IoTEdge Network

An M2M Economy for Internet of Things

Powered by a Decentralized Edge Computing Network

Website: https://iotedge.co

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Disclaimer This paper is intended to be a technical overview. It is not intended to be comprehensive, nor to be the final design. So non-core aspects are not covered, such as APIs, bindings or programming languages.

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Background

The Internet of Things (IoT) is one of today's most widely discussed technology topics. Gartner predicts that Internet of Things devices will reach 14.2 billion in 2019 and 25 billion in 2021.It is estimated that more than 70 billion nodes will be connected to the network by 2025.

And also IoT is the application expansion and extension of Internet, communication network and sensor network. It makes a potential service provider by effectively integrating the resources of sensor network, communication infrastructure and industry infrastructure. With the advent of 5G era, the era of interconnection of all things will shine from dream into reality

From smart agriculture through to smart cities to smart factories, the expectation is that IoT will be transformative. The 4th industrial revolution. However, the reality is that IoT still remains a promise. And, more significantly, IoT remains fragmented. Indeed, most of the applications that do exist are vertical solutions that do not represent a dynamic, interconnected world that the name, internet-of-things, would suggest. The Internet of Things is also facing serious challenges.

Consensus mechanism

Current consensus systems, such as job certificates or stakeholder certificates, are flawed to make themIt is difficult to adapt to Internet of Things equipment. For example, work proves that the system requires powerful computing power and a large number of memory end nodes, which is expensive for consumers.

Unified standards

The global Internet of Things environment lacks a unified standard system. Dozens of standardization organizations around the world have issued 250 standards. At present, most of the Internet of Things systems are based on the standards of their manufacturers. The information formed is often discrete and fragmented, forming a fragmented information island. This is one of the reasons that hinder the development of the Internet of Things. At the same time, there are many incompatible information and information fragments in the wide area of the Internet of Things. These point and line information data need to be anchored by chain information to make discrete information holographic. Through cross-vendor access and liquidation, it is conducive to breaking the trust barrier between the local Internet of Things and the wide-area Internet of Things and improving information fluency.

Real-time

In the traditional simple and light transaction process, there will be trust friction in the information collaboration between things, which results in low collaboration efficiency. The traditional network architecture is usually centralized. The efficiency and utilization of the edge end are obviously insufficient. In the Internet of Things, it is impossible to send all information to the center for centralized processing. A real-time and efficient edge-based solution is needed.

High Cost

Existing IoT solutions are expensive because of the high infrastructure and maintenance cost associated with centralized clouds, large server farms, and networking equipment. The sheer amount of communications that will have to be handled when there are tens of billions of IoT devices will increase those costs substantially.

Security

IoT has already turned into a serious security concern that has drawn the attention of prominent tech firms and government agencies across the world. The hacking of baby monitors, smart fridges, thermostats, drug infusion pumps, cameras and even the radio in your car are signifying a security nightmare being caused by the future of IoT. So many new nodes being added to networks and the internet will provide malicious actors with innumerable attack vectors and possibilities to carry out their evil deeds, especially since a considerable number of them suffer from security holes.

The more important shift in security will come from the fact that IoT will become more ingrained in our lives. Concerns will no longer be limited to the protection of sensitive information and assets. Our very lives and health can become the target of IoT hack attacks [1].

There are many reasons behind the state of insecurity in IoT. Some of it has to do with the industry being in its “gold rush” state, where every vendor is hastily seeking to dish out the next innovative connected gadget before competitors do. Under such circumstances, functionality becomes the main focus and security takes a back seat.

Monetize

Most existing IoT solutions lack meaningful value creation. “Being connected” is the most used value proposition. However, 85% of legacy devices lack ability to interact or cooperate with each other due to compatibility issues. The data sharing for business and operational insights is nearly impossible.

Privacy

Privacy challenges originate from the fact that IoT interacts with the physical world in direct and automatic ways, and the amount of data collected will increase substantially when it scales up. Some of the common privacy threats are:

1. Identification
2. Position and tracking
3. Profiling
4. Privacy-violating interaction and presentation
5. Life cycle transitions

6. Inventory attack
7. Linkage

All these common privacy threats are due to data leak at device level, during communication, or more often by centralized parties.

