

Digital Technologies for Food Traceability



ดร.กฤดากร กล่อมการ

FACTory Classroom

วิศวกรรมระบบไอโอที-สารสนเทศ สจล

The diagram illustrates a smart supply chain system for food products. It features a conveyor belt with various items: a crate of apples, a carton of milk, and a tray of fish. A hand holds a smartphone displaying a QR code, which is being scanned by a device labeled 'RFID'. A speech bubble from the fish tray lists 'Origin', 'Exportion', and 'Expiration'. A large blue arrow points down from the top, and another points right from the fish tray towards the bottom right. A barcode is shown on the left, labeled 'UPC Bar code', with a scanner icon below it. The bottom right corner contains the text '2. Sensor: Bacng l' and 'QR Code, RFID'.

3. IOT

The diagram illustrates a Smart Food Chain IoT Gateway system. It features a central 'Food Chain IoT Gateway' device connected to various components: a 'Smart farm' with a tractor and 'Soil sensors', a 'Smart cold storage warehouse' with a refrigerator and a light bulb, and a 'Data' center with a server rack. The gateway is also connected to a cloud icon representing the internet. The system is designed to monitor and manage the food chain from farm to warehouse to data center.

4. Blockchain

4. Blockchain

Breaking Points of the Traditional Supply Chain System

Paper-based systems and isolated databases (Data Silos) in the Web 2.0 can no longer guarantee food safety.



Farm



Processing Plant



Logistics



Retail Store



Data Vulnerabilities

Data is stored separately and is easy to counterfeit.



Credibility Crisis

Case Study 2016: More than 500,000 food safety violations found in 9 months (China).

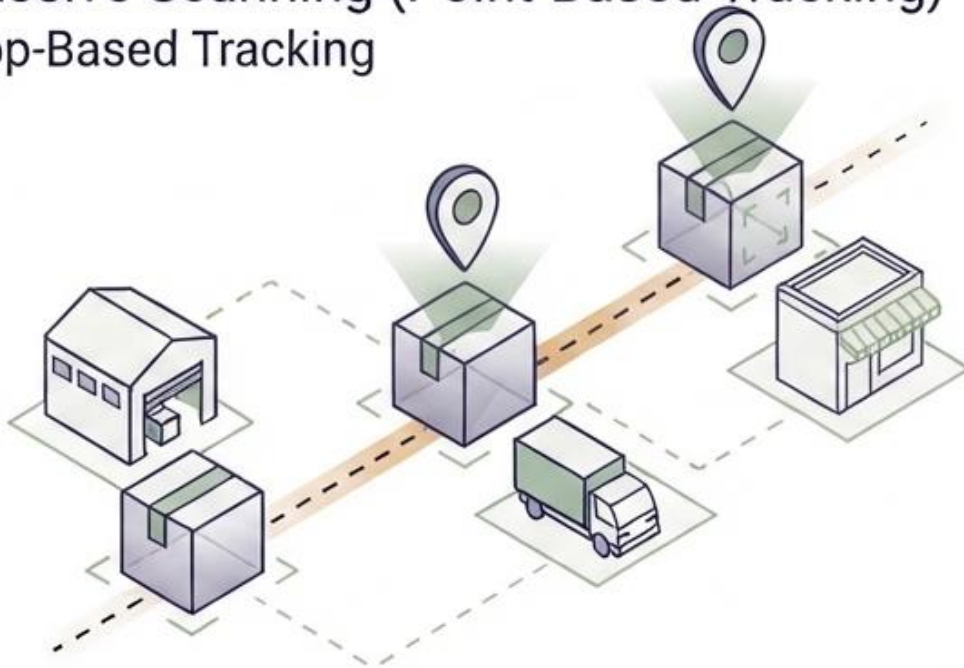


Delays

Traditional back-tracing takes several days to weeks.

Data Acquisition Architecture: Point Scanning (Passive) vs. Continuous Broadcasting (Active)

Passive Scanning (Point-Based Tracking) Hop-Based Tracking



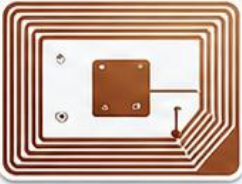
- Technology: QR, RFID
- Low cost per unit; Suitable for consumer goods
- Relies on smartphones or handheld scanners at receiving points

Active Tracking (Real-Time) Real-Time Tracking

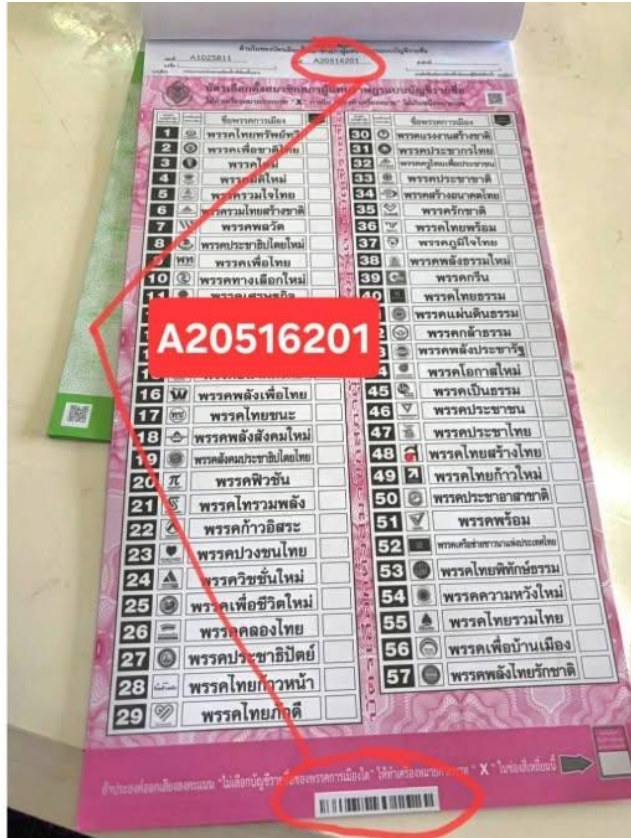


- Technology: GPS, UWB
- High device cost and monthly data fees
- Suitable for high-value assets (containers) and requires a reverse logistics process for device retrieval

Key Technologies for Food Traceability: Sensor

	Description	Pros	Cons
1D Barcode 	Store dozens of characters 	Many standards 	Small distortions can destroy readability 
QR code 	2D code, Easy to scan, store thousands of character 	Resilient to distortion 	Can create fake codes 
RFID 	Radio Frequency Identification 	Ideal for tracking assets 	Not often or easily scanned by consumers, potential interference 
NFC 	Close range RFID 	Convenience 	Adoption barriers 

What happened?



The Election Commission (EC) is being criticized because ballots contain **barcodes or QR codes**, and some people worry these codes could be used to identify how an individual voted, potentially violating the secrecy of the ballot.

Down stream tracking

MACHINE-READABLE CODES IN ELECTION ADMINISTRATION

AUTHENTICATING BALLOTS



A unique, encrypted QR code or barcode on each ballot acts as a digital fingerprint. Tabulators or scanners verify it as an official ballot issued by the specific jurisdiction.

PREVENTING COUNTERFEIT BALLOTS



Cryptographic codes are hard to replicate. If counterfeits are created, a scanner flags duplicates or non-existent codes, neutralizing ballot-stuffing.

TRACKING BALLOT DISTRIBUTION (LOGISTICS)



Scan ballots at each step: leaving the printing facility, arrival at local offices, and delivery to polling places to maintain a strict chain of custody.

TRACKING MAIL-IN VOTING



Unique barcodes on return envelopes allow voters to track their ballot journey online. Ensures each voter can submit exactly one ballot.

1D Bar Product code standard GS1 organization

GTIN-13/EAN UPC13 (Global Trade Item Number)



GTIN-13 Identification Number												
GS1 Country Prefix			Company Number					Item Reference				C
8	8	5	1	2	3	4	5	0	0	0	1	7

