INTERNATIONAL TELECOMMUNICATION UNION

TELECOMMUNICATION STANDARDIZATION SECTOR

STUDY PERIOD 2017-2020

FOCUS GROUP ON APPLICATION OF DISTRIBUTED LEDGER TECHNOLOGY

DLT-O-000

WG(s): 2

Beijing, 11 October 2018

INPUT DOCUMENT

Source: Chaincomp Technologies Co., Ltd.

Title: Draft of a DLT Use cases - Livestock farm data monitoring & traceability

Purpose: Proposal

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Keywords: Distributed Ledger Technologies; Use Case; Agriculture; Traceability;

Abstract: Use of DLT to track the flow of livestock farm data.

Section 1 Summary

Use Case Summary			
Use Case ID:		**Use Case Type:**	Vertical
Submission Date:	11-October -2018	**Is Use Case supporting SDGs**	Yes
Use Case Title:	Livestock farm data monitoring & traceability	**Domain:**	Agriculture
Status of Case	Pilot	**Sub-Domain**	Food traceability
Contact information of person submitting/ managing the use-case	Full Name: Hui Ding (Chaincomp) Job Title: Standard Engineer E-mail address: hui.ding@chaincomp.net Telephone number: 86-18311280681 Web site: chaincomp.io		
Proposing Organization	Chaincomp Technologies Co., Ltd., China Shenqiao Technologies Co., Ltd., Henan, China		
Short Description	Blockchain-based trusted data storage and dissemination among stakeholders in the meat industry, combined with IoT-based effective and		

	complete livestock farming monitoring and data collection enables efficient data sharing and promote food safety.		
Long description	Current large-scale livestock farming industry in China cannot provide trusted data collection and traceability, which gives chances to food safety hazards that happened in recent years. Our use case realizes: 1) IoT-based effective and complete livestock farming monitoring and data collection; 2) Blockchain-based data storage and dissemination. The system can automatically record the environmental, physiological and feeding data and enables efficient and trusted data storage and sharing among stakeholders. After deployment of such system, 1) government inspector can access tamper-proof data to evaluate the farm and the quality of the livestock; 2) consumers will be able to access the details of his/her purchase and be assured of food safety and quality; 3) furthermore, it enables lower cost meat feeding business operation: farms, feed/drug sellers, insurance providers can share information via DLT to perform transactions in lower cost.		
SDG in Focus (when applicable)	9 – Industry, Innovation and Infrastructure 9-1 Develop quality, reliable, sustainable and resilient infrastructure, including regional and transborder infrastructure, to support economic development and human well-being, with a focus on affordable and equitable access for all		
Value Transfer:	NA	**Number of Users:**	Tens of thousands+
Types of Users:	farm owner, feed/veterinary drugs seller, insurance provider, government inspector, retailor, etc.		
Stakeholders	farm owner, feed/veterinary drugs seller, insurance provider, government inspector, retailor, consumer, etc.		
Data:	Massive amount of data is collected via sensors and devices every day from every animal in the farm, which makes it inefficient to store on DLT. In our system, such data are encrypted and stored in distributed file system, only the hash of a data unit is stored in DLT. The data unit is decided by data types and sampling frequency, e.g. the feeding data and environmental data in 24 hours.		
Identification:	Each livestock, feeding device, sensor, farm site is uniquely identified and related data are collected and recorded. Anonymity is not required.		
Predicted Outcomes:	- Safe and high-quality meat production; - Efficient livestock farming business by sharing livestock data with feed/drug sellers, insurance providers.		

Overview of the Business Problem or Opportunity
Chinese people consume nearly 70 million pigs every year, which constitutes over half of the pig meat consumption of the world. However, current large-scale livestock farming industry cannot

provide trusted data collection and traceability in different stages of the process including farming, inspection, transportation, distribution to consumer. Hence, the safety and quality of pig meat is one of the most important unresolved food issues in China.

Business Problem:

- Safe and high-quality meat product is highly demanded;
- Efficient livestock farming business by sharing livestock data with feed/drug sellers, insurance providers.

Opportunities:

- IoT-based effective and complete livestock farming monitoring and data collection can automatically record the environmental, physiological and feeding data;
- Blockchain-based trusted data storage and dissemination among stakeholders;
- Data close to livestock has great value in ensuring food safety and preventing fraud in logistics and sales process. Lack of such data will result in the lack of the most important source data for farm-oriented monitoring.

Why Distributed Ledger Technology?

