Ubique Chain of Things (UCOT)

"Ultimate Supply of Every Chain,
Smart Internet of Every Thing"

White Paper

V2.2

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1.0 Executive Summary

1.1 Background

Emergence of IoT and evoluation of supply chain

The Internet-of-Things (IOT) is a new generation network of computing systems, objects and machines connected by sensors/devices with sensing and actuating capabilities. In the absence of human intervention, sensors in the IoT can automatically collect and analyze information, thereby enabling communication among all objects in the network.

Supply chain, as a natural component of the IoT ecosystem, requires better management and value transfer mechanism to achieve self-optimization in each link and node along the chain.

IDC forecasts that the world market for IoT solutions will grow from $1.9 trillion in 2013 to $7.1 trillion in 2020. IoT Device shipments will reach 6.7 billion in 2019 at a CAGR of 61%. In addition, Mckinsey Global Institute estimated that by 2025, the economic impact of IoT application could reach $3.9 to $11.1 trillion.

According to GSMA's report "How China Is Scaling the IoT", China is the world's largest Machine-To-Machine (M2M) market with 74 million M2M connections and has now become the global leader in the deployment of IoT.

As the Internet-of-Things keeps expanding, the need for interoperability, security, identity verification and resources sharing across numerous networks become a necessity.

1.2 The Problems

Current IoT systems have been developed based on a centralized architecture, in which devices and equipment are connected through centralized servers residing in the cloud.

With the rapid expansion of the IoT network, billions of nodes comprised of sensors and devices have joined the network, increasing the complexity of the entire network. It is, therefore, becoming more and more expensive to maintain an infrastructure sustained by centralized servers. Moreover, as the number of devices increases, so does the chance of fraud and malicious attacks.

It is expected that in the near future an unprecedented flow of data collected by these devices worldwide will be generated and processed quietly through the execution of pre-programmed procedures with physical actuators, which will manage more and more aspects of our lives. Therefore, without reliable IoT interaction, data privacy, security and trust will become the priorities that need

to be resolved promptly when potential systemic failures could trigger disastrous consequences.

It is also believed that fundamental security risks will increase exponentially as 50 to 200 billion connected devices will come online by 2020.

Therefore, future IoT system should be designed to upgrade from expensive centralized architecture to decentralized autonomous ecosystem without having to worry about tampering of security parameters. Such an ecosystem should be able to provide a trustful environment for cost reduction, device autonomy, platform scalability, operational security, and redundancy against cyber attacks.

1.3 The Solution

1.3.1 Definition of Blockchain

The Blockchain is one of the most disruptive innovations since the invention of the Internet.

Simply put, Blockchain is a decentralized distributed cryptographic (hashed) ledger with a digital log that can record state changes and transactions that are sharable across public or private network.

The upgrading and maintenance of distributed ledger is achieved through a network of nodes with each node executing and recording the same transaction history. The transactions within a specified period of time on blockchain will be time stamped and grouped into blocks, each of which is identified and verified by a unique hash value that is generated via a cryptography-based hash algorithm. Then, the blocks will form a linear sequence, where each block refers to the hash of the previous block, creating a chain of blocks called the blockchain (Figure-1).

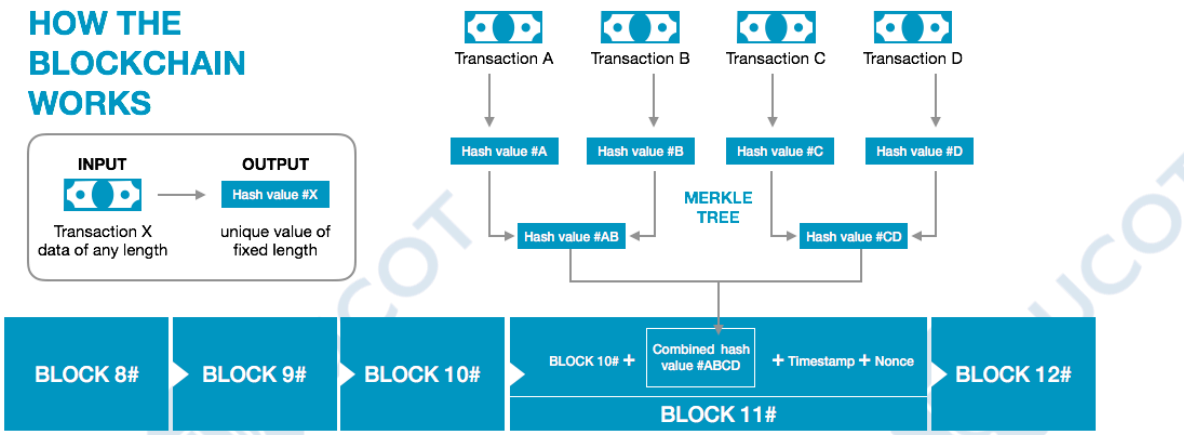


Figure 1. Sample Bloc

The following features of Blockchain can be used to reshape IoT ecosystem:

- Distributed public/private ledger and decentralized peer-to-peer network can eliminate the incidence of single point failure;
- Transactions need to be verified by the nodes in the network to solve the problem of centralization;
- Once a transaction record is generated, it exists in a blockchain that can not be altered or forged and can be audited at any time.
- Automating the traceability of product along the supply chain;
- Provide better protection for data transferred across physical devices in the IoT;

1.3.2 UCOT Ecosystem

Ubique Chain of Things (UCOT) is a structured ecosystem combining the latest Blockchain technologies with 5G telecommunication, which is designed for the next generation of smart IoT platform to solve critical issues on authentication, security and interoperability across supply chain and IoT networks. It can help businesses to address challenges with regards to device validation and authorization. It is also believed to protect the grid network while eliminating reliance on centralized administration.

UCOT can enable different businesses and customers in the same supply chain to improve efficiency, lower operating costs, strengthen authentication, and protect data privacy by improving tamper-resistance and interoperability among the nodes across the supply chain.

The vast amount of real-time data created in the UCOT ecosystem will also be utilized by various UCOT applications.

The vision of **UCOT** team is to build the best ecosystem to empower supply chain management and smart IoT system with the automated M2M controls and the optimal process of value transfer.

1.4 The Outlook

The core team of **UCOT** envisions an era of **"Ultimate Supply of Every Chain, Smart Internet of Every Thing"**

UCOT has already anchored a few business clients who share the same vision as the team and are willing to join the ecosystem to build the ecosystem jointly and leverage the UCOT platform to increase the operational efficiency of their supply chain and accelerate the intelligence of the IoT, including the Six Avenue Group of Australia, which owns the best cross-border supply chain between

Australia and China and operates an e-commerce platform with annual sales volume of hundreds of millions (in RMB). They hope to further upgrade their cross-border supply chain through the UCOT solution and quickly extend their advantages to other international online shopping markets such as Japan, South Korea and the United States.

2.0 UCOT Ecosystem Design

2.1 Conceptual Framework

2.1.1 Background

In the past, the traditional supply chain has been managed by manual paper passing. Recent tracing technologies use bar code or QR code labels, which can be easily copied. RFID, though technically improved, can still be copied or stripped off and reused by dishonest operators or intermediate merchants, leading to proliferation of counterfeit products. Moreover, all of these labels or tags have to be handled manually, or pass through a narrow reader gate in the case of RFID. Therefore, they cannot actively sense the environment or physical locations, and therefore are unable to provide a comprehensive view of the handling and movement of goods.

The Internet of Things (IoT) enables real-time tracking of items in the supply chain and is poised to transform our lives and unleash enormous economic benefit. However, inadequate data security and trust are severely limiting its adoption currently. These challenges can be overcome by Blockchain – a distributed ledger that can not be tampered with.

UCOT aims to develop a smart IoT security ecosystem based on blockchain technology to improve supply chain traceability, so as to enable secure data acquisition, tamper-resistant storage, and trusted data sharing throughout supply chains.

We have successfully demonstrated the tamper-resistant capability of blockchain-based IoT in our lab using Raspberry Pi IoT test platform (Figure-2.).

In the demonstration, one of the Raspberry Pi devices was “hacked” and its record (a temperature measure) was modified. We showed that the blockchain could successfully discover and repair the tampered record automatically through synchronization. The conclusion is that the blockchain has dedicated tamper-resistance and self-repair capabilities, which must lead to its widespread application in the field of IoT security, especially supply chain traceability and falsification functions.