Abstract

Existing IoT solutions are expensive because of the high infrastructure and maintenance cost associated with centralized clouds, large server farms, and networking equipment. The sheer amount of communications that will have to be handled when there are tens of billions of IoT devices will increase those costs substantially.

This paper introduces IoTEdge Network, a decentralized edge-computing networks for Internet of Things, The clear solution would be to introduce “Sharing Economy” into IoT edge devices, where each of the sub-systems can be shared and reused. Even better, each sub-systems can sell or buy service to/from their neighbors in an on-demand fashion. For example, a device has sensor to collect data but no storage to store them and no direct link to send data to the gateway to the outside world, and it doesn’t have enough computing power and required algorithms to do real time data analytics on the edge. To turn these data into something useful, it needs to buy some memory space from a storage in its neighborhood, or sell it to some device with analytics capability to turn it into knowledge, after that the knowledge needs to be resold to devices with connection to the outside internet, where these aggregated knowledge will further sold to other interested parties.

Interestingly, this is exactly how our human economy functions and why our human society is so prosperous. To enable all the cooperation between devices we need to support transactions between them and let each device able to monetize on their service to others, in real time, on the spot, automatically without human intervention. This was for long time a pipe dream until blockchain technology came into existence. By leveraging fast maturing blockchain technology, we can introduce a light-weight M2M currency (coins) which is running on a public ledger for IoT ecosystem and also connect the value chain of this coin to the outside mainstream crypto-currency. By doing this, a closed loop value chain can be formed and each IoT device is able to monetize its service right away and becomes profitable. Turning cost of IoT device into a profitable investment will give a huge incentive for people to buy and install IoT related devices and join the whole IoT ecosystem.

Today, IoTEdge is building an economic-driven solution for the Internet of Things. Blockchain technology is used to establish the interaction protocol layer, collaborate with the edge nodes of the Internet of Things to create decentralized IaaS, PaaS, SaaS. The blockchain enables devices to trust each other and creating an abstract Meshed network. Consensus is used to ensure the devices and transactions.

The new L-Chain concept is introduced to solve the problem of fast transaction between edge nodes and the ledger, so as to avoid its rapid growth.

By using existing hardware devices, IoTEdge will greatly reduce the cost of deployment and trust of the Internet of Things network. Relay technology is applied to devices with different protocols and structures to form edge computing networks. And in the overall architecture, we can learn from the existing mature cloud technology to achieve flexibility and scalability. And IoTEdge will be widely compatible with existing devices architecture, CPUs and embedded OS.

Benefits & Challenges

Currently, IoT system depend on Client/Server communications, centralized trust brokers and protocols and security mechanisms to identify network nodes and control communication. A solution would be to decentralize IoT networks in order to improve speed and connectivity. In many cases, substituting over-the-internet connectivity for local communication between devices will help increase speed and efficiency.

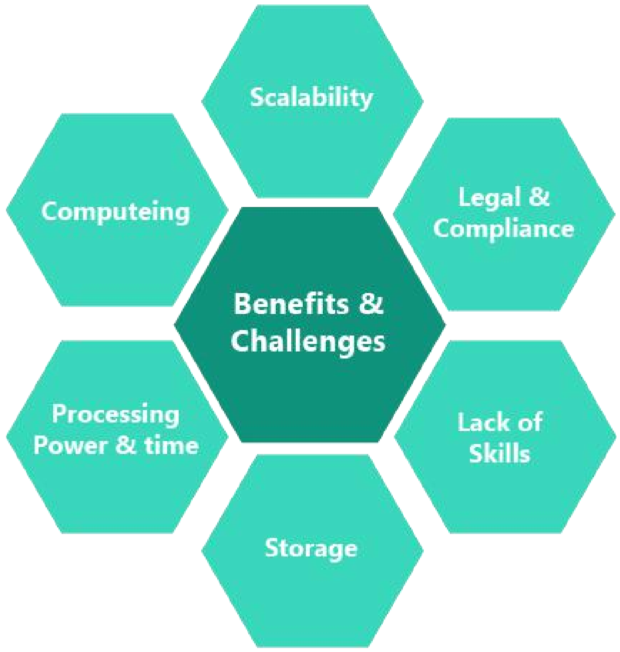
Benefits

A decentralized approach to IoT networking would solve many of the issues above. Adopting a standardized peer-to-peer communication model to process the hundreds of billions of transactions between devices will significantly reduce the costs associated with installing and maintaining large centralized data centers and will distribute computation and storage needs across the billions of devices that form IoT networks. This will prevent failure in any single node in a network from bringing the entire network to a halting collapse.