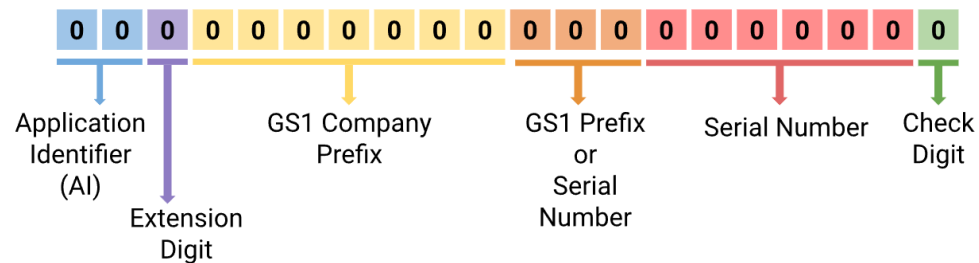
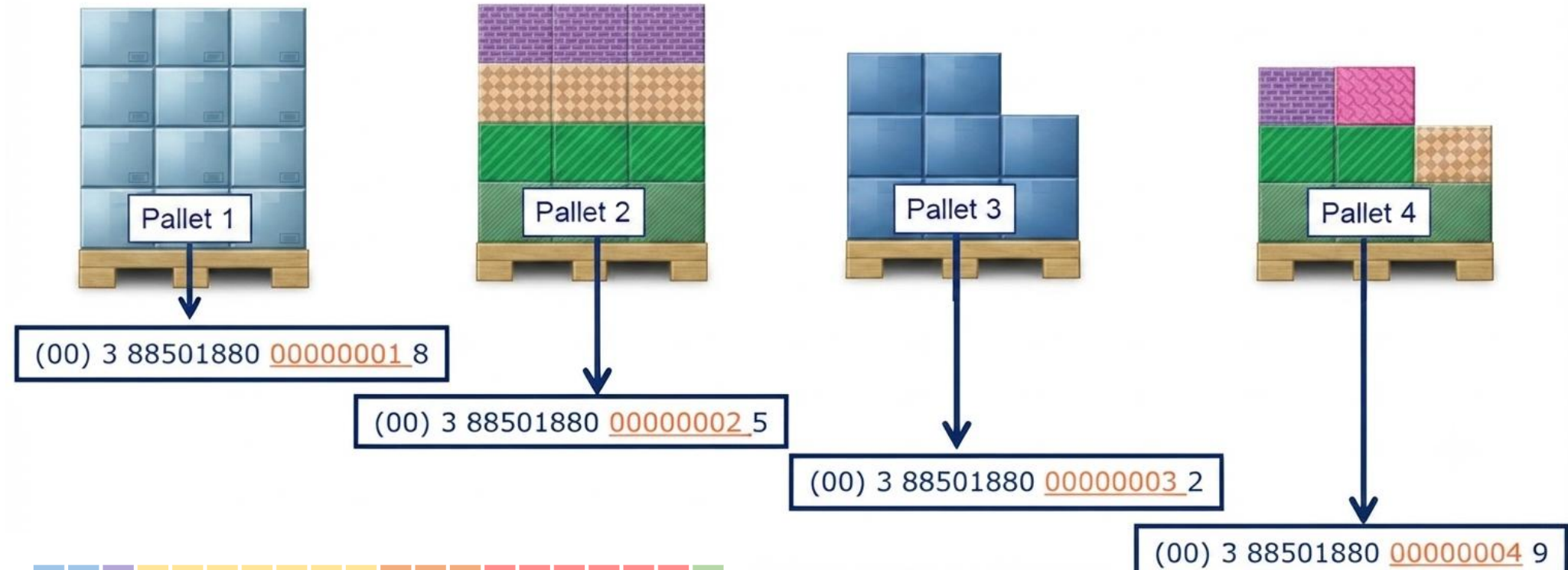


1 885 12345 0143 C



2 885 12345 0143 C

Serial Shipping Container Code (SSCC)



(Logistic unit:SSCC Barcode GTIN-18)

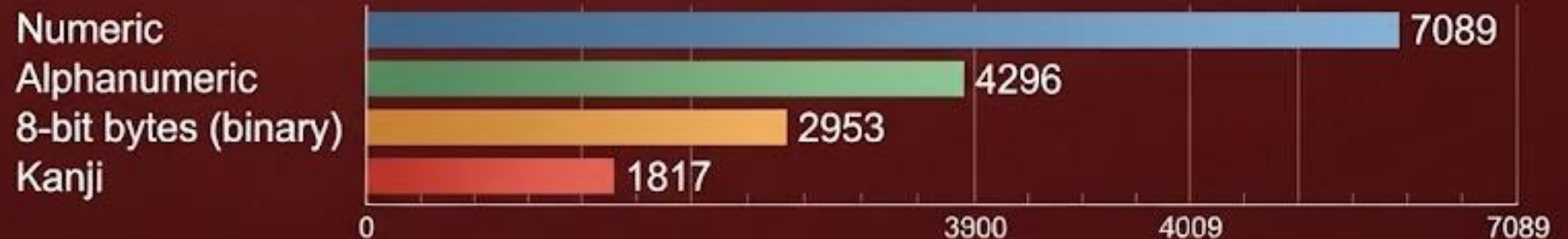
Quick Response -2D barcode

Symbol size



Type & Amount of Data (Mixed use is

Information capacity and versions of the QR Code



Error correction (data restoration)



QR code guide to WWW.





My Story



The history of this bottle begins in the heart of the Alta Murgia National Park, in the Italian region Apulia. Here, in a perfect union between innovation and tradition, the Torrevento winery pursues a development plan that has always been founded on Sustainability, Research and Quality, for the production of representative wines of Castel del Monte, Salento and Primitivo areas, as an “Ambassador of the wines of Puglia in the world”. Learn more about My Story at <https://www.dnv.com/mystory>



Agronomic Activities

Torresanta Vineyard, Corato, Italy

01/03/2021-19/09/2021



Harvesting

Torresanta Vineyard, Corato, Italy

19/09/2021-20/09/2021

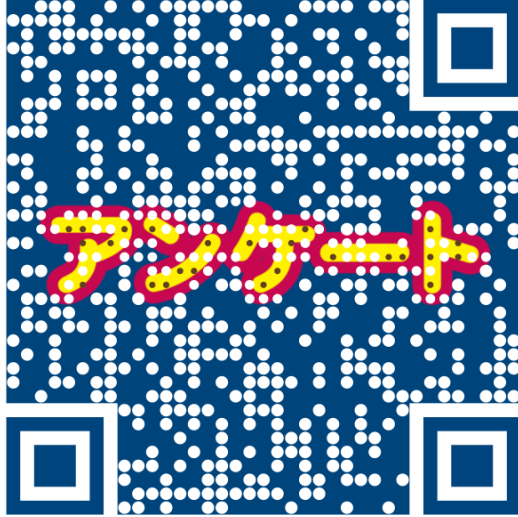
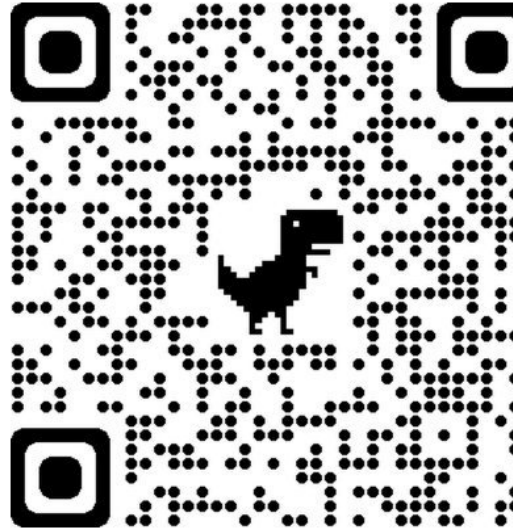


Vinification

Torrevento Winery, Corato, Italy

20/09/2021-22/09/2021

Aesthetic QR





<https://qrtrace.acfs.go.th/login>

<https://acfs-qrtrace.com/ProductInformation/VE01811/FG670603KL004/KL004>

<https://acfs-qrtrace.com/ProductInformation/VE01811/FG670708KL003/KL003>



ข้อมูลผลิตภัณฑ์/Product Information

ชื่อสินค้า/Product Name:

มายชอยส์ฝรั่งกลมสาลี่

ผลิตภัณฑ์/Brand:

ร้าน ฐานกิต กลิ่นทนอม

[คลิกเพื่อดูรูป](#)

ล็อตสินค้า/Product Lot:

FG670603KL004

ควรรบริโภคก่อน/Expiration Date

10/06/2567

โรงคัดบรรจุ/Manufacturer:

ร้าน ฐานกิต กลิ่นทนอม

[คลิกเพื่อดูรูป](#)

ที่อยู่/Address:

78 ม.5 ต.คลองใหม่ คลองใหม่ สามพราน นครปฐม 73110



ข้อมูลผลิตภัณฑ์/Product Information

ชื่อสินค้า/Product Name:

มายชอยส์ฝรั่งกิมจู

ผลิตภัณฑ์/Brand:

ร้าน ฐานกิต กลิ่นทนอม

[คลิกเพื่อดูรูป](#)

ล็อตสินค้า/Product Lot:

FG670708KL003

ควรรบริโภคก่อน/Expiration Date

15/07/2567

โรงคัดบรรจุ/Manufacturer:

ร้าน ฐานกิต กลิ่นทนอม

[คลิกเพื่อดูรูป](#)

ที่อยู่/Address:

78 ม.5 ต.คลองใหม่ คลองใหม่ สามพราน นครปฐม 73110

มาตรฐานที่ได้รับการรับรอง/Certified Standard:

GAP

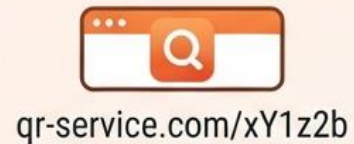
Dynamic QR code encodes a short redirect URL. The destination is managed on a server

STATIC QR CODE



- **CONTENT:** Embedded directly in code.
- **EDITABILITY:** Cannot be changed once printed.
- **DATA:** No tracking or analytics.
- **APPEARANCE:** Denser, more complex pattern.
- **BEST FOR:** Fixed info, Wi-Fi, vCards.