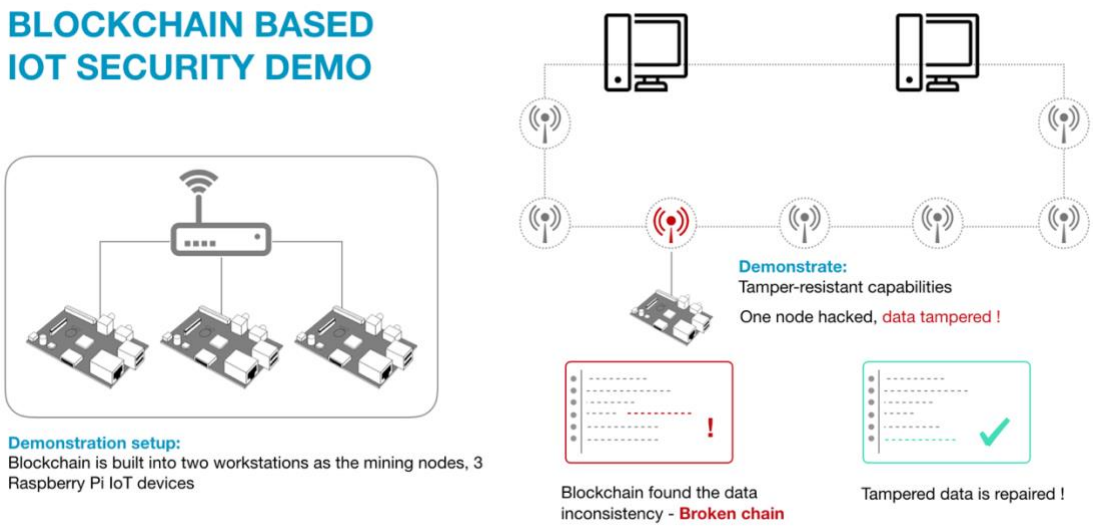


Figure 2. Blockchain-based IoT System Demonstration

2.1.2 Design Overview

UCOT can be applied to the next generation of digitalized supply chain, as shown in Figure-3, where the blockchain-based IoT can track the supply chain logistics, and use smart contracts to manage commercial transactions while implementing commodity logistics management. All the data are shared in a secure and trusted manner throughout the supply chain.

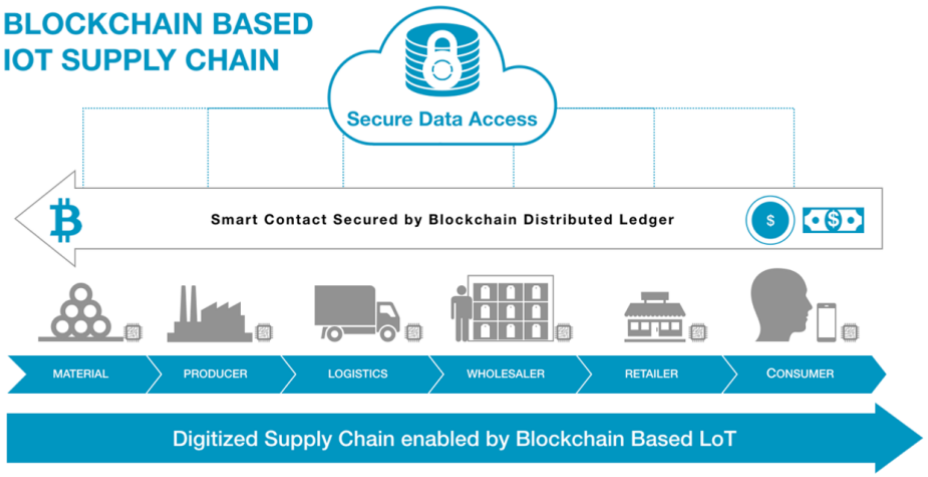


Figure 3. Digitized Smart Supply Chain powered by Blockchain based IoT

In summary,

- Within the physical space of supply chain, we will develop a blockchain-based smart IoT platform, where the inteligentized goods can autonomously communicate and interact with the nodes in supply chain to ensure the traceability and tamper-resistance of the source information of goods via blockchain technology.
- Within the financial space of supply chain, we will automate the business process with smart contracts, so the inteligentized goods can autonomously initiate payments with real-time flow of the physical goods.
- The collected data is shared among the business entities across the supply chain through a Node.js-based web service backend by calling Web3 JavaScript API. The backend can communicate with local nodes via this Web3 API so the data stored in pre-built smart contracts are shared across the whole blockchain in the manner of "RPCcall"。
- The business entities can build traditional database at the edge of blockchain if the information stored on the blockchain needs to be stored elsewhere for further purposes. Data Retrieving/Creation under CRUD model, for instance, might become one of the most significant bottlenecks of pure blockchain database (Note that C-Creat, R-Retrieve, U-Update, D-Delete. In blockchain-based platform, U and D are usually not used). Thus, the traditional database, instead, can be used to handle this problem by replacing blockchain at the edge of blockchain network, so as to improve the efficiency of interactive data processing between App service and blockchain, as shown in Figure 3.

The design of these structures predicts the basis for the formation of a new trade ecosystem, and takes into account new supply chain financing concepts, including faster transaction processing and new liquidity management solutions.

2.2 System Architecture

The UCOT System consists of three layers, from bottom up: the IoT layer, the Blockchain layer, and the Service layer, as shown in Figure-4.

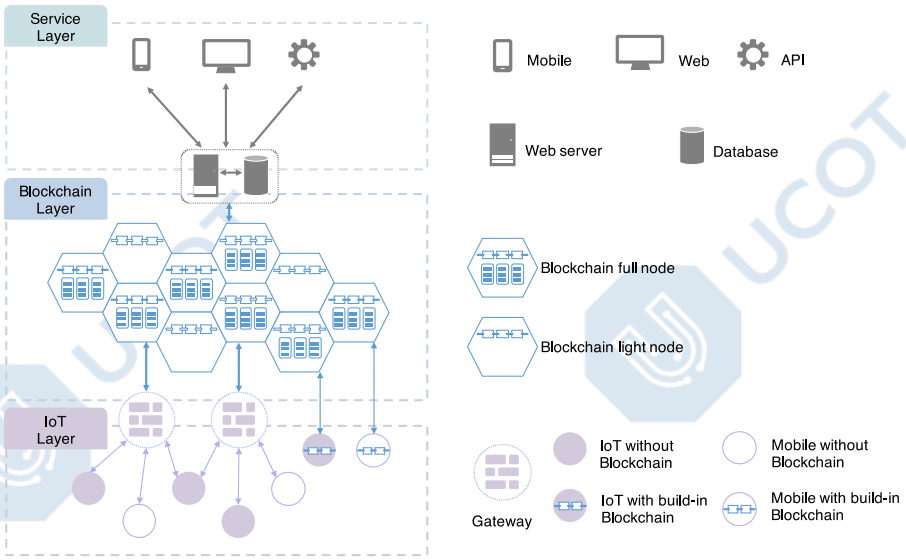


Figure 4. UCOT System Architecture

2.2.1 IoT Layer

A secure IoT platform is the core part of the IoT layer, which includes following devices:

a. Embedded IoT tracking devices attached to the goods throughout the supply chain with limited power

b. Fix high-power IoT nodes, e.g. video surveillance cameras

c. Mobile devices with supply chain Apps installed

The IoT platform enables supply chain tracking and product provenance traceability. In IoT Layer, the applications running on *lite embedded devices and the lite mobile devices* (as shown in Figure-5) are design to be as simple as possible to meet the requirement of resource-limited devices. The lite embedded device and the lite mobile devices will upload data to the blockchain network through the gateway. To be specific, the applicatiosn on the lite embedded devices can sense the environment and upload the data automatically, while the applications on the lite mobile devices will provide manual updating interfaces. The applications use asymmetrical encryption authentication algorithm to sign the collected data to ensure tamper-resistance.

The *gateway* in the sensory layer, as shown in Figure-5, is in charge of protocol translation, account management, device management and security.

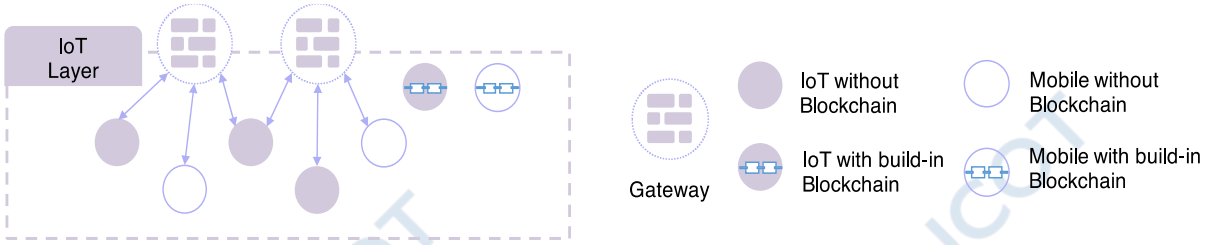


Figure 5. IoT Layer

a. The Gateway provides the interface for translating different kinds of communication protocols, e.g., UDP and CoAP in NB-IoT devices, to the blockchain network by sending transactions.

b. The Gateway needs to realize the management of accounts and devices. In device management, lite devices should obtain the authorization before uploading data to the blockchain networks. This component is specially designed for the case that certain users use the accounts in the blockchain system to configure the end devices . The configuration process is also recorded on the blockchain system. it is noted that the identities of end-devices shall correspond to the accounts in the blockchain network. The system will be managed based on the accounts rather than the end devices. The account management is designed for the devices that have accounts in the blockchain network, which can directly upload data as transactions.