With millions of devices communicating across a network, you need data in real time to be at your best. Networking technology from IoTEdge, gives you a reliable, secure and fast network that will help you make the most of your resources in the field and make sure your data is where you need it, when you need it.

The computing power available in edge devices continues to increase — and as it does, it's also becoming more and more affordable. When those devices become both more powerful and more affordable, intelligence and action can both be distributed to the outer edges of the network. That means high-resolution data from network sensors can be quickly analyzed at the edge without having to transport lots of data over the network and to the utility back for analysis.

Challenges



The decentralized, autonomous, and trustless capabilities of the blockchain make it an ideal component to become a foundational element of IoT solutions. It is no surprise that enterprise IoT technologies have quickly become one of the early adopters of blockchain technology.

Design and Architecture Overview

Before we dive into the design and architecture details of IoTEdge, let's recap on what are the main bottlenecks for IoT's development: cost, monetization, security, and privacy. And how we can design a blockchain powered platform to solve these problems and kick-start the long promised machine-to-machine economy. However, there is one last mile before the utopia becomes reality: the existing mainstream blockchain technologies like Ethereum is still way too slow, too resource-intensive and expensive for billions of IoT end devices doing trillions of transactions in a short time. One interesting project called IOTA (https://www.iota.org/), aiming for an universal transaction platform for Internet of Things (IoT) devices. Instead using mainstream blockchain, it introduced so-called Tangle to work as the ledger for recording transactions between IoT devices. Tangle is claimed to be fast, light-weight and scalable. Yet, it is less secure and not really IoT friendly in truly ubiquitous computing devices, especially on those battery powered small sensor nodes. More specifically, we found a few potential drawbacks of Tangle:

1. There will be billions of IoT devices globally going on chain and it's impossible to expect each IoT end devices to keep a permanent ledger for all global transactions;

2. The transaction validation algorithm, the so called Tip-selection, will become slower and slower as the tangle tree grows. In each transaction validation, the algorithm always starts from the genesis block (the tree root) and does Markov Chain Random Walk down to the leaves of the Tangle tree, to pick an un-validated transaction, the so-called tip. Obviously the computation complexity of each validation will increase linearly as more and more transactions recorded on the tree. This will significantly increase the operation burden of IOT nodes and it's hard to make a real-time guarantee for each transaction.

3. Tangle does not require consensus on each transaction, only doing a light weight validation by future transactions afterward, and if there is conflict in two transactions, it de-orphans the one with lower confidence. This makes the network quite vulnerable to potential high powered attack in real time.

In overcoming the drawbacks of Tangle, our key philosophy is ***locality vs globality***: Internet of Things (IoT) network has seemingly two contradictory facts, it is inherently global (billions of nodes connected together globally) and local (embedding themselves very deeply into the physical world around them, and mirroring the physical neighborhood closely). Borrowing the idea and success of the Internet, we also architect IoTEdge Network to be two-levels: the local level chain, we call it **L-chain**, would be based on Tangle but an improved one, so-called **LST-Tangle** (explained later), just as the Local Area Network (Layer 2) in the Internet architecture; and the global level chain, we call it **G-chain**, would be based on Ethereum, just as the IP Protocol (Layer 3) in the Internet architecture.

G-chain and L-chain are not two independent separate parts but two interacting subcomponents of one integral chain. L-Chain is essentially a short-term running ledger which records the detailed micro-transactions among its neighborhood only for a period of time, called T. This time period T is adjustable given different design, e.g. one day, one week or one month etc. After every time period T, a consolidated version of the L-Chain ledger for the last T period will be put into G-Chain, just as a regular macro transaction, validated with consensus algorithm and becoming part of a block in G-Chain. With this design, we are able to keep the local IoT devices running ultra fast and light-weight short term ledger (L-Chain) with a constant storage footprint, while at the same time achieving a global consensus and permanent ledger with macro transactions at the G-Chain.

