. Particularly according to the Fortune's projection, the AI industry will increase at a CAGR of 33.6% till 2028, almost 8 times the current market value, reaching 360 billion. And GSMA reported in 2020 that the global IoT devices connected accounts for 12.6 billion and projected to be doubled in 2025.

Number of connected global IoT devices from 2015 to 2025 (Projection)



We would assume if the AI Technology Network accounts for 1% the world market, then the jump-up incentive can reach the end. Therefore, 0.246 billion connected devices serve for 30 billion AI market is the milestone we would like to achieve, approximately 1ZB data procession. Before the milestone, the computing incentive per cycle jumps up to award the increasing network capacity. After the milestone, the remaining computing incentive per cycle will simply half every three years to maintain the stable and long development of the AITN economy.

The computing reward per cycle



### 3.2.2 Work Utility

To quantify the network capacity, we define a measurement unit called work utility. 1 standard work utility equals 1PB possible computing capacity per incentive cycle. The calculation of work utility will be divided into two parts: the fixed part and the variable part. The fixed part focuses on the physical capacity of the devices, now basically accounting for the computation specifications: CPU, GPU, RAM. Since the IoT devices vary a lot on the hardware components, we now adopt only a few basic units and give a simple weighted function to measure the single device's fixed part of work utility. The detailed samples can be learnt on our NFT website. However, the fixed part is the theoretical capacity that a device can contribute to the network, we will not lean on too much on this part and after the milestone, the fixed part will not be counted in the

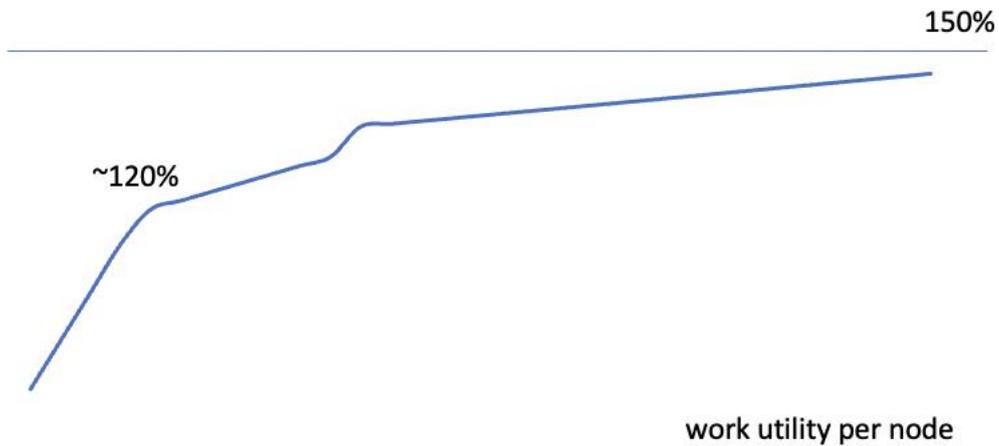
contribution allocation of market AITN earned.

The variable part is more vital, because it is the actual contribution the device makes in every cycle. This part will further be divided into two parts: the data production/processing and the communication waste. Clearly, the data production/processing is a positive item, and the communication waste is a negative item. Thus, the vital part is calculated as the byte of data produced/processed per second multiplies by the difference of actual work time and the channel communication time.

### 3.2.3 Incentive allocation weight

The AI Technology Network will incentivize the capable nodes to operate more devices. Since only one distribution device in the node needs to communicate with the demand server for order instructions and allocates the task can avoid much unnecessary communication between atom devices. Another practice experience supporting device group is that a group of IoT devices work within a certain physical distance can decrease the communication time. For example, manufacture robots in the same industrial zone or all the IoT devices in the same family, both can save considerable communication waste in the network. However, rational thinking can tell this group optimization won't save all the communication cost, nearly 300 devices will reach the current limit, 50% as experimented while only 30 devices can make an obvious difference of 20%. Therefore, as the work utility within the node increases, the node's incentive allocation addition will increase diminishingly until 150%.

## Diminishing Node's Incentive Allocation Addition



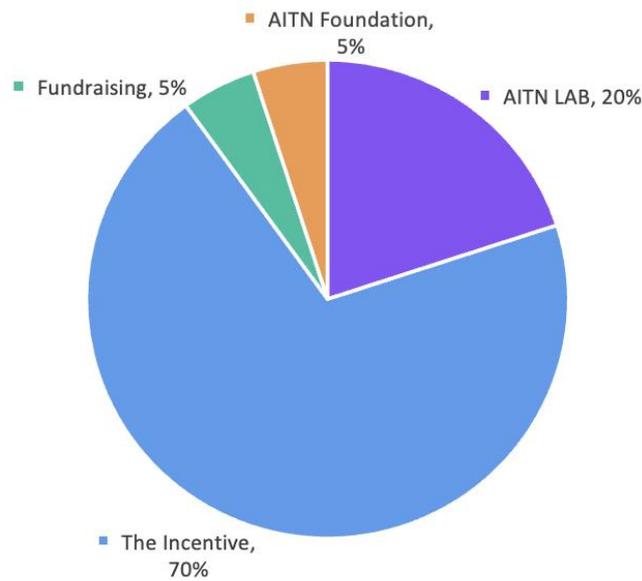
Important, the computing incentive will directly send to the node address per cycle. And node can allocate the total incentive to individual devices according to its own rules, suggesting by work utility (note that the fixed part is theoretical capacity and may not really contribute) or actual data production/processing.