The Gateway should be secured against attacks, e.g., DDoS and exploit. With the help of Gateway, the system can support new devices and protocols independent of the core blockchain network.

2.2.2 Blockchain Layer

The blockchain layer will provide a secure and accessible digital ledger to all the stakeholders across the supply chain and execute the smart contract to complete the payment. We aim to build a blockchain-powered IoT platform that will revolutionize the entire supply chain. Smart contracts built on top of the platform will enable faster payment related to supply chain flows.

Combining blockchain with IoT will revolutionise the entire life cycle of supply chain and applications and cultivate a positive environment of further development. Just imagine that temperature and location sensors can make use of the private/consortium chain to provide real-time updates on the status of the food products. Similarly, think about the use of smart contracts to exchange insurance and maintenance services to provide real-time information on any product

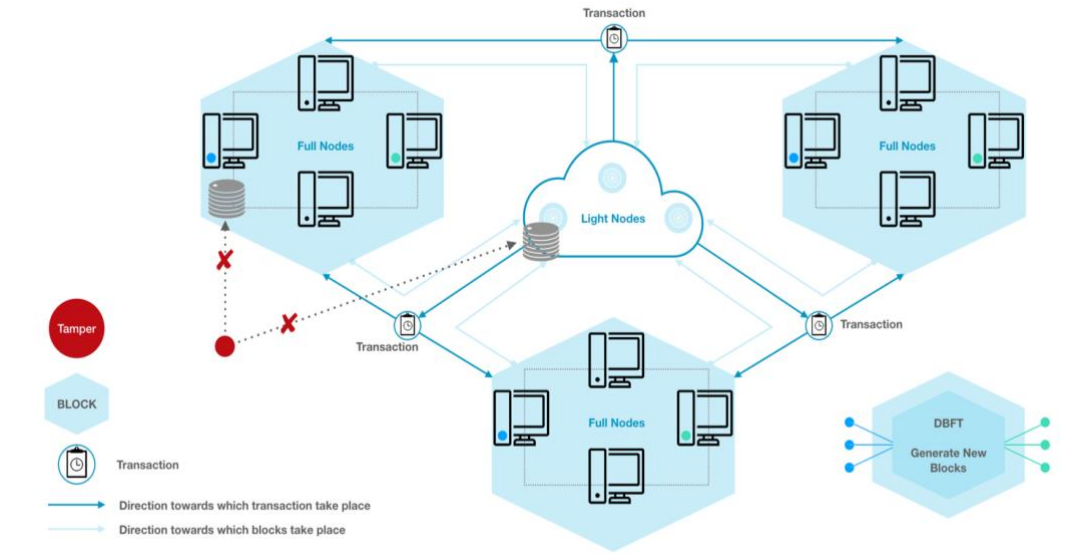


Figure 6. Tamper-resistant blockchain-based Smart IoT Platform

Design Principles

The distributed ledger technology based on blockchain rectifies the five key defects of IoT:

a. In a typical scenario, the blockchain-based distributed ledger can provide trusted consensus network, and ownership record, transparency and communication support for the IoT.

b. It should be noted that an architecture of IoT that collects and stores data by relatively-centralized server as the consensus nodes can write the information into local ledgers and synchronize with other local ledgers to ensure the security and uniqueness of the facts.

c. Blockchain adds a tamper-resistant timestamp to each block containing transaction information for the future use.

d. Blockchain with high-level encryption technology can solve one of the critical flaws of the IoT, that is, the inconsistent security standards.

e. One of the most important innovations of the blockchain is the digital agreement or smart contract, which can be applied to blockchain data in IoT field to implement the commercial contracts.

Blockchain Architecture

We will first use Ethereum as the kernel architecture of our blockchain-based IoT network. Ethereum is a platform and a "Turing Complete" programming language that enables developers to build and release next-generation

decentralized applications (Dapps). The benefit of being compatible with Ethereum is to lay a foundation for the interoperability among many other smart contracts running on top of Ethereum platform.

Firstly, we need to understand the definition of state in Ethereum. Ethereum is an account-based blockchain consisting of two essential components:

- Transactions represent state transition functions
- The result of these functions can be stored

A "full/archival" node uses Google LevelDB to store local data, which contains all transactions and transaction results for all the blocks.. This would include all historical states, even those no longer valid or valuable. This allows the client to query the state of blockchain at any time in the past without having to re-calculate everything from the beginning. Although this will likely require a fairly large storage space, but it is not strictly necessary as conceptually blockchain data can include:

a. Chain Data. It is the list of blocks forming the chain, meaning that this data is stored on-chain. Ethereum blockchain includes state roots that store the root hash of the hash tree representing the system state at the time the block was generated.

b. State Data. It is the result of each transaction's state transition and is stored off-chain (on the hard drive of each full/archival node). Therefore, it is usually seen as a local database. It is a Merkle Patricia Tree called world state, which consists of a mapping from account addresses to state roots that are stored in chain data, where these state roots are calculated from individual account balances, account nonce, contract code and storage root. Note that the storage root is the root hash of a Merkle Patricia Tree with leafs storing the data via current contract code.

While all chain data will be needed to ensure cryptographic chain-of-custody and that nothing has been tampered with, old state data can be discarded (known as "pruning"). This is because state data is implicit data. That is, its value is known only from the calculation rather than the actual information communicated. By contrast, chain data is explicit and stored as the blockchain itself.

A "light" node only stores chain data. To be specific, only block header is stored in the node. It queries the current state of the blockchain by looking up the state root included in chain data from other available "full/archival" nodes. Besides, other information such as block body, cost, and bloom can be fetched from other available full nodes with light-peer service. This allows Ethereum Blockchain to be implemented easily on IoT sensors, smart phones and any embedded device and so on. Note that in our environment a light client is implemented on any IoT device rather than a full client

Development Tools & Methodology

A.Development Tools

a. Runtime Environment - EVM (Ethereum Virtual Machine)

b. Language - Golang/Nodejs/ Solidity

c. Command Line Interface (CLI) - Geth

d. Platform - Linux, Mac, Windows

e. Installation - Binary or scripted

B. Development Methodology

a. Platform - Mac Windows.

b. Install CLI (Command Line Interface) Geth.

c. Create a private chain / Testnet on Ethereum.

d. Install Solidity compiler (SolC) through "chocolatey" (A package manager for Windows).

e. Link SolC in geth

f. Develop and execute sample contracts.

g. Formulate a list of contracts required for IoT supported SCM (Supply Chain Management).

h. Develop smart contracts and test.

i. Accept "Token" and smart contracts.

j. Establish interface between smart contracts and API.

Smart Contracts

Smart contracts will be built on top of the Blockchain-based IoT platform. The smart contracts can validate the delivery of goods and automatically execute token exchanges among the parties along the supply chain. Smart contracts can not only define the rules and penalties in an agreement in the same way as traditional contracts do, but also automatically enforce those obligations. Undeniably, these smart contracts are faster, cheaper, and more secure than traditional systems.

In the scenario of a supply chain, a Smart Contract is a sort of a BoL (Bill of Lading), i.e., a ticket that outlines the journey of a product from a manufacturer (seller) to the wholesaler (buyer) through a shipper/carrier according to specific terms and conditions. The Smart Contract implements these conditions of the contract and enables token exchanges in response to supply chain flows

Product Information for the Customer

Figure 7 shows a sample template of information available to the customer at the time of delivery about a meat product he ordered.