L-Chain:

The L-chain supports machine to machine micro, local transactions, which happens frequently at millisecond level, in a neighborhood with 10s to 1000s devices. After observing the key traits of the IoT transactions:

Key traits of the IoT transactions:

1. High frequency: tens to thousands per hour

2. Low value per transaction: dominantly sub-dollar transactions
3. Simple tasks: machine To machine cooperation
4. Locality: tens to thousands of nodes in a neighborhood (neglected by IOTA)
5. Low latency: milliseconds to seconds level (Neglected by IOTA)
6. Constrained resource: low battery, low memory, low bandwidth, low computing power (Neglected by IOTA)
7. Low reliability: low cost simple devices in unstable environment.

We introduced local short term Tangle, the **LST-Tangle**, which is running within certain VLAN network, forming a local small world within a given time frame, in itself.

LST-Tangle:

“LST” stands for “Local” and “Short term”. Micro transactions between IoT devices are local because, as we observed, interactions between IoT devices are all within a limited neighborhood and has nothing to do with the interaction outside their neighborhood. Thus the ledger running on IoT devices only needs to reach consensus among their peers in that neighborhood. Ledger running on IoT devices should be short-term since what happens right now on a IoT devices generally has nothing to do with what happened long time ago, it does not make sense to use storage on IoT devices as a permanent global ledger, as what happens to other classical blockchain. On the other hand, the algorithms running on IoT devices need to be light weight and real time.

Before going into LST-Tangle, let’s go over how Tangle and especially its core algorithm “tip selection” work: when submitting every transaction to Tangle, which is a Directed Acyclic Graph (like a tree) starting with the genesis edge, each running Tangle client needs to first validate two un-approved previous transactions on Tangle, called ‘Tips’. The way how it chooses the two tips are as follows: running twice Markov Chain Random Walk from the genesis edge toward the end of the DAG, until it reaches a tip.

To make Tangle algorithm local and short term, we propose two major modifications to Tangle’s core algorithm, the so called “tip-selection” algorithm:

1. The ledger running on each LST-Tangle client will be a local DAG, where all the transaction records are only from the IoT devices within their neighborhood. Thus the tips, namely the un-validated transactions are also only local tips within their neighborhood.
2. The DAG tree will be periodically “trimmed” and only kept the DAG graphs within last time period “T”. Since DAG is basically a tree, the way to trim the DAG is as follows: if the current

time is T_current, the period for short term Tangle is T, then among all the approved transactions happening at the time (T_current - T), we choose the one transaction with the highest confidence (the confidence computation is the same as how Tangle compute the confidence when resolving tips conflicts, for details please refer Tangle white paper: https://www.iota.org/research/academic-papers) Then we make this transaction, called it G0, with the highest confidence as the new genesis transaction and cut off all the DAG before G0. The old DAG before G0 will not be simply thrown away, instead, it will be summarized and consolidated into one macro transaction and submit it into G-Chain, there this macro transaction will be kept permanently.

G-Chain:

The G-Chain keeps and supports a global ledger for macro transactions which happens at minutes or even hours level. These macro transactions are between different services provided by entities joining the M2M economy market, such as a contract of buying storage or computation power from a neighboring IoT service provider. This contract once signed into the global ledger, will be fulfilled with a collection of micro transactions between IoT devices at the L-Chain level. This G-Chain can be perfectly implemented on blockchain (liked Ethereum) as it has very good smart-contract support.

Proof of Stake posterior (PoSp):

At the same time, we will also introduce the Proof of Stake posterior (PoSp) concept: which consolidates the local micro LST-Tangle transactions together into macro transactions and do Proof of Stake consensus on the newly generated macro transactions, later.

Recap: Key features in design:

1) Empowering a market for computation (raw computation power + algorithms including ML), storage, bandwidth, data (raw data -> preprocessed data -> knowledge -> insight), actions (all kinds of actors in the environment)

2) Every transaction value is limited at the local level, thus making potential attack less harmful.

3) All micro-transactions happened before will be reached consensus **later** at the higher level, with Proof of Stake (PoS), so we call it Proof of Stake posterior (PoSp)

This will greatly reduce latency and resource consumption at the IOT end device, while keeping the network extremely secure at the macro transaction level.

3-levels Nodes

3-level nodes architecture to combine the best of the two worlds:

1. Global nodes or G-nodes (service level):

Transaction: macro transactions between service providers, e.g. subscription contracts between different entities;

Chain: running G-Chain client, powered by Ethereum;

Host: running on server-like computers;

Transaction cycle: per day;

Scale: global level, millions owners!