### 3.3 The Allocation

#### 3.3.1 Distribution of AITN Token

AITN is designed to support the development of AI Technology Network. Therefore, its distribution is vital for highlighting our mission: building a decentralized brain for the welfare of the whole community. AITN is limited public resource with a total supply of 2 billion, referred to as `The_Total_Supply`. Of the AITN genesis block allocation, 5% of `The_Total_Supply` will be allocated for fundraising, mainly for manufacturing experimental robots. 20% of `The_Total_Supply` will be allocated to AITN Labs.

Together with all kinds of donation from the AITN community, it will be used to build the digital twin world and train the decentralized brain. Another 5% of The\_Total\_Supply will be allocated to the AITN Foundation, which will discover how AI can help the charity, especially those big issue that everyone feels a heavy burden like global warming. The remaining 70% of The\_Total\_Supply will all serve as incentives for computing rewards, liquidity rewards (Defi planned in the AITN economy) and circulating rewards (future robot service market in the AITN economy).



### 3.3.2 Parameters of AITN Economy

Here's a summary of initial parameters set in the AITN Economy.

Parameter	Value	Description
The_Total_Supply	2 billion \$AITN	The maximum amount of AITN that will ever be created

The AI Training Service Incentive Reserve	1 billion \$AITN	Tokens reserved to award the computation capacity in the Network
The Defi Service Incentive Reserve (To be developed)	0.2 billion \$AITN	Tokens reserved to award the market competition in the economy
The Payment Incentive Reserve (To be developed)	0.2 billion \$AITN	Tokens reserved to award the payment for robot service in the economy
The Incentive Cycle	24 hrs	Time between two incentive allocation (not including the training fee)
The milestone capacity	1 million work utility	The minimum network computing capacity to sustainably develop in the
The maximum node's incentive allocation addition	150%	The limit that communication waste saved by group working and hybrid parallelism
The suggested devices in one node	30-300	The number of IoT devices range that minimum and maximum effective

		communication waste saving lies in. (Note that communication waste is not linearly related to work utility.)
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## What to be expected in the AI Technology Network

AI Technology Network will always evolve to meet the demands of community and markets. The AITN DAO will take the responsibility to propose detailed plans and encourage community members to vote.

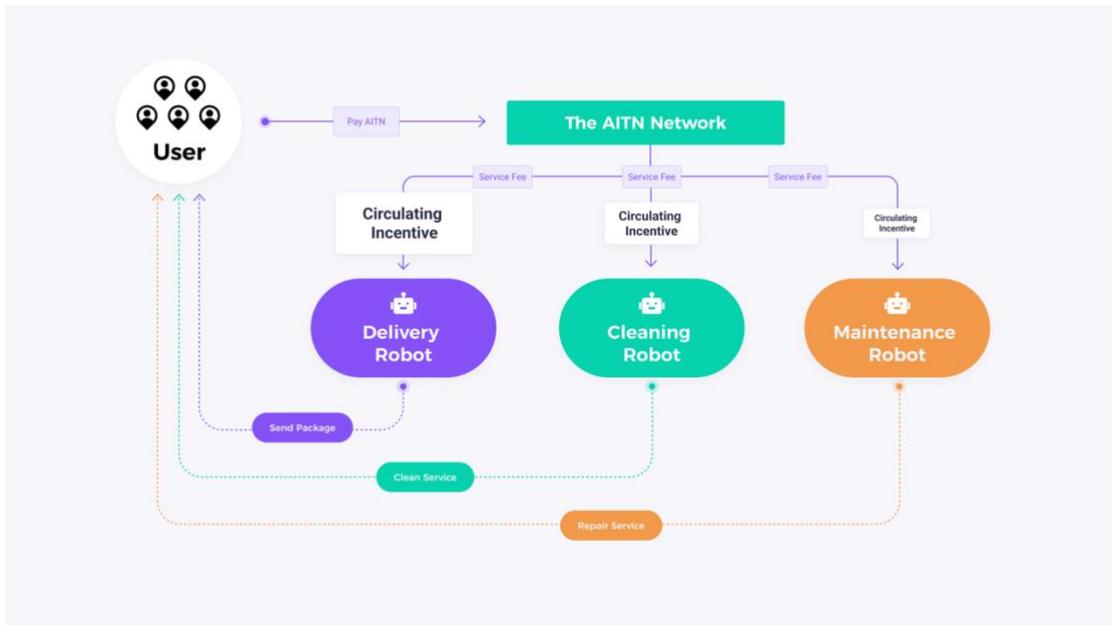
The upcoming features are:

### 4.1 Open access and robot service

A complete access standard shall be discussed and set by AITN DAO to engage existing IoT devices from household and public.