DYNAMIC QR CODE

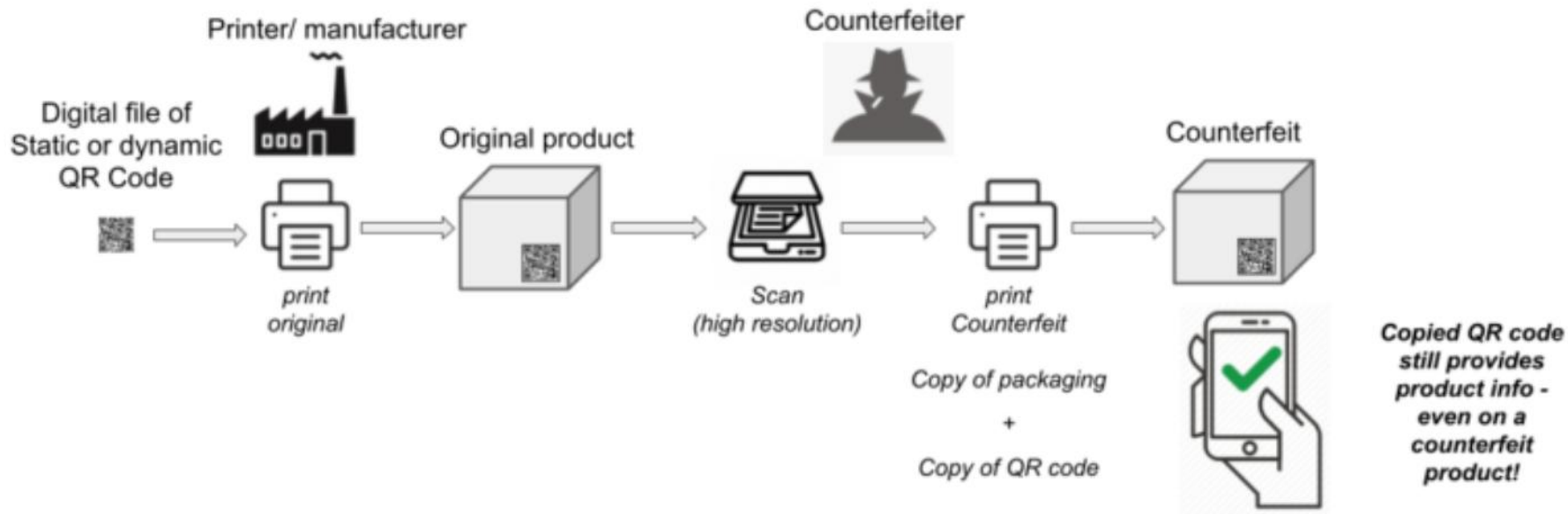


- **CONTENT:** Redirects via short URL.
- **EDITABILITY:** Destination can be updated anytime.
- **DATA:** Tracks scans, location, time, device.
- **APPEARANCE:** Cleaner, less dense pattern.
- **BEST FOR:** Marketing, menus, events.

KEY DIFFERENCE: **STATIC** is Fixed, **DYNAMIC** is Editable & Trackable.

at Qr-service: statistics > time, location, device.

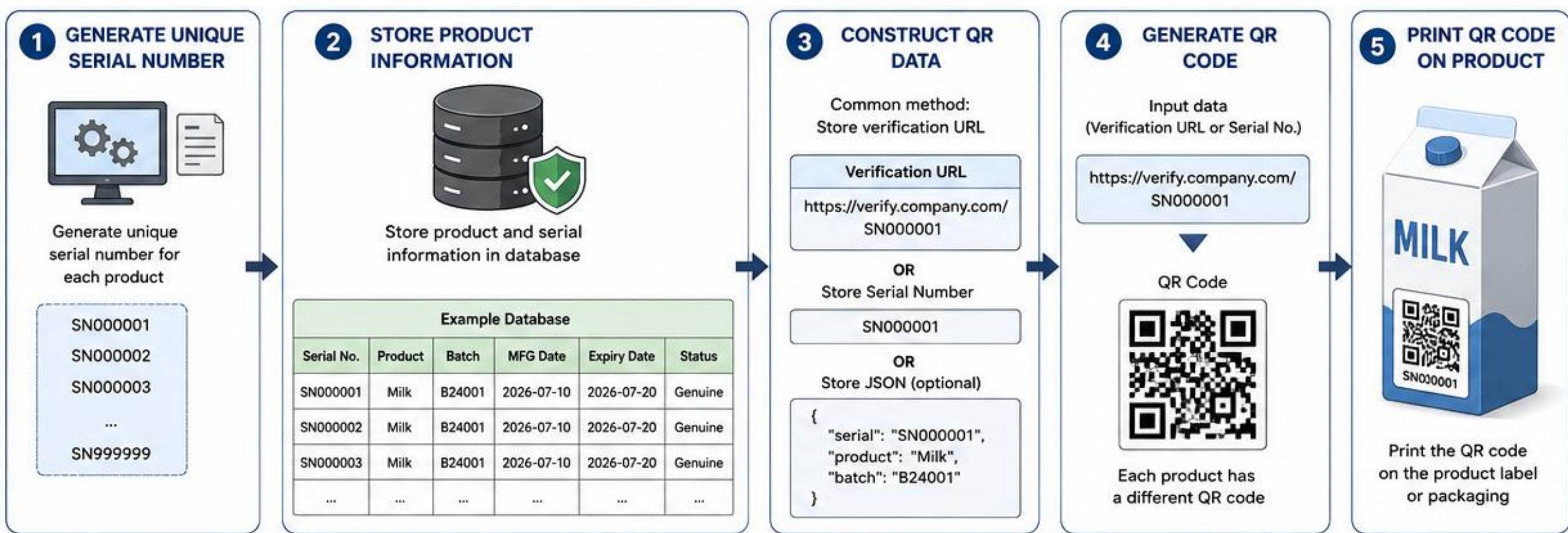
QR-Anti counterfeit



Insert secure graphic code acts as copy sensitive layer ,
user authentication require **specific apps**

Serialized QR

a unique QR code containing a unique serial number or identifier.
unique tracking method and traceability throughout the supply chain.



Serialized QR

VERIFICATION PROCESS (CUSTOMER SCANS QR)

A SCAN QR CODE



Customer scans the QR code using a smartphone camera or app

B SEND DATA TO SERVER



The app or browser sends the data to the verification server

C SERVER CHECKS DATABASE



The server checks if the serial number exists and is valid

D RETURN RESULT

**Genuine Product**
Product: Milk
Batch: B24001
MFG Date: 2026-07-10
Expiry Date: 2026-07-20
Status: Genuine

**Invalid / Counterfeit**
This product ID is not found or has been reported as counterfeit.

E RECORD SCAN HISTORY



Record scan details:

- Location
- Time
- Device
- Number of scans

BENEFITS



Counterfeit Detection
Detects fake or duplicated products.



Traceability
Track products through the supply chain.

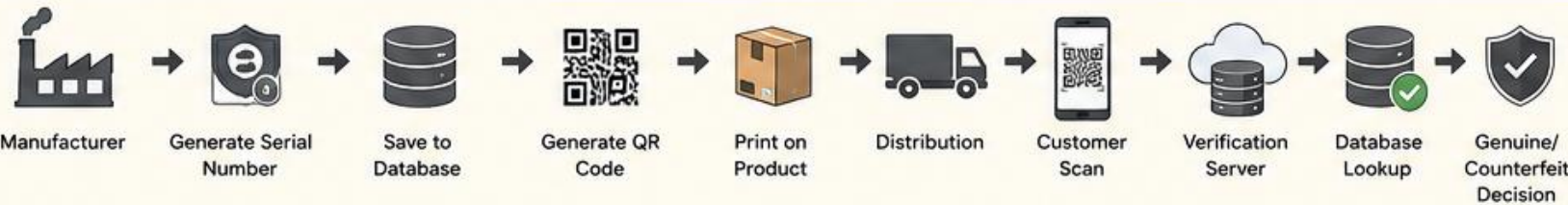


Scan Analytics
Collect data on time, location, and frequency.



Consumer Trust
Provides transparency and builds brand trust.

SUMMARY WORKFLOW



SECURITY ENHANCEMENTS (OPTIONAL)



• **Digital Signature** (e.g., ECDSA/RSA) – Prevents data tampering and forgery.



• **Random, Non-Sequential Serial Numbers (UUID)** – Prevents guessing valid IDs.



• **Scan History Analysis** – Detects duplicate scans from different locations or unusual patterns.



• **Tamper-Evident Labels** – QR code is destroyed or visibly altered when the package is opened.

Encrypted QR code, try this



[https://www.2cq.co/dom/d.aspx?C3E85B041F5D43669A1E28CDDDD6ED46D730E6A906320F03ECB17E4D09F7BB6F37F3E+0028200003355+8090000411\\$](https://www.2cq.co/dom/d.aspx?C3E85B041F5D43669A1E28CDDDD6ED46D730E6A906320F03ECB17E4D09F7BB6F37F3E+0028200003355+8090000411$)



- C3E85B041F5D43669A1E28CDDDD6ED46D730E6A906320F03ECB17E4D09F7BB6F37F3E
- 80 hexadecimal characters (40 bytes). This resembles a cryptographic token or hash used to uniquely identify an item
- 0028200003355 GTIN
- 8090000411 serials No.