2. Intermediate nodes or GL-nodes (intermediate level, connecting both worlds of G and L chain world):

Transaction: both macro transactions between services and micro transactions between IoT devices;

Chain: running G-L-Chain dual client, powered by both Ethereum and LST-Tangle.

Host: running on dedicated server-like computers, close to the neighborhood (local area network) it is serving, besides gateway, switch or router etc.

Transaction cycle: minutes level.

Scale: from 100s to 100,000 nodes.

3. Local nodes or L-nodes(machinelevel):

Transactions: support machine to machine micro, local transactions;

Chain: running L-Chain client, powered by LST-Tangle;

Host: running on IoT devices;

Transaction cycle: millisecond level;

Scale:from 10s to 1000s nodes;

End-to-End Security

IoTEdge is a secure and trusted system for sending, receiving, and transmitting network data from endpoints. The secure and trusted foundation consists of three main parts:

Physical level secure and trusted terminal identity ID

In the IoTEdge system, the sensor (the source of data) has a built-in trusted root based on hardware secure storage. Based on the trusted root, the sensor has a physical-level trusted identity. All of the transactions and data from the sensors is physically trusted.

In L-Chain of IoTEdge, the sensor generates an ID indicating its identity, which is physically secure and trustworthy. In the whole system, it uniquely identifies the sensor and all data generated from the sensor. So all data generated from the sensor cannot be tampered with.

Trusted terminal data transmission environment

In the IoTEdge system, in order to ensure the security of the data transmission source and the transaction, a trusted and secure data transmission endpoint system is constructed based on the physical trusted root. In this system, all core components and APIs involved in data transmission are subject to security metrics to ensure the security credibility of endpoint transactions and data transmission sources.

The third is the chain of trust. In the IoTEdge system, the data transmission uses the LST-Tangle trusted chain, which is based on a chained architecture of directed acyclic graphs (DAGs) to form a decentralized network. To further ensure the reliability of transactions and data transmission.

Secure data encryption

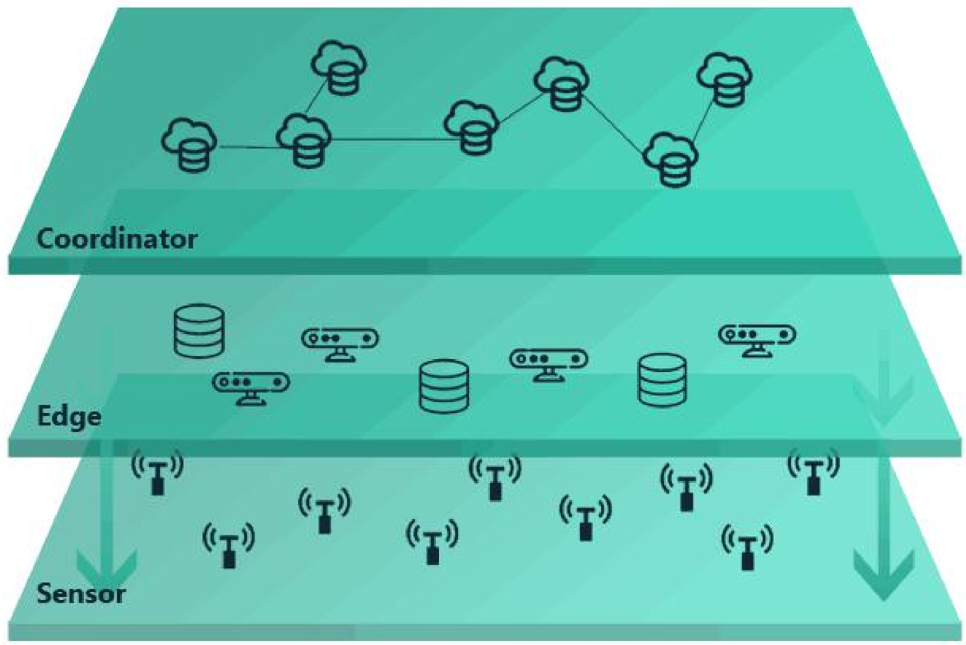
The IoTEdge system adds encryption mechanism of the transmitted data, and only authorized parties can read and reconstruct the entire data stream.