With the world population reaching the ceiling, robots will replace much human labor to provide services. The International Federation of Robotics 'executive summary showed that in 2020, the operational stock of industrial robots had already been computed at 3,014,879 units and was projected to grow stably by 10% to 2024. Current cryptocurrencies' exploring of daily payment struggles on the Impossible trinity of decentralization, speed and security. We notice the problem may not be solved in the established worldwide trade system. However, within the to-be-established robot trade system, standard robot service transaction, gradually growing amount of transaction, increasing connected nodes and the payment network optimization by a decentralized brain, all these features contribute to build satisfied experiment ground for a practical decentralized public payment network.

To facilitate the experiment, the AI Technology Network has reserved 10% of The\_Total\_Supply for the circulating incentive. The detailed incentive plan will be left to AITN DAO's decision.



## 4.2 Defi

A Defi will be developed to encourage more AI market participants. The current design of the AI Technology Network is still not able to break the power of giant platform since they have already accumulated much more capital and experience. However, given capital and time, fair competition can activate the market to a new era.

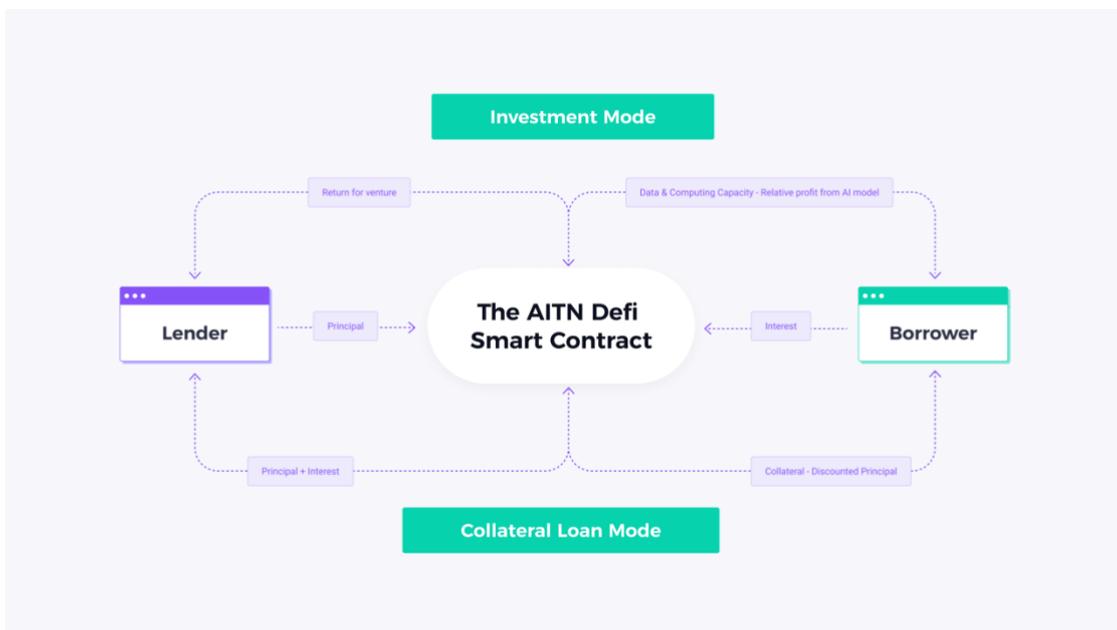
There will be two modes in the Defi, investment mode and collateral loan mode.

Lender plays as venture capital in the investment mode. Borrower, the AI start-up can only use the investment for purchasing data and computing in the AI Technology Network through the defi\_investment smart contract. And the trained AI model will be minted a multi-sig NFT through the defi\_investment smart contract to indicate the shared usufruct. Afterwards, if the venture investor wants to get his return instantly, he can sell the relative part of the AI NFT on the NFT market.

In the collateral loan, borrower needs to lock his crypto assets in the

defi\_loan smart contract and then can borrow discounted AITN. In this mode, the usage of borrowed AITN is not restricted. However, the borrower not only needs to pay the agreed interest regularly but also needs to add crypto assets to maintain the leverage ratio if the market value of his collateral decreases.

Defi participants on Both sides can receive the liquidity incentive, the detailed incentive allocation will be discussed and decided by AITN DAO which welcomes all the community member to join.



### 4.3 Digital Twin World

AITN Lab is hoping to cooperate with the AITN Network, together building the digital twin world. Now we start to work on the ground construction of the digital twin world. We are excited about hearing ideas from the Network Community and adopting fascinating metaverse technology to vividly build this lovely digital world.

We will report the digital twin world progress through AITN official website [aitn.io](http://aitn.io) periodically. Make sure you don't miss the update and thanks for your feedback.