- The distributed ledger technology will enable trusted data storage and dissemination among untrusted stakeholders and reduce the chance of data manipulation.
    - Inspector can access tamper-proof data to evaluate the farm and the quality of the livestock;
    - Consumers will be able to access the details of his purchase be assured of food safety and quality.
    - Lower cost meat feeding business operation: farms, feed/drug sellers, insurance providers can share information via DLT to perform transactions in lower cost.

Section 2 Current process

Current Solutions

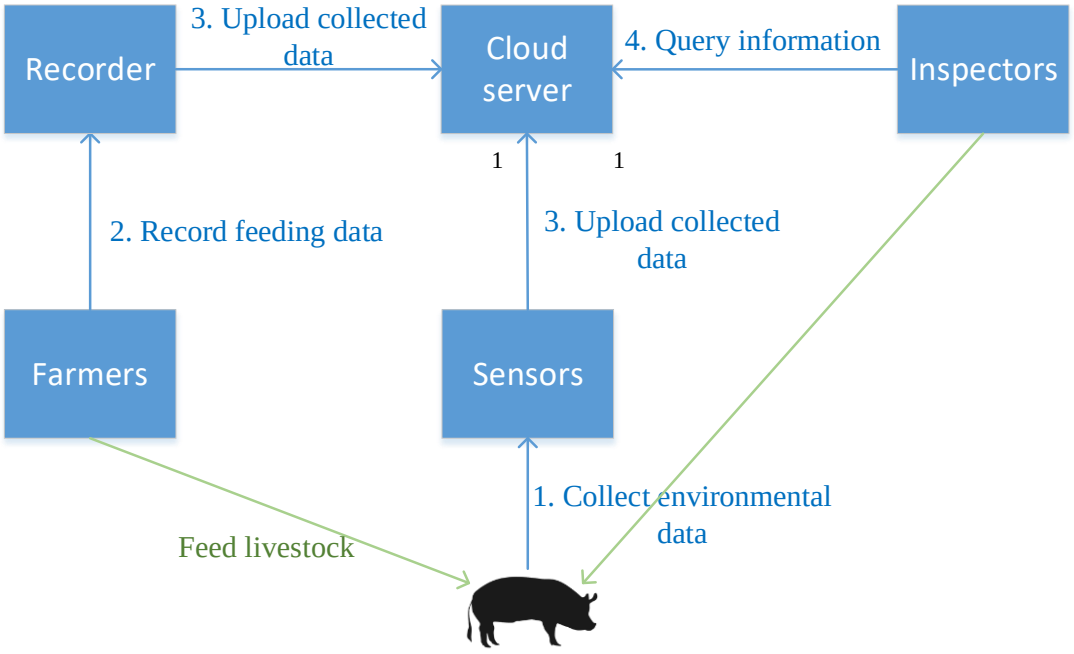
Current system monitors the feeding, living environment of livestock.

- Feeding system usually includes RFID ear tags for pigs and RFID reader on feeding devices. The reader identifies a pig by its tag and determines whether one pig has eaten to avoid excess feeding.
- Temperature, humidity and light data in the breeding house are collected by sensors to monitor the living environment of the pigs so as to avoid diseases.

However, current system doesn't obtain detailed information such as specific types of feed intake and physiological data of livestock. Furthermore, the authenticity of information is untrusted because sensing data is collected in the farm's own network and directly uploads to the its own private cloud. Data can be manipulated by certain party during the collection and storage process, making it difficult for government inspector and consumers to obtain the real information.

Existing Flow (as-is)		
Step	**User Actions**	**System Actions**
1.	Collect environmental data	Sensors collect environmental information of livestock houses.
2.	Record feeding data	Check RFID tags of livestock and prompt if they are fed repeatedly for the farmers. Record feeding information input by farmers, and store them in local storage temporarily.
3	Upload collected data	Sensors send collected environmental data, feeding devices send stored feeding records to private cloud servers respectively, and store them in the cloud.
4	Query information	Request access permissions to the cloud, and then query for the required information when authorized.

Process scheme (as-is)



Data and information (as-is)		
Data	**Type**	**Description**
1	Identification	It includes the identity information of livestock, specifically, the RFIDs of livestock, is implemented on ear tags.
2	Environmental data	It includes the environmental status data of livestock houses, such as temperature, humidity, and lighting.
3	Feeding data	It includes the livestock feeding records, such as feeding amount, time, feeding frequencies and so on.