IoTEdge uses IOTA-MAM (Masked Authenticated Message) technology to encrypt the entire data stream on sensor and other devices. Only authorized parties can read and reconstruct the entire data stream. It works very much like a radio, and only listeners with the correct channel can listen. The concept of a channel is also adopted in the MAM. Channel owners can post new data, and viewers can subscribe to channels to get the data available.

The IoTEdge system explores the security and trustworthy design of data generation and transmission, and forms a complete trusted channel from the endpoint to the network: secure and verifiable hardware identity; data security and trusted transmission environment; And DAG-based LST-Tangle trusted chain.

Platform Architecture

The IoTEdge service can be divided into three levels on the network architecture, as shown in the following figure, from top to bottom, the coordinator layer, the edge node layer and the sensor layer.



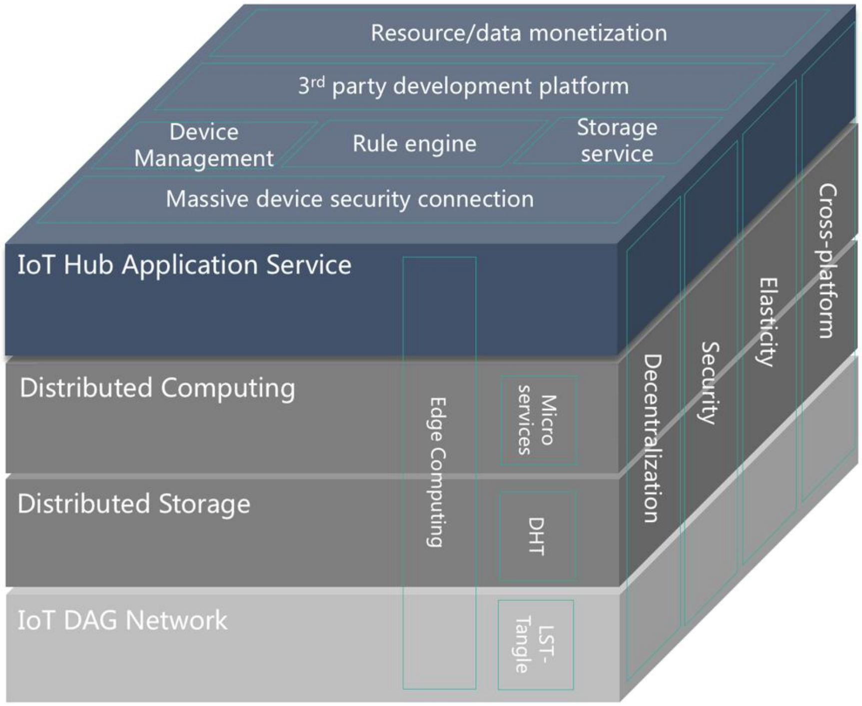
Roles in network

The ***Coordinator*** consists of a group of servers with built-in IoTEdgeCoordinator that form a decentralized Coordinator cluster. Coordinator contains PoSp validator, Edge node layer service deployment and orchestration, Web service and other functions.

The ***Edge*** consists of a large number of network edge devices connected to the Internet, including IoT gateways, edge distributed servers, and embedded controllers etc. The Edge node layer can be further subdivided into the following four sub-layers.

The ***Sensor*** contains thousands of types of sensors such as temperature, humidity, pressure, speed, and light. They communicate with edge nodes via wired, WiFi, Bluetooth, Zigbee and other communication technologies to deliver sensor data.

Edge node Layer



Based on the LST-Tangle network, the Edge node layer builds a decentralized distributed computing and storage architecture that provides a decentralized IoT application service. Developers or users can run IoT services on distributed node devices distributed around the world based on the IoTEdge Edge node SDK, such as secure connections for massive devices, device management, rules engines, storage services, and more. Monetization can be made through the transaction of data and computing power and storage resources.

The entire Edge node layer has the advantages of decentralization, security, elastic scalability, and cross-platform. The decentralized architecture enables the computational and storage resources to be balancedly scheduled; as mentioned above, the security mechanism of the Edge node layer makes the entire network end-to-end secure; the flexible extension allows the network scale to be flexibly changed according to needs, to meet different users and different needs of the stage; IoTEdge provides SDK support for different hardware platforms, and the use of container technology enables developers to flexibly select the appropriate development language according to their own preferences and business requirements, improving development efficiency.