Encrypt QR code unique package ID



Counterfeit Detection

Product GTIN: 产品 GTIN
Name: 产品名称
Batch: 批号
Expiration: 过期日期
Destination: 目的国家
Sub Destination: 目的城市
Serial No.: 编号
Status: 产品状态
Validated: 被验证次数

 [Click here to report](#) 

RECALL - DO NOT CONSUME
CALL: 1-700-70-70-70



Counterfeit Detection

Product GTIN: 产品 GTIN
Name: 产品名称
Batch: 批号
Expiration: 过期日期
Destination: 目的国家
Sub Destination: 目的城市
Serial No.: 编号
Status: 产品状态
Validated: 被验证次数

 [Click here to report](#) 

EXPIRED



Counterfeit Detection

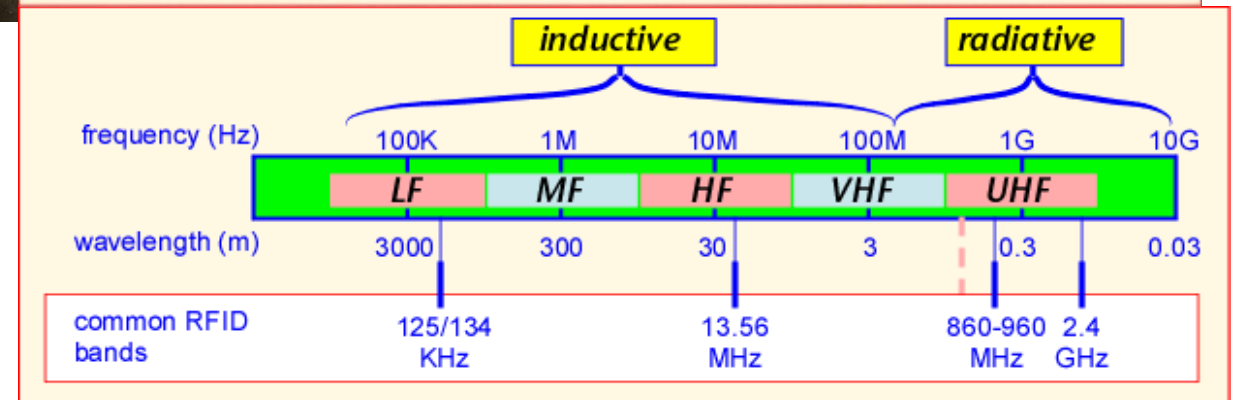
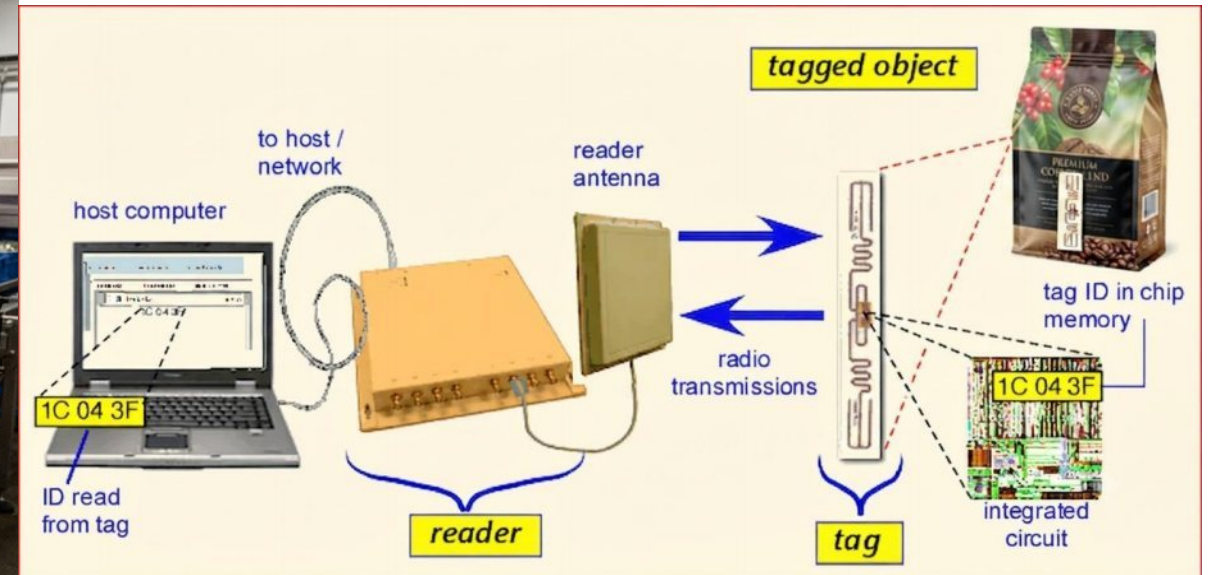
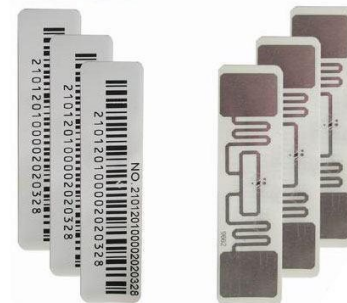
  

Product GTIN: 产品 GTIN
Name: 产品名称
Batch: 批号
Expiration: 过期日期
Destination: 目的国家
Sub Destination: 目的城市
Serial No.: 编号
Status: 产品状态
Validated: 被验证次数

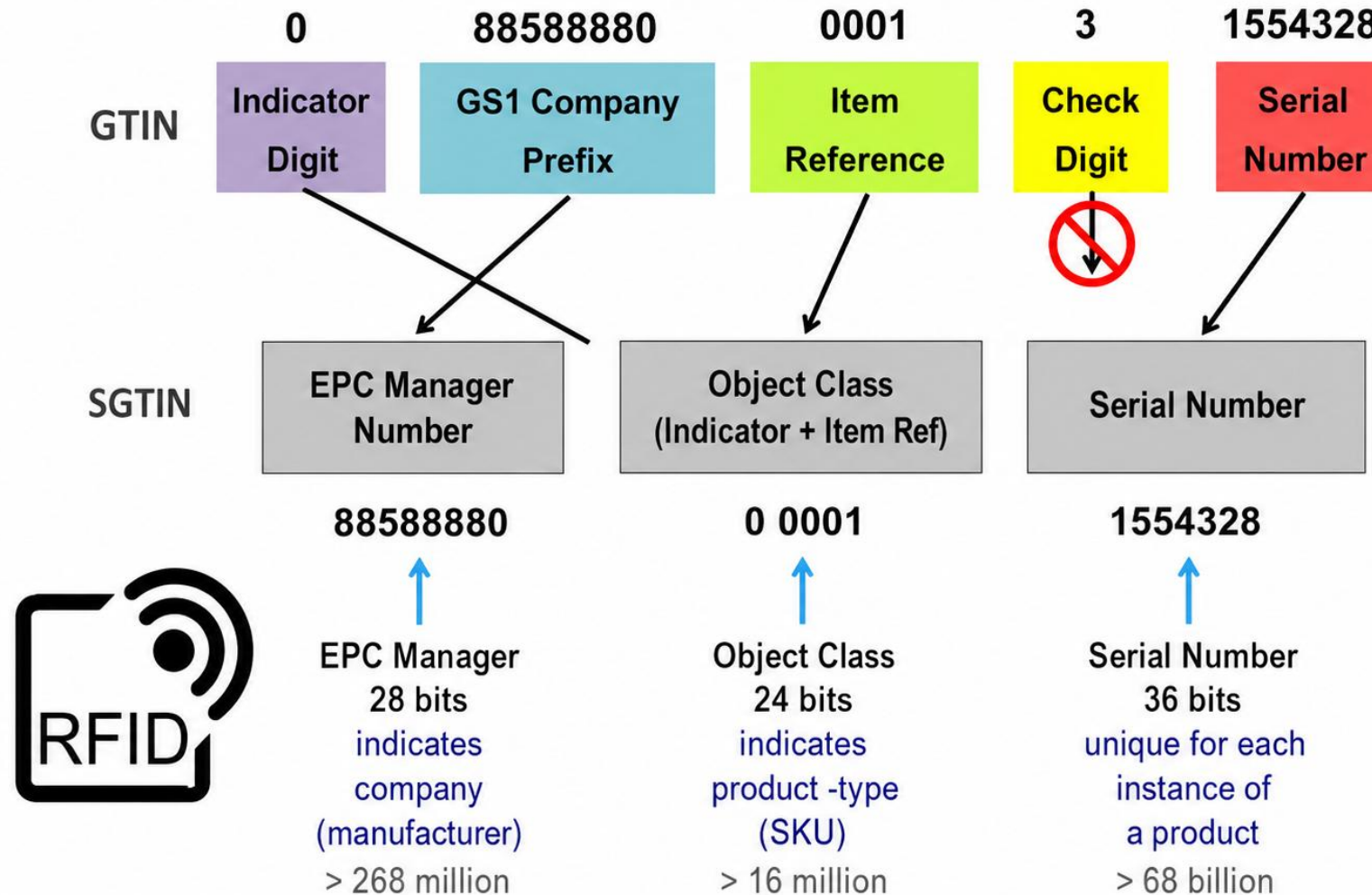
 [Click here to report FAKE item](#) 

