Blockchain-Enabled Supply Chain

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Basic introduction of **Blockchain**

How blockchain can be used **in supply chain management**

**Advantages** of using blockchain in supply chain management

**Challenges** of using existing blockchain
INTRODUCTION – BLOCKCHAIN
BLOCKCHAIN IS ... ?

Distributed Ledger

Immutable

Decentralised
DIGITAL SIGNATURE

Properties

- Message integrity
- Owner authenticity
- Signing (secret) key to sign
- Public key to verify
HASH FUNCTION

Properties
- Produce a unique “fingerprint” of a document / piece of data
- Even you modify a single bit, the “fingerprint” will look totally different!
- One-way
- Very difficult to find two different documents to produce the same “fingerprint” (collision resistance)

Source: codeclimbing.com
EXAMPLE – CRYPTOCURRENCY

Alice sends 1 Bitcoin to Bob

Transaction

Alice’s balance –1
Bob’s balance +1

Source: freecodecamp.org
EXAMPLE – CRYPTOCURRENCY

99B80F93F32MD2
Data: “Hi im the first blocks data.”
Previous Hash: 0

V890FDSUF8D9290
Data: “Satoshi smells”
Previous Hash: 99B80F93F32MD2

3XSE9KASS9R0CK5
Data: “...So this is a blockchain”
Previous Hash: V890FDSUF8D9290

Source: cylab.be
SECURITY GUARANTEE

Blockchain consensus protocol provides security guarantee

- Immutable
- No double-spent
- No over-spent

from

- Digital Signature
- Hash Function
TRACEABILITY

“GS1 is a neutral, not-for-profit organisation dedicated to the design and implementation of global standards, technologies and solutions to improve efficiency of supply and demand chains by adding useful information to any exchange of goods or services”
Identify: GS1 Standards for Identification

GLN Global Location Number  GTIN Global Trade Item Number  SSCC Serial Shipping Container Code  GRAI Global Returnable Asset Identifier  GIAI Global Individual Asset Identifier  GSRN Global Service Relation Number

Capture: GS1 Standards for Barcodes & EPC/RFID

GS1 Barcodes
- EAN/UPC
- GS1-128
- ITF-14
- GS1 DataBar
- GS1 DataMatrix
- GS1 QR Code
- GS1 Composite Barcode

GS1 EPC/RFID
- EPC HF Gen 2
- EPC UHF Gen 2

Share: GS1 Standards for Data Exchange

Master Data  Global Data Synchronisation Network (GDSN)  Transactional Data  Electronic Data Interchange (EDI)  Event Data  EPC Information Services (EPCIS)

Interoperability
- Item Master Data
- Location Data
- Item/Shipment Tracking
- Traceability
- Product Recall/Withdrawal
- Pedigree
- Purchase Order/Despatch Advice/Invoice
### Harvesting

**Crate-level identification**
- GTIN: 09504000219109
- Batch/lot: B20171202-1
- Attributes:
  - Production date: 2017-05-22

**Who**
- (GLN) 9504000219000

**What**
- (GTIN) 09504000219109
  - (Batch/Lot) B20171202-1
  - (QTY) 200

**Where**
- (GLN) 9504000219901
  - (GLN extension) PL-A023

**When**
- 2017-05-22T13:15:00+06:00

**Why**
- Harvesting

### Manufacturing

**Case-level identification**
- GTIN: 09501101530003
- Batch/lot: AB-123
- Attributes:
  - Expiration date: 2017-12-02

**Who**
- (GLN) 9501101532007

**What**
- (GTIN) + (Batch/Lot) + (QTY) (Ingredients)
  - (GTIN) 09501101530003
    - (Batch/Lot) AB-123
    - (QTY) 500

**Where**
- (GLN) 9501101530911

**When**
- 2017-07-14T23:20:00+01:00

**Why**
- Manufacturing

### Shipping

**Pallet identification**
- SSCC: 395011015300022013
- Contents:
  - 20 cases of GTIN: 09501101530003
    - Batch/lot: AB-123
    - Expiration date: 2017-12-02

**Who**
- (GLN) 9501101532007

**What**
- (SSCC) 395011015300022013

**What**
- (GTIN) 09501101530003
  - (Batch/Lot) AB-123
  - (QTY) 20

**Where**
- (SGLN) 9501101530928
  - (GLN extension) ST-5

**When**
- 2017-08-02T09:12:00+01:00

**Why**
- Shipping
SUPPLY CHAIN TECHNOLOGY

TECHNOLOGIES USED IN TRACEABILITY SYSTEMS

- RFID: 67 (60 Food, 7 Others)
- IoT: 6 (5 Food, 1 Others)
- Barcodes: 26 (23 Food, 3 Others)
- EPCIS: 14 (12 Food, 2 Others)
- DNA Analysis/Barcoding: 9 (8 Food, 1 Others)
- Blockchain: 6 (6 Food)
- WSN: 9 (9 Food)
- Cloud Computing: 2 (2 Food)
- Big Data Analytics: 4 (4 Food)
- Chemical Markers: 4 (4 Food)
- NFC: 4 (4 Food)
Item Level