IoT DAG Network Layer

The transport network of IoTEdge is a trusted network based on LST-Tangle. LST-Tangle is a trading architecture based on directed acyclic graph (DAG) that enables higher transaction throughput. At the same time, IoTEdge integrates the security and trust mechanism of the edge nodes and sensors, so that the data and transaction transport layer of the whole system has a complete security and credibility mechanism.

Distributed Computing Layer

The Internet of Things business traffic is characterized by bottom-up (terminal-edge nodes-cloud) and centralized (device traffic at the same site point to one cloud), and only a few scenarios will have divergent traffic. The IoT services business can be split into multiple, relatively independent services for parallel processing based on the data stream.

Based on the above two points, IoTEdge adopts a microservice architecture for distributed computing:

- Decentralized Governance: By subdividing the business functions of the IoT Hub into different tasks, using the appropriate tools to accomplish their tasks, each microservice can be considered with the best tools (eg Different programming languages).
- Decentralized Data Management: The microservices architecture tends to adopt the Polyglot Persistence approach, allowing each microservice to manage its own database and allow different microservices to be used differently. Data persistence technology.
- Infrastructure Automation: Through automated deployment technologies (such as Kubernates+Docker), the difficulty of building, deploying, and operating microservices is greatly reduced, enabling the rapid implementation of massive decentralized IoT Hub services.

Monetization

We believe IoT networks are very fragmented and its applications are extremely diversified, completely embedded into the physical environment it is serving. This characteristics implies that IoT cannot be successful in a centralized, top-down, vertical fashion, as many traditional big companies' failures have proved it.

IoTEdge economic system depends on the sharing of its own resources and data by the devices(edge nodes, sensors). It will be rewarded by devices's contribution. There are two kinds of rewards:

- By Resources: Resource holder setup a list price for resource (by time, by connectivity ...), and buyer using the resources;

- By Conditions: To meet certain conditions for a certain rule.

IoT needs to evolve in decentralized entities, cooperating with each other like how a market economy is functioning: buying what it needs from other players, and selling what other need. In each transaction, each part of the network can make a profit from this transaction right away, be it IoT device owners, network owners, storage providers, computing power providers, service providers etc. This will greatly encourage every party to join the Eco system and proliferate IoTEdge platform into different applications.

In a future not too far away, a machine to machine economy will emerge from this evolution and will unleash all the hidden potential of IoT. Like what Uber and Airbnb have done to unused cars or unused houses, IoTEdge has potential to unleash many more unused resources in every corner and leaf in our environment.

Use Cases

Below are applications that may be of immediate relevance to potential users of the IoTEdge Network. The healthcare, industrial, smart city and home device markets are considered to be current movers in the IoT space.

Note that these potential applications are provided for illustrative purposes only and IoTEdge Network users are solely responsible for their use of such applications, if any. IoTEdge assumes no responsibility for the function or availability of these or any other applications of the IoTEdge Network.

Supply chain and Logistics

Supply chains are traditionally highly fragmented. Many companies cannot identify precisely how much product they have in any given place at any one moment in time. For example, in product transportation, even through the transfer of goods through multiple logistic companies, The products' status can be tracked to ensure deliverying safety and timely; For example, products, inventory, sales, all of data are recorded, so as to facilitate sales team and production team to infomation sharing, improve operation efficiency. Things and systems are becoming more and more intelligent, thus gradually entering a complete virtual world.

Traffic and Vehicle

DAPP, which runs automatically in the Internet of Things, makes vehicles become intelligent application terminals. Owners can use block chains to track Internet of Things equipment, such as annual vehicle inspection, auto insurance tracking and so on. Automatic data exchange between vehicles, such as: road congestion source map transmission data, so that car owners can understand the real-time traffic situation, to achieve safer automatic driving, automobile automated navigation, road rescue, etc.

Intelligent devices

Sensors can be used to track the status of bridges, roads, power grids, and even to help remote areas monitor natural disasters, prevent large-scale mountain fires, pests and other disasters, achieve intelligent urban management, predict urban greening and pollution, and maintain, and share efficient urbanization management. Relaying different Internet of Things can effectively circulate resources. At the same time, it greatly lowers the access threshold of the Internet of Things, shortens the development cycle and reduces the risk of application development. In the future, it will be widely used in smart grid, smart logistics, smart home, smart billboards, smart cities and military applications.