FAKE

Radio Frequency IDentification

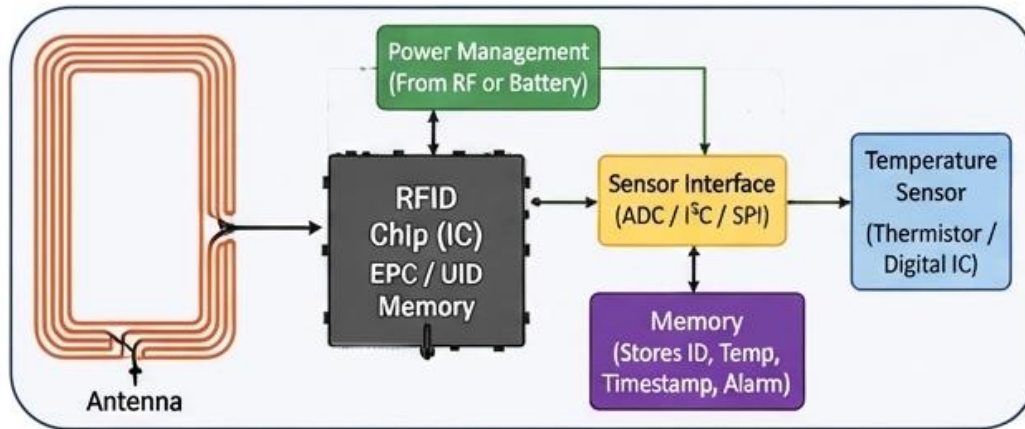


RFID-Electronic product code: GTIN>Serial GTIN



RFID temperature sensor

RFID Temperature Sensor Architecture



Device Examples



Passive RFID Temperature tag

Low cost, reads current temperature only.
Reading distance: typically 1–10 m

Battery-Assisted Passive (BAP)

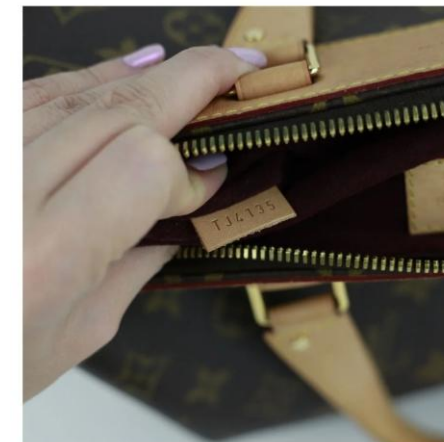
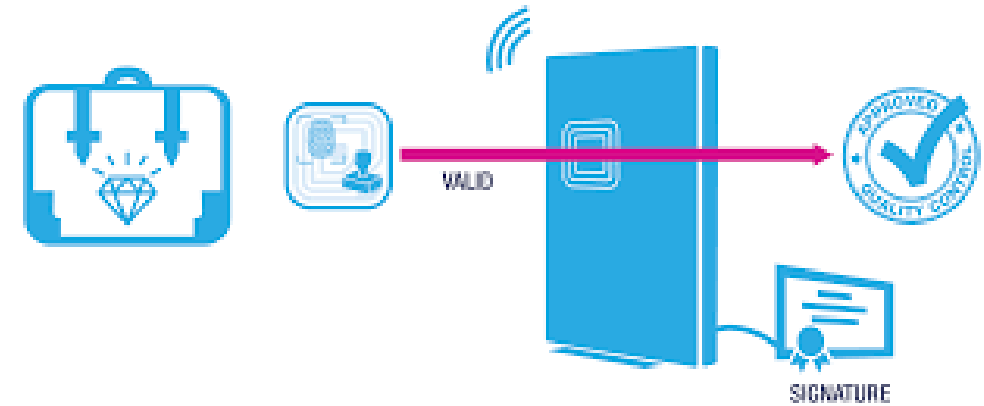
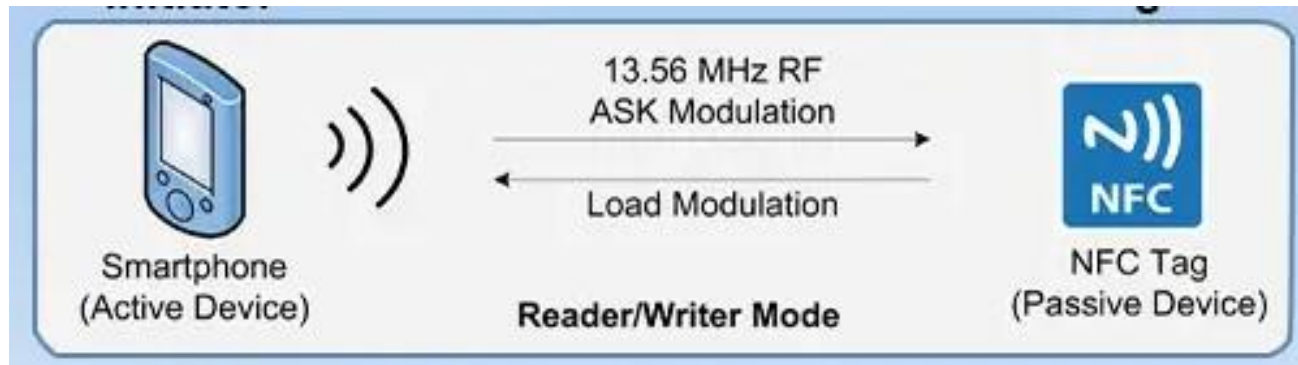
Small battery powers the sensor
Can log temperatures between scans
Better accuracy and longer range than passive tags



Active RFID Data Loggers

Internal battery powers sensor and transmitter.
Records temperature continuously. Long communication range (30–100 m or more)

Near Field Communication (High Frequency-short range RFID)