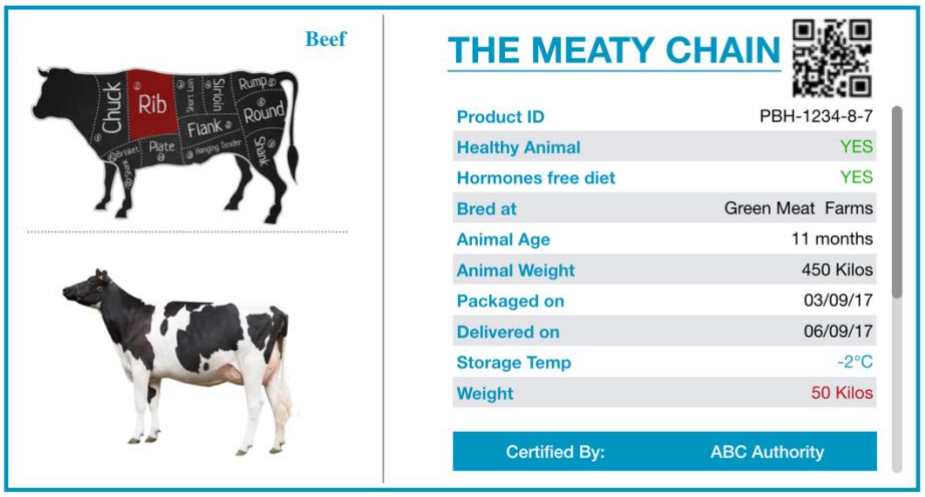


Figure 7. Sample Product Information Available to the Customer

Product Information are Available to The Stakeholders on Need to Know Basis

Similar to the product information available to a customer, a supplier or a consignee may also be able to view some information about the products being sold/bought. Figure-8 shows a template of information about a batch of products being sold by a supplier. The supplier can monitor the current location and the temperature of its products during transit/shipment. 。

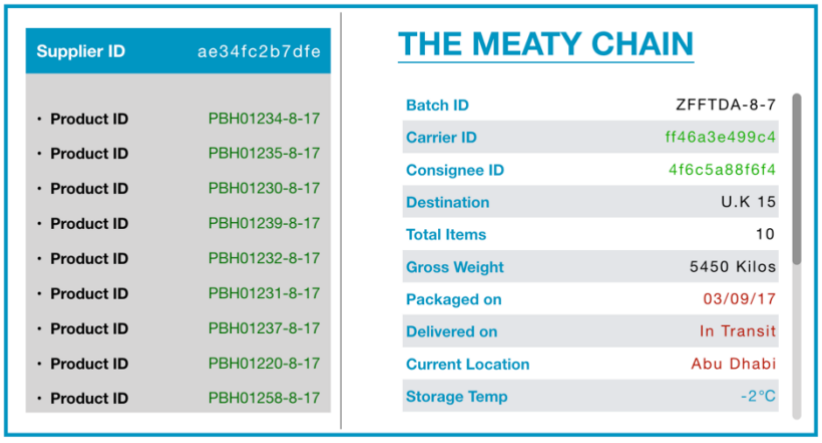


Figure 8. Batch-wise Information Available to the Supplier

Instances of Smart Agent (Sensor) Operation

The likely events/instances in which the smart agents can be activated and send respective sensors data to the Blockchain are as under:

a. At the time the carrier receives the product.
b. At each stopover in transit, where the product is placed in a warehouse or storage.
c. At the destination.
d. At the time the product is handed over to the consignee.
e. At the time the product is sold to a retailer.
f. At the time the product is sold to a customer.
g. At a specified time interval.

Token

If the distributed business ecosystem is an organism, then the Blockchain can be the skeleton, and various applications and services are the muscles and organs. However, the body cannot work without blood circulation. Hence the "Token" is essential for any value transfer in the Blockchain between various stakeholders/components. Its value depends on what you do with it. The possible scenarios include:

a. A token can be used to control access (**an entry ticket**).
b. Creating a token on Ethereum is more secure, as the security is provided by all the miners who are supporting the Ethereum network. .
c. Finally, by creating a token in Ethereum, our coin will be compatible with any other contract running on Ethereum platform.

Token Creation for UCOT

The token to be used in UCOT ecosystem is named "UBI". All the stakeholders and service providers will need UBI to initiate a transaction, execute a smart contract and to access other services.

a. Monitoring and managing Blockchain scalability issues.
b. Freezing accounts
c. Monitoring Smart Agents for power issues and sensor calibration

UBI will act like a native measurement in the ecosystem. A good example of this is if you want to use any service in UCOT, the cost to execute that service will be measured in UBI. It is imperative to mention that these are just the usage tokens, they won't give you any particular rights or privilege within the network itself. To facilitate nano payments, UBI can go to a smaller subunit or 10^{-9} (9 decimal places) of UBI, called "nUBI".

Development Methodology and Tools

a. Finalize payment structure in UBI and nUBI i.e., what all services require payment and what is the cost?
b. Create a token contract to generate the required number of tokens. The token will be issued to the creator of the contract.
c. Distribute tokens to all the stakeholders (Based-on predefined criteria, who gets what).
d. Design and implement use of UBI and nUBI in customised Ethereum Blockchain.
e. Establishe the interface between token and smart contracts.
f. Establishe the interface between token and API.

Management Issues: Some issues that have to be consistently monitored for security and efficiency of the UCOT ecosystem include:

d. Management of accounts.
e. Monitoring and management of Blockchain scalability issues.
f. Detecting and freezing the accounts on malicious activities.
g. Monitoring smart agents for power issues and sensor calibration.
h. Management of smart contracts for the life cycle of a product in the supply chains.

2.2.3 Service Layer

Services are provided through a backend database, front-end web interfaces, and mobile Apps. A distributed database will be developed to manage the supply chain data. User account management and data access control will be developed, such that digital information along the supply chain can be shared among all the participants in a trustful manner.

The applications on the website and mobile devices provide services to businesses and users through the user interfaces. This part can be adjusted according to the business requirements. Specifically, the service layer realizes the services, including distributed database, identity (ID) management service,

Blockchain content access service, token service, data request service, data sharing service, and tracking service.

Distributed Database

This layer provides two kinds of data types with different types of access:

a. Public Data Storage: Data are recorded altogether in a public Blockchain, e.g., configurations/requirements of users.

b. Shared Blockchain Records: Data belongs to a specific group of users and do not open to other users. Require specific access control.

There are two types of data with different form and sources: **IoT Related Data**. There are two kinds of devices that provide raw data:

1) Data uploaded by lite end-devices with poor computational / communication power, e.g., NB-IoT devices in the first-stage system. Data is automatically collected or manually uploaded and sent to the Blockchain level through agents. These devices do not run Blockchain applications. Authorized users will manage these end-devices, and the configuration process of the end-devices is securely recorded by another Blockchain-based service (devices management service). Although data needs to be processed and secured by an additional process (encryption and authentication) before being recorded in the Blockchain, it is specifically designed for low-power devices and thus is more flexible.

2) Data uploaded by high-performance end devices that can run blockchain programs, such as Wi-Fi enabled Raspberry Pi. For such devices, data is collected and directly written into the Blockchain in the form of transactions.

3) We would develop unique ID-based labels/devices. These labels will be attached to the products and will send data automatically to the Blockchain network. Once the label is attached to a product, automatic recording would start, and a random number would be allocated to the product. Once the label is peeled off the product, the tracking record would end, and the label is waiting to be triggered again by the next attachment. The tracking records are recorded in the Blockchain network. The ID of the label is unique and permanent in the Blockchain network, and the random numbers are used for each tracking process.

Flowchart:

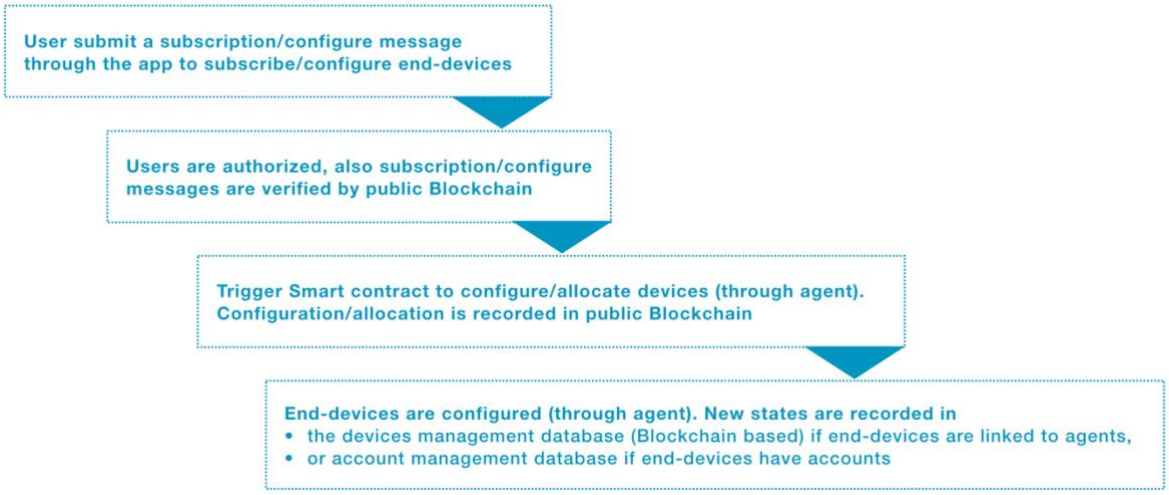


Figure.9 Flowchart

b. **User's Arbitrary Data.** Users can access to the system and upload data to the Blockchain. The data* is bonded with each user. This kind of data is in more flexible form, and is not limited to sensory data. Moreover, the data can be either in plain text or encrypted.