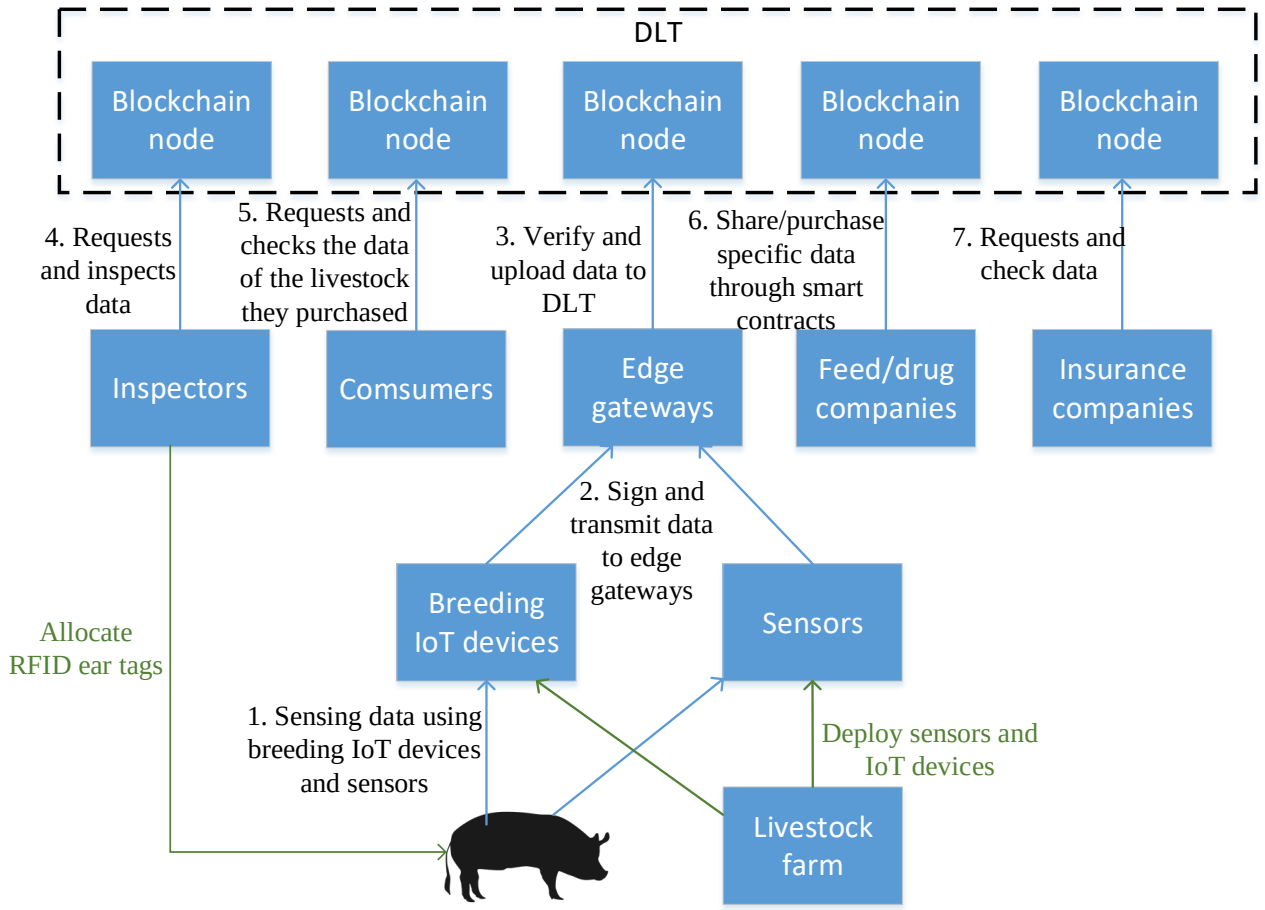
Participants and their roles (as-is)		
Actor	**Type/Role**	**Description**
1	Livestock farms	Deploy sensors in livestock farm; tag livestock; construct data collecting systems; collect and manage data in private clouds; authorize access to the cloud; employ livestock farmers.
2	Livestock farmers	Feed livestock; record feeding information.
3	Inspectors	Allocate RFID ear tags, access and analyze feeding data as well as environmental data to inspect farming processes.