Wine Using NFC anti-counterfeiting Solution

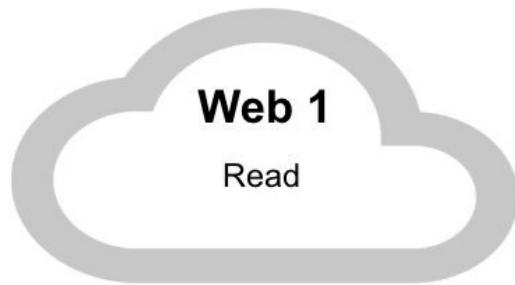


Encrypted dynamic code, one change at a time,
cannot be copied

Brand official website,
the only brand certification in the world

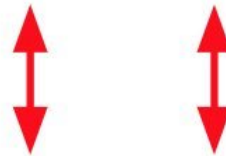


Information Economy

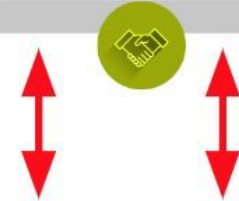


From book Token Economy

Platform Economy



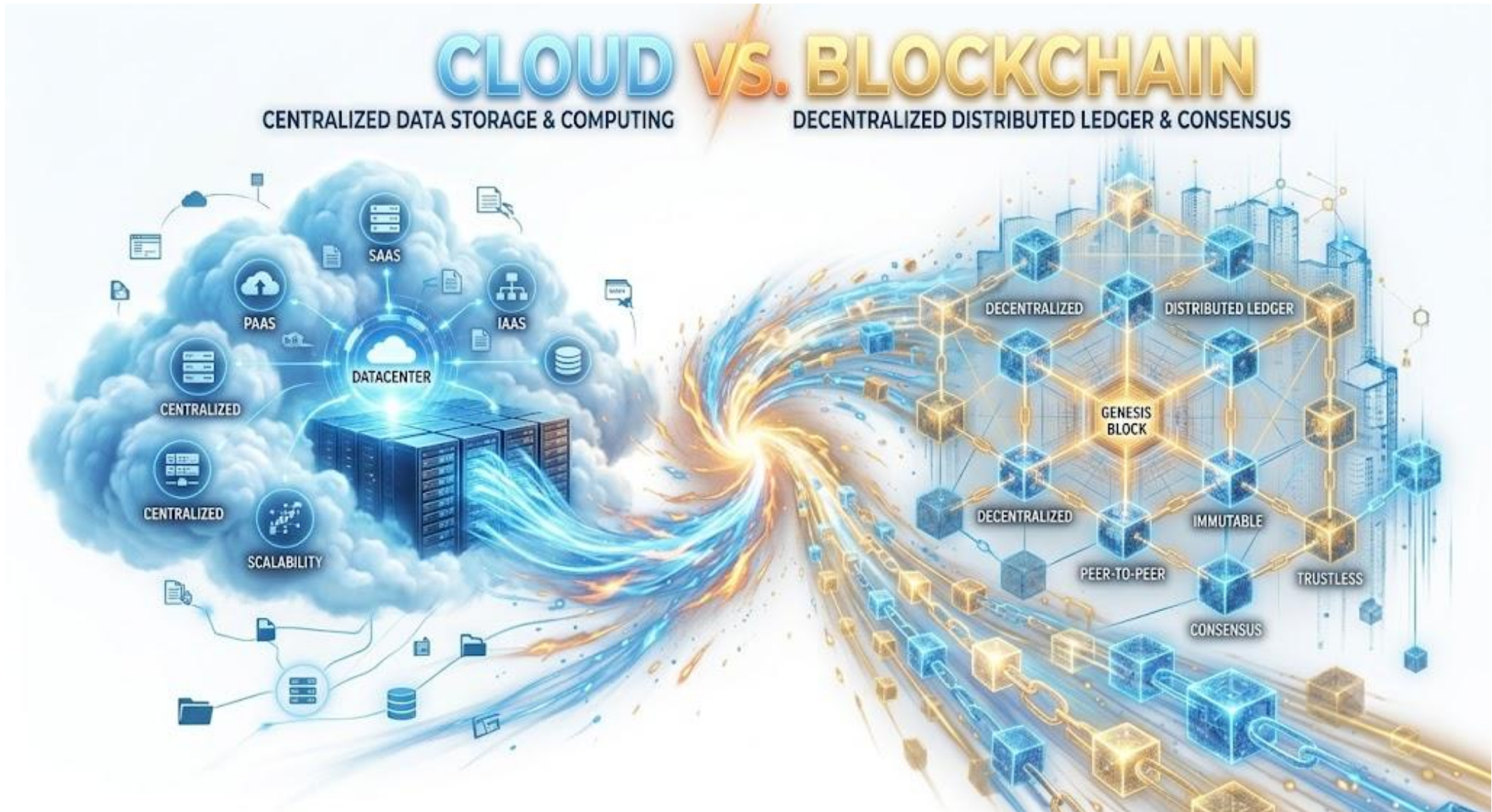
Token Economy



INTEGRATED FOOD TRACEABILITY IOT ARCHITECTURE MODEL



Key Technologies for Food Traceability>data base



CLOUD

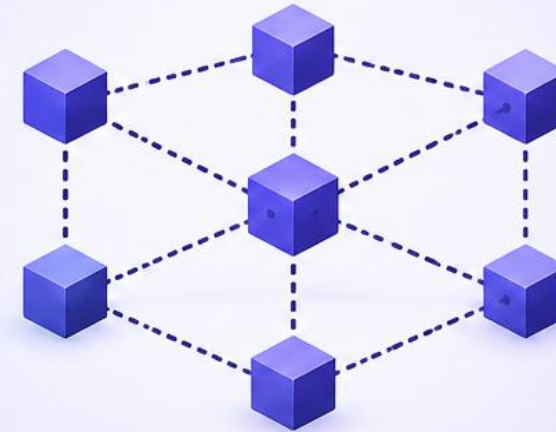
Centralized Computing



VS

BLOCKCHAIN

Decentralized Network



Architecture

Centralized
Data stored on central servers



Control

Controlled by a single entity
(e.g., company or provider)



Performance

High performance
Low latency



Scalability

Easily scalable
Resources can be added quickly



Cost

Pay-as-you-go
Ongoing operational costs



Security

Secure, but vulnerable to
centralized attacks



Use Cases

Web hosting, storage, apps,
databases, backups



Architecture

Decentralized
Data distributed across the network



Control

Controlled by network participants
(no single point of control)



Performance

Lower performance
Higher latency



Scalability

More complex to scale
Depends on consensus mechanism



Cost

Variable costs
May include transaction fees



Security

Highly secure and tamper-proof
Resistant to attacks



Use Cases

Cryptocurrency, smart contracts,
supply chain, identity, voting

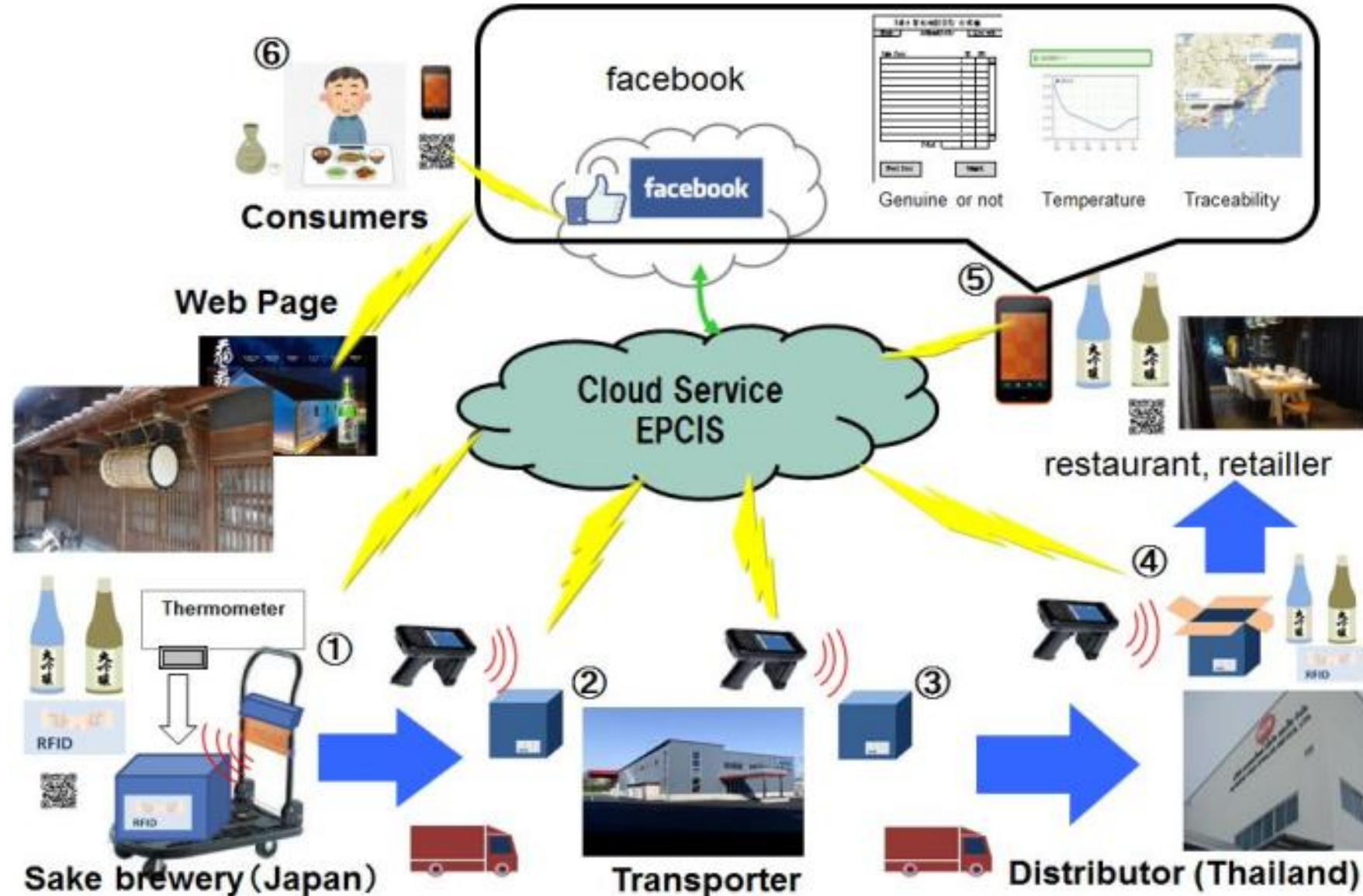
Visibility Verification of Japanese Sake Supply Chain

GS1-Thailand IBM Japan



The bottles were sealed with EPC tags an outer box with a temperature data logger.

Record Each bottle, Box location, shipment airport Dept, arrived date and time .

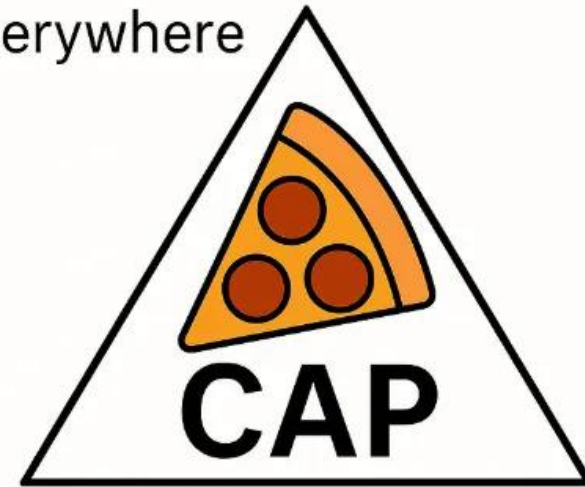


All data must the same in every node



Consistency

same order,
everywhere



Availability

always
serve pizza!