**The data may be recorded directly in the form of raw data (encrypted or not) and transferred into transactions later, or directly recorded in the form of transactions.*

Flowchart:

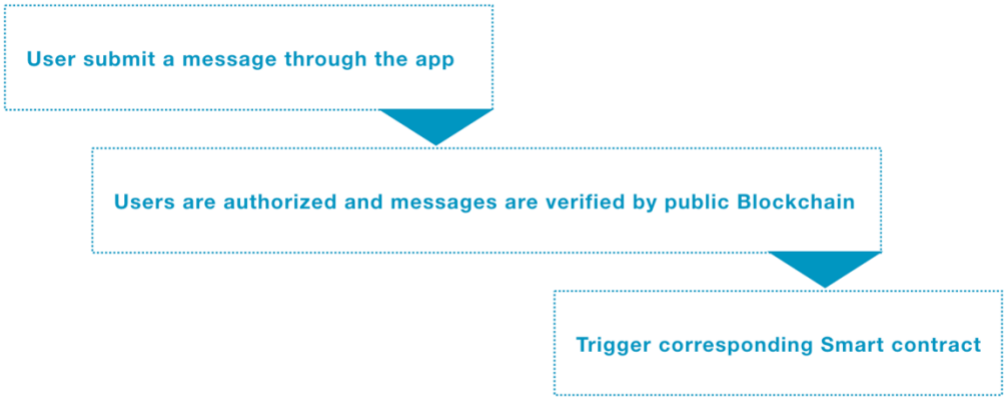


Figure.10 Flowchart

Identity Management

The ID management service corresponds to the account management and device management in the lower layers, e.g., creating accounts and updating the accounts of devices. In the Blockchain explorer service, users can browse the

blocks and transactions in the Blockchain records, e.g., the accounts of the transactions, the generation time of the blocks, and the height of a block. The crypto-token of the system is realized in the token service. Users can get the balance based on their past behaviors and drive their business by spending the crypto-token. With data request service, users can define filters and then obtain the required data from the Blockchain. The Blockchain system supports complex data sharing business based on multilevel permission management. Users can define data sharing strategies according to the specific business requirement. In the tracking service, the system will analyze the collected data and visualize the result.

Access control

From the perspective of security and privacy, the data on blockchain may include some sensitive information such as transaction details and products' location. So, proper encryption method should be usedhere to provide users with a safe, private trading environment. Data access control is a method to ensure the accessibility of legal users while protecting data from unauthorised users. We use this technique to support hierarchical access control in our design.

For example, we will be able to track the location information of a product moving from point A to B as the original message. The users in the system are divided into different hierarchies with different authority. As shown in the simplified three-level structure below, illegal users can not access any information. The lowest level of users only have access to the black line segment, which can also be decrypted by users in higher level. The red segment is only visible to highest level of users.

One of the techniques that can realize the hierarchial structure is Attribute-based encryption(ABE), which views identity as a set of descriptive attributes. It is an one-to-many public key encryption method. This method can not only solve the key distribution problem in symmetric encryption, but also share the information that IoT devices captured with various users.

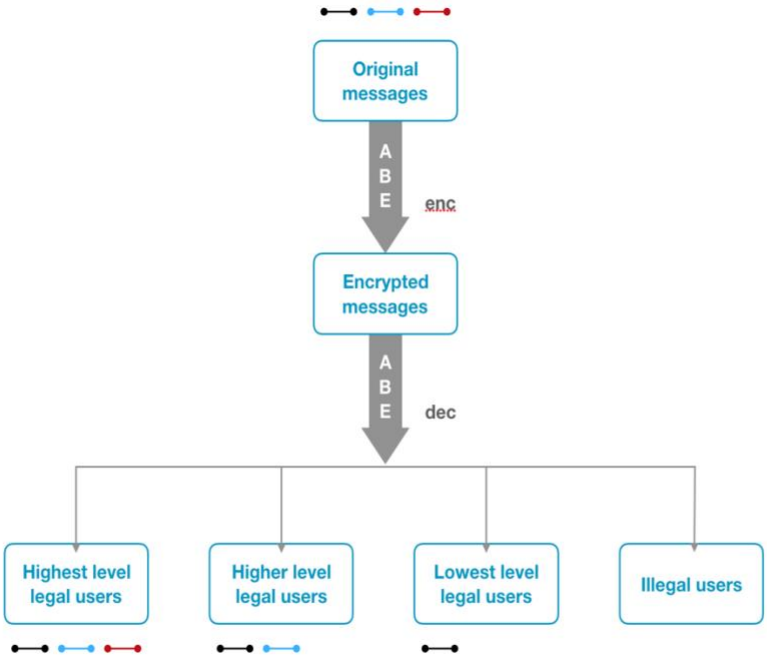


Figure.11 Attribute-based Encryption

3.0 Core Technical Team

UCOT ecosystem is developed by **Ultimo Digital Technologies (UDT)** team, who is dedicated to building and developing a Blockchain-enabled smart IoT ecosystem. The development of **UCOT** integrates next-generation telecommunication technologies with smart Internet-of-Things (IoT) platform powered by state-of-the-art Blockchain technologies.

Besides deploying **UCOT** to facilitate and optimize industrial supply chain between business and customers, **UDT** also helps enterprise clients to develop customized business solutions based on Blockchain technologies according to their specific needs.

UDT team, bringing together elites professors and scientists from the Cyber Security Laboratory at the University of Technology, Sydney (UTS), Australia and the CSIRO and a group of excellent Ph.Ds in computer network engineering. Among them, CSIRO is the highest scientific research institution in Australia and also the birthplace of technologies such as the fundamental principles of modern Wi-Fi and atomic absorption spectrometry.

The core member of UDT team are all recognized leaders in IoT and security research, with a large number of related publications in top international conferences and journals. The project leader, Professor Ren Ping Liu, has extensive experience in delivering industry solutions.

Executive Director, Science & Technology

Ren Ping Liu is a Professor at the University of Technology Sydney (UTS), the School of Electrical and Data Engineering. In UTS, he leads Network Security Lab in the Global Big Data Technologies Centre. He is also the Research Program Leader of the Digital Agrifood Technologies in Food Agility CRC, a government/research/industry initiative to empower Australia's food industry through digital transformation.

Prior to that, he was the Chief Scientist at CSIRO (The Commonwealth Scientific and Industrial Research Organisation), where he led wireless networking research activities. He is specialized in network design and modelling and has delivered networking solutions to a number of government agencies and industry customers. Professor Liu was the winner of Australian Engineering Innovation Award and CSIRO Chairman's medal.

Professor Liu has over 100 research publications and has supervised over 30 PhD students. His research interests include Markov analysis and QoS scheduling in WLAN, VANET, 5G spectrum sharing, Blockchain based Smart IoT design, and network security.

Professor Ren Ping Liu is the founding chair of IEEE NSW VTS Chapter and a Senior Member of IEEE. He served as TPC chair for BodyNets2015, ISCIT2015, WPMC2014, as OC co-chair for VTC2017-Spring, BodyNets2014, ICUWB2013, ISCIT2012, SenSys2007, and in Technical Program Committee in a number of IEEE Conferences.

Ren Ping Liu received his B.E.(Hon) and M.E. degrees from Beijing University of Posts and Telecommunications, China, and the Ph.D. degree from the University of Newcastle, Australia.

Chief Researcher

Wei Ni received the B.E. and PhD degrees in Electronic Engineering from Fudan University, Shanghai, China, in 2000 and 2005, respectively. Currently, he is a Senior Research Scientist and Team Leader Data61, CSIRO (The Commonwealth Scientific and Industrial Research Organisation) in Sydney, Australia. Prior to this, he was a Senior Researcher, Devices R&D, Nokia (Jan 2008 March 2009), and a Research Scientist and Deputy Project Manager, Research & Innovation (R&I) Center, Bell Labs, Alcatel/Alcatel-Lucent (Jan 2005 Dec 2007). His efforts led to an Alcatel-Lucent internal venture and three product projects, ten accepted IEEE standard technical proposals, and 25 patents. He has published 38 journal papers and 29 conference papers. Dr Wei Ni serves as an Editor for Hindawi Journal of Engineering since 2012, Secretary of IEEE VTS NSW Chapter since 2014, Track Chair of VTC16-Spring, Track Chair of

VTC17-Spring, Chair of Student Travel Grant for WPMC 2014, and Publication Chair of ISCIT 2015.