**EAN/UPC**
Carries a Global Trade Item Number (GTIN)

or

**GS1 DataMatrix**
Carries a GTIN with extended data such as Batch/Lot/Serial Number

*The GS1 DataMatrix is currently only approved for Variable Measure trade items at retail POS. It is currently not approved for Fixed Measure items but is being considered by the Grocery Industry.*

Case Level

**GS1-128**
Carries a GTIN with extended data such as Batch/Lot/Serial Number

or

**GS1 EPC/RFID**
Carries a Serialised GTIN or an SSCC

Pallet Level

**GS1-128**
Carries a Logistics Label or GS1 SSCC

or

**GS1 EPC/RFID**
Carries a Serialised GTIN or an SSCC

**Please check and confirm that EPC/RFID tags are accepted in your supply chain before implementing.**

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**GS1 Data Carriers:**

<table>
<thead>
<tr>
<th>Barcodes</th>
<th>EPC-Enabled RFID Tags</th>
</tr>
</thead>
<tbody>
<tr>
<td>EAN/UPC</td>
<td>HF RFID</td>
</tr>
<tr>
<td>GS1 DataBar*</td>
<td>UNIF RFID</td>
</tr>
<tr>
<td>GS1 DataMatrix</td>
<td></td>
</tr>
<tr>
<td>GS1-128</td>
<td></td>
</tr>
<tr>
<td>ITF-14</td>
<td></td>
</tr>
<tr>
<td>GS1-128</td>
<td></td>
</tr>
</tbody>
</table>
WHY
BLOCKCHAIN
IS NEEDED?

Blockchain technology can provide the greatest impact in Supply Chain and Logistic Management.
Increased Automation

- Reduce paperwork and administrative (in particular, auditing) costs
- Blockchain and smart contract automatically do the task

Image Source: itsupportguys.com
Improved Collaboration

• Strengthen corporate reputation through providing transparency of materials used in products
• In traditional (multi-)cloud-based system, each party may use an independent (and disconnect) system
• Getting information along the supply chain may become timely and costly
Global Supply Chain Compatibility

- Reduce potential public relations risk from supply chain malpractice
- Use a single system along different parties across the supply chain in different jurisdictions
  - Current supply chain management platforms include: Builder box, SAP Business by design, Cin7, Freightview......
- Ultimate goal of blockchain – with challenges to instantiate
Traceability and Transparency

• The most important and visible benefit of using blockchain
• Increase traceability of material supply chain to ensure corporate standards are met
• More efficient way to trace
• Stronger confidence to customers on the product quality

Image Source: lpffp.com
Optimized Security and Accountability

- Lower losses from counterfeit / gray market trading
- The immutability of blockchain ensures the security of the supply chain management system
- Provide accountability, if the product is damaged (together with other secure data collection devices)
EXISTING SOLUTION NOT GOOD ENOUGH

We can’t just put the red wine or beef information into the Bitcoin or Ethereum blockchain!
Data Source Error

- Blockchain can ensure data is immutable, but how about……
- Data maybe wrong from the source!
- How to verify the correctness of the data source?
- Some physical devices + cybersecurity protocols should be deployed together
Data Privacy

- In the blockchain, everyone can see all data, which is obviously not desirable
- Sensitive information (e.g. quantity, financial transaction record etc.) should be hidden, especially from the competitors
- Compliance on regulation for data privacy
- Some kind of access control should be enforced
Interoperability

- Blockchain is a network of ecosystems, how to connect the blockchain for supply chain management to the global value chains?
- Need to connect with different data collection devices and readers
- Different supply chains may have different front-end data collection, e.g. mining, building, food etc.
Scalability

- Traditional blockchain systems use Proof-of-Work consensus mechanism, which is not scalable
- Existing scalable blockchains (e.g. using Proof-of-Stake, Proof-of-XXX) have various security concerns

Image Source: oracle.com
Ongoing Research

More R&D is needed to provide a complete solution from the production place to the customers’ end!
Monash Blockchain Technology Centre

monash.edu/blockchain

Blockchain Technology Centre

The Monash Blockchain Technology Centre will bring together world-leading expertise across Monash University to explore and develop the technology of blockchain — and create impact across different industrial and societal sectors.

This centre will develop new technologies to use in blockchain systems, introduce relevant blockchain topics into cross-faculty curriculums and provide targeted training in different sectors of industry.
THANK YOU
WE LOOK FORWARD TO WORKING WITH YOU

FIND OUT MORE AT Monash Blockchain Technology Centre
monash.edu/blockchain

OR

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