Partition Tolerance

can survive
broken
communication

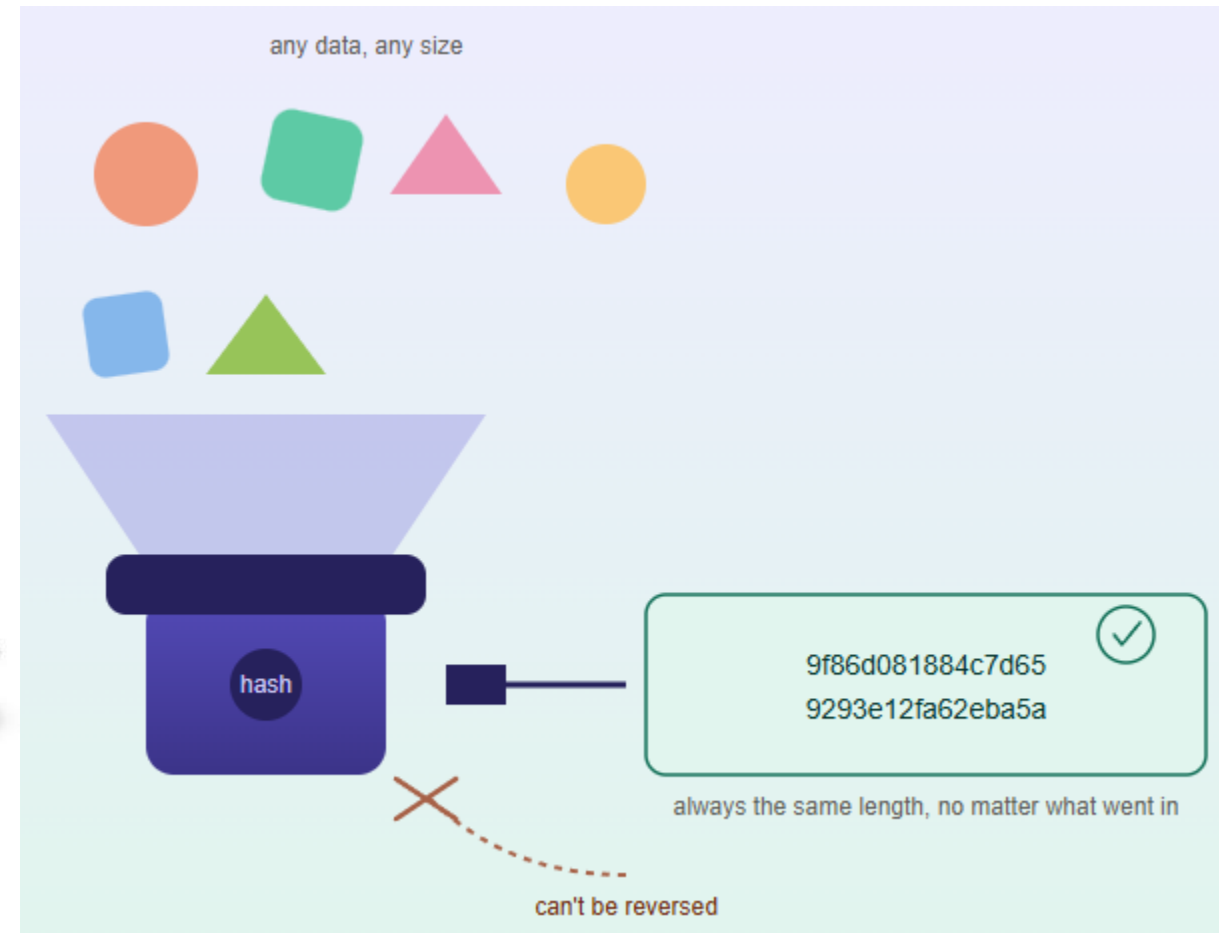
Bitcoin: A Peer-to-Peer Electronic Cash System

Satoshi Nakamoto
satoshin@gmx.com
www.bitcoin.org

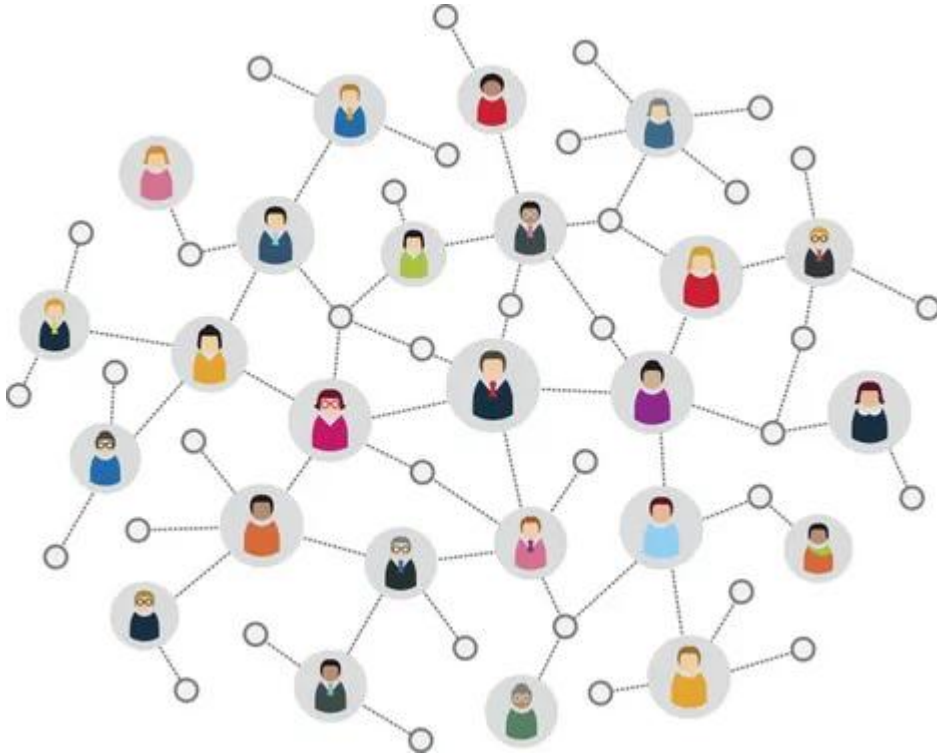
Abstract. A purely peer-to-peer version of electronic cash would allow online payments to be sent directly from one party to another without going through a financial institution. Digital signatures provide part of the solution, but the main benefits are lost if a trusted third party is still required to prevent double-spending. We propose a solution to the double-spending problem using a peer-to-peer network. The network timestamps transactions by hashing them into an ongoing chain of hash-based proof-of-work, forming a record that cannot be changed without redoing the proof-of-work. The longest chain not only serves as proof of the sequence of events witnessed, but proof that it came from the largest pool of CPU power. As long as a majority of CPU power is controlled by nodes that are not cooperating to attack the network, they'll generate the longest chain and outpace attackers. The network itself requires minimal structure. Messages are broadcast on a best effort basis, and nodes can leave and rejoin the network at will, accepting the longest proof-of-work chain as proof of what happened while they were gone.

S. Nakamoto, Bitcoin: A peer-to-peer electronic cash system, May 2009.

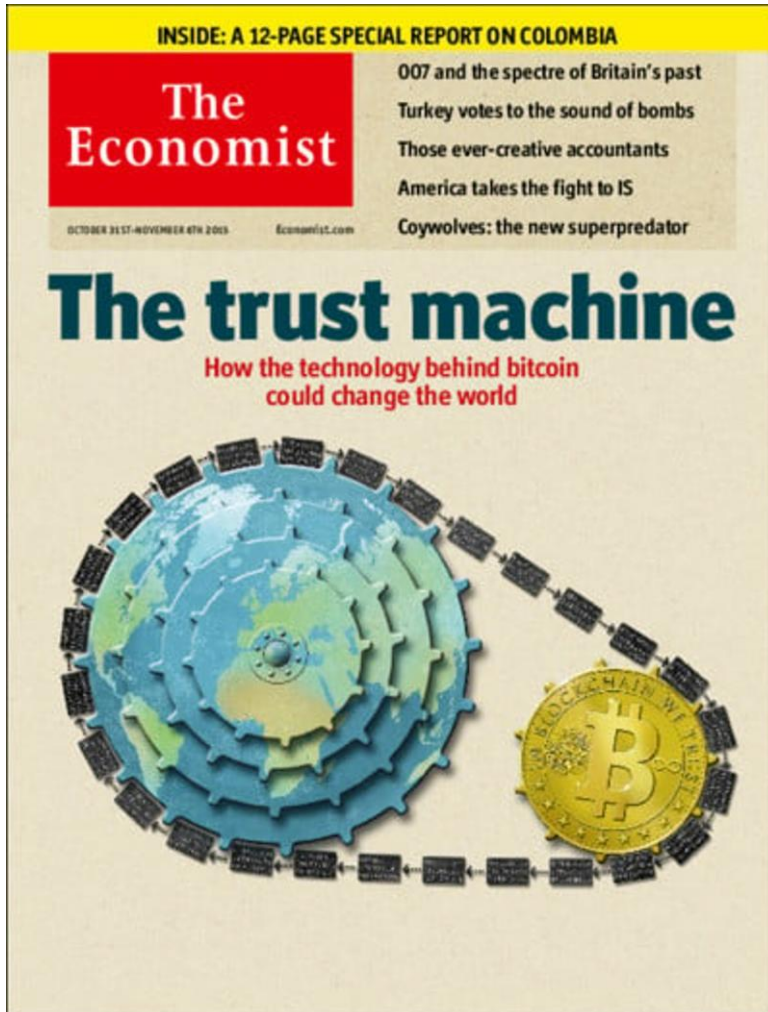
Hash function as “chewing” or “digest” function