Healthcare

Given the aging baby boomer generation and the many use cases IoT can provide for healthcare, the healthcare industry can derive substantial benefits from IoTEdge Network products. For example, consider the case of adding IoTEdge security into an IoT solution, used for a proprietary health application platform, which is then built upon by application companies creating connected monitoring products, analytics tools, trackers, and other innovations.

An inventory sensor inside a hospital emergency room blood-storage appliance could autonomously order re-stocks of specific blood types from regional suppliers based upon existing inventory, electronic health record reports of scheduled surgeries, and day-of-week historical ER needs. This system could be secured with the IoTEdge.

Industrial IoT, Smart Cities

Industrial IoT requires a secure ecosystem within which a wide array of device types can seamlessly operate together to help manage the consistent execution and monitoring of workflow across multiple processes. Additionally, industrial IoT devices often need to extend autonomous interoperability to include resources beyond the domain of the manufacturing facility. The result is a need for trusted identity, reputation, and the ability to ledger user-defined key events.

Regarding smart cities, municipalities are finding ways to employ automation to seamlessly connect IoT devices and resources to lower power consumption, reduce traffic congestion, enhance air quality, increase safety, and improve overall livability. IoT will be at the core of many of these efforts, and providing security across this broad array of attack surfaces will be essential.

Comparison

	IoTEdge	**IOTA**
Layers	3 Layers	Mono
Hardware/RTOS	General	Their own CPUs/boards
Mining	YES	NO
Realtime Transaction	High	Medium
Rewards	YES	NO
Security	High	Medium
Usages	IoT Hub(PaaS), LoRa gateway sharing(Hardware), Asset tracking, Data Collection	Micro Transaction
Token	Data Sharing, Computeing Sharing, Micro Transaction	Micro Transaction

Future Research Work

Self learning LST-Tangle

Machine learning based automated optimization and continuous self improvement of L-Chain .

Since our L-Chain is running LST-Tangle, which is local and short term, the whole L-Chain can be parameterized and optimized using ever improving machine learning algorithms and ever accumulating operation data. This means our LST-Tangle could be flexible and adaptive to the local neighborhood, given that each neighborhood has different network size, topology, applications etc, thus having different requirements on Tangle. Even better, this adaptation would be automated, without human intervention. Further, since it is adaptive and self-improving, LST-Tangle will be future proof and no hard fork will be seen as what happened to bitcoin and bitcoin cash, or ethereum and ethereum classics.

AI in IoTEdge

With emerging IoT edge ML capability, such as newly announced Google's Cloud IoT Edge (https://cloud.google.com/iot-edge/), after collecting data from sensors, followed by going through analytics in another service, learned knowledge in the form of data model, can be put back to use into IoT edge automatically. This will greatly increase IoTEdge's potential application areas.

Token Distribution

Token Name: IoTEdge Token

Total Token Supply: 1,000,000,000

Private sale	**20.04%**
Public sale	6%
Advisor	4.96%
Foundation	10%
DEV Team	15%
Marketing & Ecosystem	20%
Mining Reward	24%

The total token supply will be fixed. For manage the liquidity of tokens and improve networks stability, some issued token are limited to different unlocking periods. Especially for consultants, founders and foundations, the release period is 4 years. The licenses obtained by mining, that is, those to motivate node operators, while increasing the value of services delivered by agents, will gradually be released.

Core Team

The IoTEdge Network, founded in Silicon Valley in the U.S. 2018, the HQ in San Jose and R&D Center in Beijing. Core team earned P.h.D. and master degrees from Carnegie Mellon University, University of California (UCSB), Nanyang Technological University, Singapore (NTU), Peking University and top universities, and worked for Cisco, Microsoft, Fortinet, Tencent, HP, Arista, and Fortune 500 companies.

Conclusion

This whitepaper introduces IoTEdge, a decentralized edge-computing networks for Internet of Things. We innovated in the following aspects: Well-balanced distributed network that maximizes scalability and privacy in a cost-effective, Consensus with instant finality greatly improving the throughput of the network and reducing transactional cost; Lower cost, lightweight, scalable, high reliability and extensible blockchain dedicated for Internet of Things.