Project Supervisor

Mehran Abolhasan completed his B.E in Computer Engineering and PhD in Telecommunications in 1999 and 2003 respectively at the University of Wollongong. From 2003-2004, he worked at Smart Internet Technology CRC and Office of Information and Communication Technology within the Department of Commerce in NSW, Australia. In 2004, he joined the Desert knowledge CRC and Telecommunication and IT Research (TITR) Institute to work on a joint project called the Sparse Ad-hoc network for Deserts project (Also known as the SAND project). From 2004 to 2007, Prof. Abolhasan led a team of researchers at TITR to develop prototype networking devices for rural and remote communication scenarios. Furthermore, he led the deployment of a number of test-beds and field studies in that period. In 2008, he served as a Director of Emerging Networks and Applications Lab (ENAL) at the ICTR institute. During this time, he won a number of major research project grants including an ARC DP project and a number of CRC and other government and industry-based grants. In March 2010, he accepted the position of Senior Lecturer within the Faculty of Engineering and IT (FEIT) at the University of Technology Sydney (UTS), where he is now an Associate Professor. In 2014, he accepted the position of Director of Research Programs at FEIT. In 2016, he was appointed as a Deputy Head of School for Research in School of Computing and Communications, UTS. A/Prof. Abolhasan has authored over 100 international publications and has won over one million dollars in research funding. His Current research Interests are in; Software Defined Networking, IoT, Wireless Mesh, Wireless Body Area Networks, 5G Networks and Sensor Networks. He is currently a Senior Member of IEEE.

Our Team Members

JOHN BAIRD | **Chief Executive Officer**

Masters of Computer Forensics, Post Grad Dip. Computing, BSc in computing at Macquarie University. CEO at Revio Cyber Security, Former Vice President of Credit Suisse, Former CTO of Deutsche Bank, CSIRO Scientist, Panel Chairmen of NSW Government ICT Industry Advisory panel.

RENPING LIU | **Chief Technology Officer**

B.E.(Hon) and M.E. degrees from Beijing University of Posts and Telecommunications, China, and the Ph.D. degree from the University of Newcastle, Australia. Professor at the University of Technology Sydney, Former Principal Scientist at CSIRO, the winner of Australian Engineering Innovation Award and CSIRO Chairman's medal.

MEHRAN ABOLHASAN | **Program Supervisor**

B.E in Computer Engineering and Ph.D. in Telecommunications in 1999 and 2003 respectively at the University of Wollongong. From 2003-2004, he worked at Smart Internet Technology CRC and Office of Information and Communication Technology within the Department of Commerce in NSW, Australia. Deputy Head of School for Research in School of Computing and Communications, UTS. A/Prof.

PHILIPA RYAN | **Partner Investigator**

LLB with Honors and Ph.D. in Law in 1999 and 2013 respectively at the University of Technology Sydney (UTS) and University of Sydney. Founding member of the UTS Blockchain Creative Clusters. Member of the Standards Australia Blockchain Technical Committee. Deputy chair of the Australian Computer Society's Blockchain Technical Committee. Published articles on the legal implications for exchanges conducted on blockchain networks. Co-author of the ISO Blockchain and Distributed Ledger Technologies Technical Committee Smart Contracts Report.

HUBERT CHU | Chief Operating Officer

Member of Blockchain Strategy Programme at Saïd Business School, University of Oxford; Master of Project Management with Distinction at the University of Sydney; Master exchange student at the University of Manchester; Double Bachelors in Engineering and Economics at Wuhan University with National Scholarship. Level 3 Professional Interpreter and Translator in the English and Mandarin languages accredited by Australian National Accreditation Authority for Translators and Interpreters Ltd (NAATI); Former Business Planning Manager at HNA Group, a Fortune Global 500 company. Extensive work experience in nine industries, including aviation, investment banking, internet education, real estate, etc.

ABIGAIL WANG | Chief Communication Officer

Master Degree in Professional Accounting, Bachelor of Commerce majoring Finance and Marketing at the University of Sydney. Previously employed by BNP Paribas Australia & New Zealand; Securities Services division. Previously elected Vice-President of the Student Union at the University of Sydney. Professional experience in media and communications industry, roles including program director and client relationship manager in media groups, content creation/scheduling, news editing, client liaison, video producing and advertising.

KAN YU | IOT Framework Engineer

Ph.D. in Computer Science from Malardalen University in 2014, M.Sc. from Chalmers University of Technology in communication engineering and B.Sc. from Beijing University of Posts and Telecommunications in China. HANS WERTHÉN Awards winner by the Royal Swedish Academy of Engineering Sciences in 2015 Postdoctoral researcher in the field of industrial IOT at Malardalen University, the visiting researcher at the University of Sydney, worked in Huawei Tech. Co. Ltd. and Datang Tele. Co. as the engineer.

ANDY LIU | Program Director and Blockchain Engineer

18 years of experience in the IT industry, ranging from blockchain system analysis, design, development, and implementation. Specialized in full stack system development, ICO project management, and has extensive experience with Solidity program testing, profiling, bottleneck analysis and performance optimization. Experienced in C/C++, Python, JavaScript and PHP developer, LAMP, Docker, AWS, and others. Member of Australia Computer Society and has PMP, SCJP, MCSE and MCDBA certificates. Andy also served Huawei, SAS and BMW Brilliance as senior developer and senior project manager. Before joining UCOT, Andy worked for AnlinTech as CTO to lead the product development of blockchain and wallet.

Our Advisors

JOSEPH LIAO

Dr. Joseph Liu is an expert of cyber security and applying cryptographic technologies into world systems. He is well-known as "God Father of Monero" because of his remarkable researches in Ring Signature, which is the theory basis of Monero (XMR) since 2011. His current technical focus is cyber security in the cloud computing paradigm, smart city, lightweight security, and privacy enhanced technology. He has published more than 80 refereed journal articles and conference papers and received the Best Paper Award from ESORICS 2014.

RYAN XU

Nickname Ryan the Martian, Co-Founder of Blockchain Global, Founder of Collinstar Capital, well-known blockchain investor, Founder of Bitcoin Development Fund, member of Asian DACA Blockchain Association, Chairman of HCash Foundation, One of the most influential KOLs in Chinese Digital Currency and Blockchain Community.

PHIL CVETOVAC

CEO & Founder of Pharma Science Australia, well versed in most areas of business and commerce, including sales & marketing, growth strategy, branding, legal, and business structure and re-structure.

JIM FITZSIMONS

Jim FitzSimons has dual qualifications in law and computer science and specialises in IT and telecommunications law, outsourcing and systems integration contracts, IP ownership and licensing, e-commerce, acting for users and suppliers of IT&T and related services in the public and private sectors.

JAYDEN WEI

CEO of Collinstar Capital, Experienced Fund Manager with a demonstrated history of working i the financial services industry. He is also the manager of Australian first blockchain venture capital fund. Master of Business and Master of Professional Accounting from Monash Universit

VICTOR JIANG

Founding Chairman of Sapien Ventures – a fintech and blockchain focused VC firm with presence across Silicon Valley, Australia and China; sits on the Board of 6 technology companies across the 3 continents (4 as Chairman); a serial entrepreneur; lived and worked across 12 countries, having worked with 5 of the largest consultancies in the world, 35 of the Fortune 50 companies as clients, and advised many startups.

ALLAN GUO

The Founder and COO of Blockchain Global Limited. The GM of ACX.IO Australian Digital Exchange. Founder and CFO of the world's first arbitrage fund of Bitcoin reserve. Founder of Blockchain Center.

KEN CAO

Professional Investor and investment banker; Board member and Director in Australia for Top 500 Chinese enterprise; General Adviser in Australia for top 10 Chinese legal firm; Former Senior Investment Official of Australian Government; Former Representative of Chinese business organization; Founding Secretary General of CCCA; The key writer of the Chinese e official edition of "Australian Annual Market Report."; Master – MGSM, Macquarie University; Familiar with M&A, IPO, International Trade, Blockchain and Venture Capital.