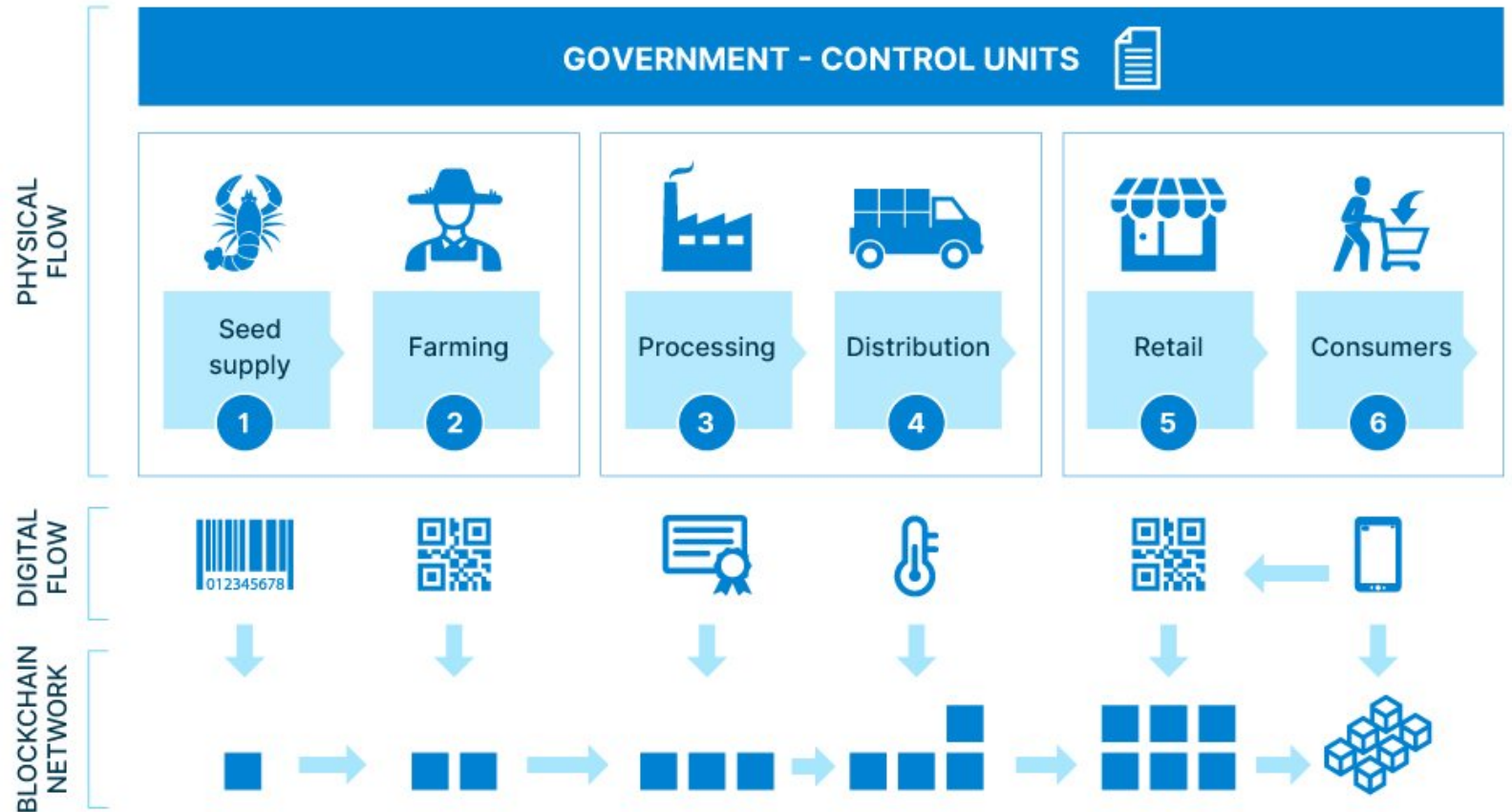
Blockchain properties



Trust Transfer...

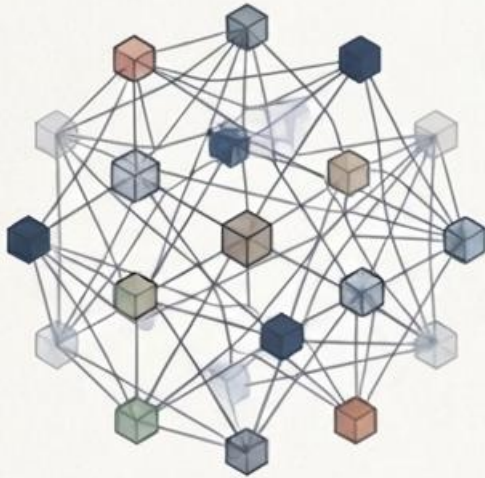


Oct 2015



Blockchain Type

Public Chain



Slow and energy-wasting
Everyone can access data
Destroys business confidentiality

Consortium Chain + PBFT



The Perfect Zone (The Goldilocks Zone)

- **PBFT Consensus:** A consensus mechanism that does not require mining. It works quickly even with some malicious nodes.
- **Hyperledger Fabric:** Allows only specific allies in the supply chain (farmers, producers, government) to join the network.

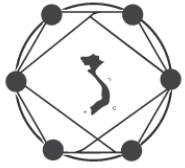
Permissionless



Permission



IBM Food Trust™



**VIETNAM
BLOCKCHAIN
CORPORATION**



VIETNAMNET GLOBAL

04/06/2019 09:59 (GMT+07:00)

Blockchain tech helps Vietnam's mangoes reach world market



Follow VietNamnet on  Google News

Vietnam's first eight tons of mangoes have reached the US market with blockchain-based traceability technology.

">



Vietnam's first eight tons of mangoes have reached the US market with blockchain-based traceability technology.

The mangoes, shipped to the US by air on April 18, were collected from My Xuong Mango Cooperative in Cao Lanh, Dong Thap. All of them met VietGap standards.



<https://vietnamnet.vn/en/blockchain-tech-helps-vietnams-mangoes-reach-world-market-536036.html>



Details

Sheep

Unique Id	e3160143-31a5-44e5-8e7f-474fb59efbbb
RFID	501040983
Custodian	Brookwater Farms
Location	Northumberlamb
Arrival at Processor	1/29/2019 1:01:59 PM

Products

Id: f6f41e30-cdf4-401a-82d2-35a9780478cf

Details

Product Type: Carcass

Batch Events

Id: 4ea9f07e-cd70-44cb-adca-8918e07bf4f8

Description: Moved to main cooler
Location: Northumberlamb
DateTime: 01/31/2019 05:30:00

Id: 61b48bf0-d651-4890-b14c-db73a5a9df20

Description: Processing for packaging
Location: Northumberlamb
DateTime: 01/31/2019 07:30:00

Id: c1e2eefe-06ef-4d21-9b10-2d459aa729be

Description: Finished packaging
Location: Northumberlamb
DateTime: 01/31/2019 09:30:00

Log

Details

Id: 28dff56-edbf-434a-908c-8a63b7d77aab

Action: Create
TxId: 0x283364ed75a83f5fbfb03b586bc6...

Events

Details

Id: 7c1b8b7c-fba5-4643-a05b-beb64f634404

Description: born
DateTime: 04/16/2018 00:00:00

Food Traceability on Blockchain: Walmart's Pork and Mango Pilots with IBM

Reshma Kamath¹

Northwestern University, Chicago, IL, USA





IBM Food Trust™



HYPERLEDGER



ZOOM

UPC 028000215200 has following Product Name Variations:

1. NESTLE TOLL HOUSE - Semi-Sweet Morsels 6.00 oz
2. Semi-Sweet Morsels
3. Nestle Toll House Semi Sweet Chocolate Morsels 170g (bbd November 17)clearance
4. NESTLE TOLL HOUSE Semi-Sweet Chocolate Morsels 6 oz. Bag
5. Nestle Toll House Semi Sweet Chocolate Chips
6. Nestle Toll House Semi-Sweet Chocolate Morsels, 6-Ounce Bags (Pack of 24)

More Info

UPC-A:	0 28000 21520 0
EAN-13:	0 028000 215200
Amazon ASIN:	B003G2QGVC
Country of Registration:	United States
Brand:	Nestle
Model #:	0002800021520
Last Scanned:	2022-04-07 19:45:42



CRYPTO
ECONOMY
www.crypto-economy.net