Other Notes

Section 3 Expected process

Expected Flow (to-be)		
Step	**User Actions**	**System Actions**
1.	Sensing data using breeding IoT devices and sensors	Collect environmental, feeding and livestock physiological information through sensors and RFID reader in the breeding house, including livestock identity, temperature, humidity, ammonia gas, hydrogen sulphide gas, light, feeding status, body mass and etc.
2.	Sign and transmit data from IoT devices to edge gateway	Data collected by IoT devices are signed by the devices and then transmitted to edge gateway.
3	Edge gateway verifies and uploads the data to distributed ledger	Edge gateway verifies the authenticity of the data and encrypts data using its private key and then uploads the encrypted data to distributed ledger.
4	Inspector requests and inspects data	Government inspector may request and inspect certain data to check the safety and feeding conditions of all livestock in their jurisdiction. Inspector decrypts the data using public keys of the encryption gateway.
5	Consumer requests and checks the data of the livestock they purchased	Consumers can request and check the data of the livestock they purchased. These consumers include downstream slaughterhouses, food companies, restaurants and meat consumers.
6	Feed and drug companies share/purchases specific data through smart contracts	Feed and drug companies can share/purchase specific data through smart contracts.
7	The insurance company requests and checks the data	The insurance company can request and check the data of a livestock farm to determine the insurance pricing.

Process scheme (to-be)



Participants and their roles		
Actor	**Type/Role**	**Description**
1	Livestock farm	Feed livestock; deploy environmental sensors, RFID readers, and breeding IoT devices; collect breeding data and then upload the collected data to distributed ledger; deploy edge gateways and data collecting systems; authorize data users to access the uploaded data.
2	Consumer	Include downstream slaughterhouses, food companies, restaurants and meat consumers. They purchase livestock products or meat products. They can traceback the breeding data corresponding to the products they purchased.
3	Insurance company	Request and analyze the breeding data of a livestock farm; determine the insurance price for that farm.
4	Feed/drug seller	Purchase specific breeding data from livestock farms through smart contracts; adjust their production plans through analyzing the acquired data.
5	Inspector	Request and inspect breeding data of livestock farms to regulate their breeding processes.

Data and information		
Data	**Type**	**Description**
1	Identification	It includes the identity information of livestock, specifically, the RFIDs of livestock, can be implemented on ear tags.
2	Environmental information	It includes the environmental status data of livestock farms, such as temperature, humidity, ammonia gas, hydrogen sulphide gas, light and etc.
3	Feeding information	It includes the livestock feeding records, such as feeding amount, feeding time, feeding frequencies and so on.
4	livestock physiological information	It includes body mass of livestock, especially the weights varieties after each feeding.

Security and privacy

1. Sensors and feeding devices sign the data they generated using their private keys.
2. Original data are encrypted using owner's private keys. Corresponding public keys are provided by the farms to inspectors for data decryption.
3. Data are stored in a distributed file system.

Main Success Scenario

- Safe meat production: Record production-side data through the temper-proof nature of the distributed ledger, which covers the daily status of the livestock and accurately reflects their health, thus making meat safety completely transparent to inspectors and downstream consumers.

- High quality meat production: Due to the temper-proof nature of distributed ledger, a farm can prove that it spends more time feeding a healthier livestock, which can give its products a high premium.

- Efficient livestock farming and insurance by sharing livestock data with feed, drug and insurance companies can be achieved by distributed ledger and smart contract.

Conditions (pre- or post-)

NA

Performance needs

1. Performance requirements for sensing data collection and uploading at edge gateway:

The edge gateway will obtain the sensing data from multiple subordinate IoT devices. In our system, each environmental sensor generates 20 bytes data per second, and one feeding device and physiologically sensing module produce approximately 30 bytes data per second. A medium-sized pig house requires approximately two environmental sensing devices and ten feeding devices, so that an edge gateway which covers only one pig house requires about 340 bytes per second.

2. Performance requirements for TPS of DLT system:

The demand for TPS is directly related to the amount of data. Regardless of storing data directly in the chain or in a distributed file system, some data need to be updated in the distributed ledger, so certain TPS is required for data submission and synchronization. A medium-sized pig farm in China usually holds 2000-5000 pigs. If one data unit is generated and stored for each pig, and the data is submitted every 24 hours, then a medium farm's demands is 0.02-0.06 TPS. When the data uploading frequency increases and the number of farms increases, such demands also increase. For example, 10000 pig farms require 200-600 TPS when they upload data daily.

3. Performance requirements for distributed data storing:

The edge gateway uploads data to a distributed ledger node for data packaging periodically. Data can be selected to store in a distributed file system, such as IPFS, rather than all data on ledge; so that the on-chain-data can only be the hash identifier to the data stored in IPFS. This reduces the space requirements for storage on the chain, but distributed storage needs to achieve a certain efficiency to meet the performance requirements of consumer when accessing.

Legal considerations

Risks

Special Requirements

External References and Miscellaneous

Other Notes