PETER CAI

Peter Cai is a Nonresident Fellow at the Lowy Institute. Previously he was a journalist with The Australian, Business Spectator, The Age and Sydney Morning Herald, covering business and economic news. Before becoming a journalist, Peter was at the Australian Treasury where he worked in the Foreign Investment Review Board Secretariat, focusing mainly on state-owned enterprises and sovereign wealth fund investment policy. Peter has a master's degree from Oxford University and holds undergraduate degrees from The University of Adelaide. Peter is currently also Group Chief Advisor with Virgin Australia.

ZEYU SUN

Co-founder of God WalletMember of Academic Committee of financial science and technology innovation laboratory at Peking University Professional digital currency traderWell-known blockchain investorThe first post-90s interviewed by British Guardian Accept CCTV2's bitcoin interview twice.

DOUGLAS WANG

Founder of JIC capital, Blockchain Robot inventor. Community operations expert.Former Sales Director of IBM, Motorola and HP. Settled in Canada in 2013, teaching Internet technology and digital currency in Canada.He has a large number of users and students in many countries and regions around the world.Researched and developed chat robot in silicon valley in 2015.In 2016, operated high-end entrepreneur community in China with more than 1.52 million members, helping domestic enterprises complete the Internet + upgrade. In 2017, he invested in several digital currency projects such as SWFTC, Genaro, MDT, ITC and PRO.

Research Partners

University of Technology Sydney

University of New South Wales

Monash University

Beijing University of Posts and Telecommunications

Business Alliance

Investors

4.0 Organization and Governance

4.1 Foundation

Australian Digital Chain Foundation (ADCF), referred as "The Foundation", is the advocacy and governing body of UCOT ecosystem.

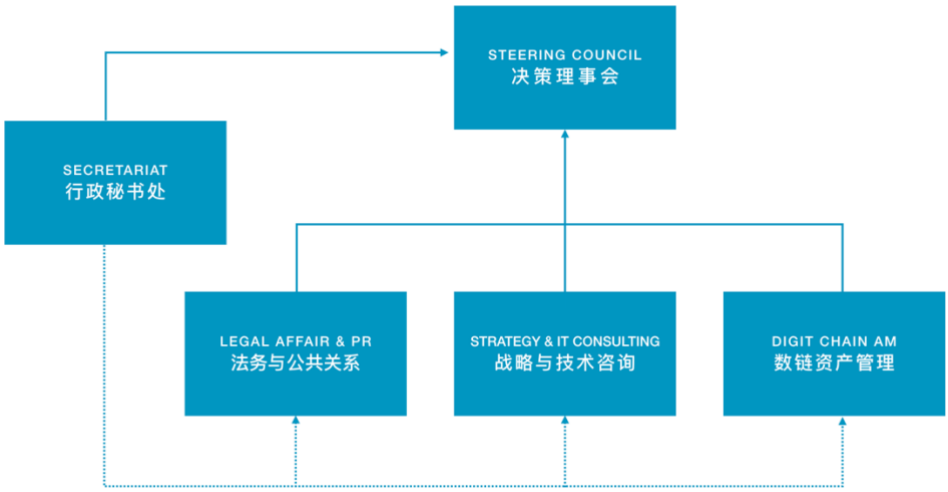
The Foundation's mission is to assist its members in being prepared to meet the challenge of a whole new era of “Ultimate Supply of Every Chain, Smart Internet of Every Thing". To reach the goal, The Foundation is committed to researching, developing and organizing resources to build a next generation, globally accessible, easy-to-use and trustworthy Smart Digital Chain-of-things ecosystem, which allows the businesses to optimize their supply chain management and intelligentization of their IoT through decentralized applications (dapps).

The Foundation's Vision is that more and more enterprises will leverage Blockchain technologies to realize asset digitization and re-model the value transfer and exchange process in the supply chain and IoT ultimately.

In this process, the Foundation will promote and support the implementation of **UCOT** infrastructure including platform, applications and frameworks and provide governance, transparency, and promotion and advocacy work.

4.2 Structure

The Structure of The Foundation is as below:



4.3 Resource and Allocation

4.3.1 Resource

The Foundation's income comes from the following sources:

- Operating income from research & development activities, consulting services, intellectual product sales, patent transfer or licensing and personal and institutional contribution, etc.
- Asset management income from investing and managing digital asset portfolio

4.3.2 Token Allocation Plan

UCOT will issue a finite number of tokens **"UBI",** totalling 1.05 billion globally, The supply of token will be distributed according to the following plan:

UBI distribution plan

Channels	%	Numbers	Details
POS	**20%**	210,000,000	Tokens will be generated through POS mining activities after UCOT moving onto public/consortium chain , increasing with more blocks being mined
Token swap plan and incentives distribution	**30%**	315,000,000	UBI is distributed through Token swap plan
Technical team , Continuous maintenance and technological development	**10%**	105,000,000	To be distributed to the technical team as their rewards for future development of the UBI. These amount will be locked up to 12 months after the Token swap plan, and gradually released with a pace of no faster than 5% per year
Enterprise Users in the Ecosystem	**10%**	105,000,000	To provide incentives to enterprise users to join UCOT ecosystem and use the platform to optimize their supply chain or improve their own IoT system. These enterprise users will use the UBI for their supply chain and IoT management on daily basis
Foundation management and business development	**10%**	105,000,000	To be reserved for various operating and upgrading costs and development of the UCOT ecosystem.These amount will be locked up to at least 12 months after the Token swap plan , and gradually released with a pace of no faster than 5% per year
Token Swap Plan （TSP）(15%) & Private placement(5%)	**20%**	210,000,000	Prominent institutional and individual investors who are very influential in the community will be regularly consulted to provide advices to the foundation in terms of technologies and business development. These amount will be locked up to at least 6 months after the Token swap plan, and gradually released with a pace of no faster than 5% per year afterwards
Total	**100%**	**1,050,000,000**	

5.0 Implementation Schedul

2017.08 Project Launched, Core Technical Team established

2017.10 Token sales (TSP) angel round completed

2017.11 Ucot.world website construction

2017.11 Token private sales completed

2018.02 Initial Cryptoken Offering

2018.05 Testing completed, Version 1.0 released

2018.06-08 Liaise with Manufacturing facilities for tracking device (chips and hardware) and communication protocol

2018.09 Business solution for individual corporation

2018.07-09 UCOT Cross-border Shopping Mall launched with strategic partners to supply products from collaborating enterprises in the ecosystem , such as baby formulas, high-end wine, brand apparel, Australian Seafood & Meat, Luxury goods, cosmetics products etc.

2018.12 Business solution integrated at industrial level

2019.06 Integrated platform for the community established

6.0 Ecosystem and Business Use Cases

The **UCOT** Ecosystem is comprised of community, enterprise users, and customers. With the development of UCOT, more and more business users and customers and other parties will join the ecosystem

6.1 Community

UCOT's community includes Core Developers, Full Node（industrial regulator, enterprises, etc）, Light Node(wholesalers, retailers), and Browser User (retailers, customers)

The criteria for determining whether a community is successful or not are:

- Successfully build a decentralized peer-to-peer system, reach the goal of minimum costs, privacy protection and long-term sustainability, while realizing users data autonomy;
- Create a more efficient market for real-time data based on physical assets and services based on new risk assessment method and in a trustless environment;
- Design for more meaningful, user-experience-driven smart network solution.

6.2 Use Cases

Supply Chain Management

Origin Verification

There is a growing demand for more transparency from brands, manufacturers, and distributors throughout the supply chain. In China, 90% of consumers are concerned about the issues regarding counterfeit products (Shan Zhai) but feel incapble of changinhg the status quo through their purchasing decisions. Many countries are starting to require companies to disclose reliable information about their products' footprints.

By using UCOT platform, we can provide product traceability service for enterprises. By recording the whole process information in the supply chain on the blockchain, we can retrieve and track the information such as the raw materials, production sites and the transportation history of the products, which will greatly improve the information transparency and authenticity in the industrial supply chain. On the UCOT platform, all information in product manufacturing, transportation and transaction process is integrated, and the value transfer system in the supply chain is rebuilt.

Supply Chain Management Efficiency

Because the data recorded on the Blockchain is time stamped with solid proof and is tamper-resistant, the disputes between the parties involved in the supply chain system can easily be resolved by determining the responsibility based on proofs and tracking information. Trading parties participating in the supply chain can share the data with each other to achieve openness and transparency. The flow of information remains intact and unobstructed at all times, ensuring that that once there is any kind of problem, the supply chain system and the participating parties can detect where the problem is promptly and develop a solution quickly and objectively, thereby enhancing the overall efficiency of supply chain management. Therefore, Blockchain technology can avoid many unnecessary disputes along the supply chain.

An open and transparent supply chain can bring many benefits to the company and help build up its competitive advantage. For example, the Australian milk formula supplier began to include scan codes on the product tank so that consumers can retrace the product back to the manufacturer; this program alone can add more than $20m brand value to the company.

Certification

Product certification is an essential tool for enterprises' brand differentiation strategy, but it is often very difficult to verify the authenticity of the certification. While proving the integrity of the product certificating process is an expensive process, it is sometimes difficult to ensure the validity of the claim even after a painstaking auditing process. On a global scale, there are many areas with a lot

of corruption, and noncompliant certificating schemes can in fact further endanger the credibility.

However, the supply chain data on UCOT platform is collected by all parties at the same time, and the blockchain will efficiently allocate impartial incentives according to pre-programmed smart contract.

The UCOT platform is an authentication system that can assign and validate certain attributes of a physical product, and implement a full-chain model of the various materials and components from the initial production through manufacture and assembly to the final customer. At each point in time, the prototype of the model will describe in detail five key properties concerning all materials and consumables it covers: the nature (what it is), the location (where it is), the quality (how it is), the quantity (how much it is) and the ownership (whose it is). The key attributs can be read and linked from pre-existing datasets such as barcodes, and reassigned along the supply chain.

Using Blockchain as a shared and secure platform, we are able to see not only the final state (which mimics the real world in assigning the materials for a given product under the ownership of the final customer), but, most importantly, overcome the weaknesses of current systems by allowing one to securely audit all transactions that brought this state of being into effect; i.e., to inspect the *uninterrupted* chain of custody from raw materials to final sale.

The Blockchain also gives us an unprecedented level of certainty over the fidelity of the information. We can be sure that all transfers of ownership were explicitly authorized by their relevant controllers without having to trust the behaviour or competence of an incumbent processor.

The following demo shows how a cross-border e-commerce provider leverages UCOT Blockchain platform in remodelling their supply chain. We will show how the original supply chain certification and audit process are revitalized on the new platform for efficient implementation. There are five participating parties in our example:

- Suppliers (e.g., a Dairy Farm);
- Manufacturers (e.g., a producer of baby formula);
- Registrars, which are institutions or organizations that provide credentials and unique identities to actors (e.g., an accreditation service);
- Agents such as certifiers and auditors, who are usually independent from each other, can maximize security by inspecting producers and manufacturers and verifying specific standards including annual production capacity; and

- Customers, the buyers, distributors, wholesalers, retailers of products along the supply chain, including the end consumer.

The main architecture of the UCOT Blockchain platform provides some modular procedures for this cross-border e-commerce platform, each of the which is deployed on the blockchain and exerts control independently. However, since the procedures work in the same Blockchain system, it is possible to perform the frictionless interaction.

Registration Module

At the beginning, a UCOT identity is created. In UCOT, everyone can use his or her private key to access their information. Depending on use cases and permissions, the data can be set as public or private. Some may contain only anonymous IDs, while others may include complete information.

The program running on this module forms the basic trust relationship between the entire base of users and the system. The program will initially be deployed by the registrar, who will register for the designated participant (i.e., the certifier, the auditor, the supplier, and the manufacturer). Participants can register digital identities and then link the blockchain-based digital identity to the identity of the real world, and record the results in the Blockchain for inspection by all. When the platform is used, the Blockchain can automatically verify the digital identity. This module allows the participant to remain anonymous

Supplier Module

UCOT provides a way to safely record the key information about the material during the transfer process.

After successful certification, these procedures are used by the supplier to prove materials or the creation of primary products. The program would specify and implement the parameters of each production equipment, including:

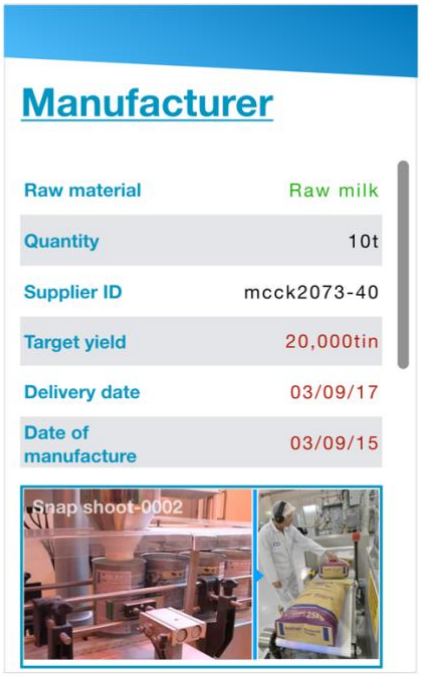
- Certification of Production capacity, such as that the "raw milk/year" is 2,000 tons;
- Production accounting, that is, production date, shelf life and sales registration;
- Product classification, that is, a detailed description of the its origin and dairy cow breed, and any other "label" of the particular attribute;

These parameters can be adjusted according to the guidelines of the certifier or after the auditors' checks, and if the audit is unsuccessful, the procedure may be withdrawn as needed (temporarily). Since the program is primarily responsible for creating the product, the supplier module forms the source of the product traceability and then links to the digital identity provided by the registrar

Manufacturer Module

The manufacturer module can realize the conversion of products from raw material input, to final product through the production process. Same as the suppliers' module, once deployed by the certification authority, the program would run automatically with the constraints by the manufacturer. However, there is another constraint: the input must be "used" for any output, just like the physical world. For example, a certain supply amount of milk powder registration requires a corresponding amount of raw milk input. After the production process is completed, the amount of raw milk input would be erased. As the process on the Blockchain is auditable,

only when the corresponding amount of raw milk consumption is no longer available, could the milk powder supply be generated.

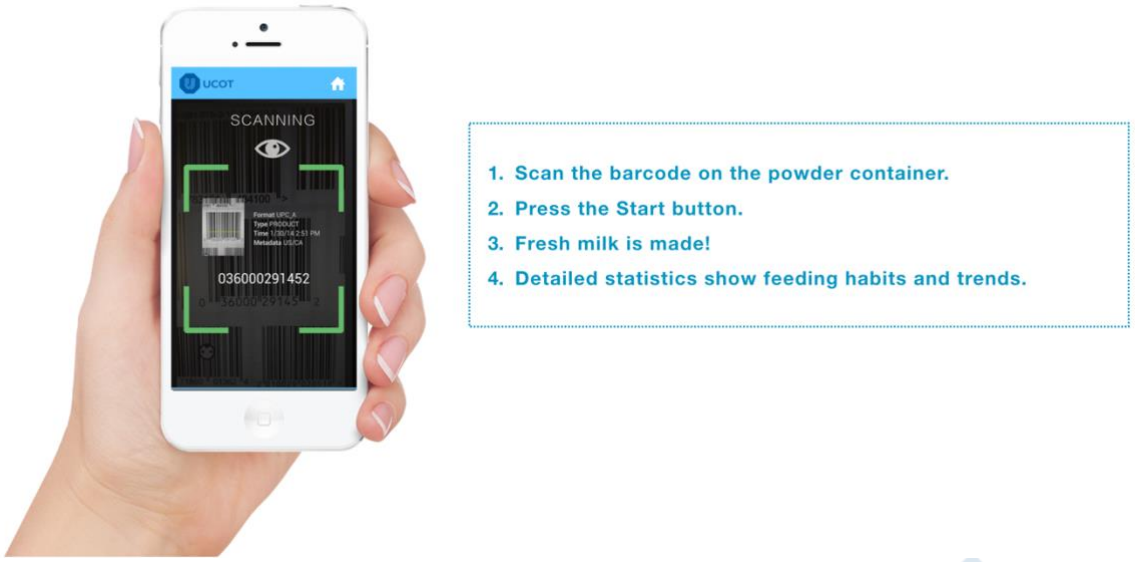


Digital Chip Tracking Module

UCOT uses self-developed electronic tags with NB-IoT standard chips, encrypted QR codes, and NFC labels to trace the physical products, the component and the origin.
In addition to the implementation of the above basic business logic, UCOT also provides the user interface that connect the product with its digital identity, so that customers on every downstream link along the supply chain can successfully carry out the purchase of goods from the upstream link.

Bar code and serial number will be hash encrypted and generate a digital link to the Blockchain via RFID and NFC or NB-IoT chip,.

User Interface Module



Applications designed with a user interface provide easier access to the blockchain

UCOT provides user-oriented applications to access security information about the product on the Blockchain. In the Blockchain-enabled supply chain, information of each transaction is auditable, and the smartphone application can read and display information to the customer in real time by checking respective block. UCOT's user interface can completely demonstrate the digitalized logistics process of the product, giving the end user a real option so that they can better implement the purchasing activities.

7.0 Contact Information

For more information, please contact: **info@ucot.world**