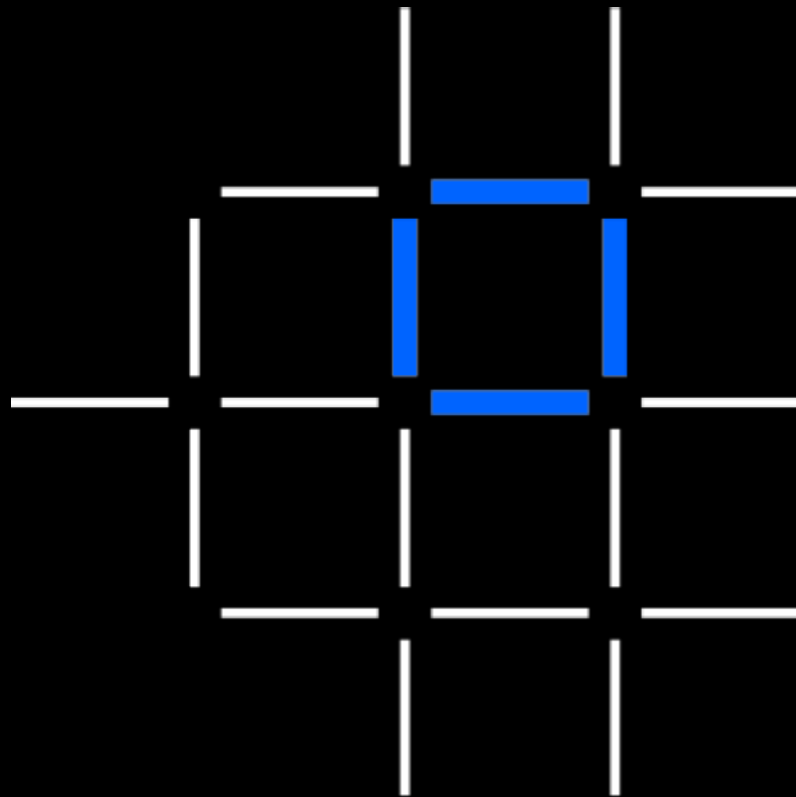


# Emerging Technologies for Digitalising Trade

ESCAP-ARTNET-ITD Online Course on  
Trade Facilitation for Sustainable Development

*Shantanu Godbole, Ph.D.  
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# Outline

- Digitalisation in Trade and Customs processes
  - A vision
- Emerging Technologies with examples
  - Blockchain
    - trade logistics and other use cases today
  - Digitization, AI, IOT
    - already being adopted
  - Cryptography (ZKP, SSI)
    - a little bit in the future
- Summary

Imagine a world where legitimate goods move across borders as easily as they move across a country – a world in which cross-border crime no longer makes the headlines



IBM

# Customs Agencies are faced with two contradictory goals

## Facilitation

Promoting economic growth by accelerating pace of legitimate trade



Technology helps resolve the tension

## Control

Protecting safety, security and financial interests of the country by maximizing compliance



# In the midst of an increasingly challenging environment

Increasingly heavy workload and service expectations

Increasingly complex network of government and private sector partners

Increasingly sophisticated and global threats

## Yemen mail bomb 'could have detonated over eastern US'

10 November 2010 US & Canada

Share

Tests on a failed parcel bomb sent on a US-bound cargo flight last month show it could have been designed to detonate over the eastern US, say UK police.

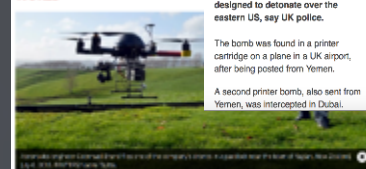
The bomb was found in a printer cartridge on a plane in a UK airport, after being posted from Yemen.

A second printer bomb, also sent from Yemen, was intercepted in Dubai.



The bomb was hidden inside a printer ink cartridge.

WORLD



**NARCO-DRONES: The Cartels' Newest, Tech Savvy Smuggling SOP Spooks Security Experts**

# Big Data creates an even greater challenge



**753M container  
movements** (TEU) p.a.  
to support global trade

**400 Zettabytes**  
of data generated  
by IoT in 2018

**1.97 Billion**  
users of mobile  
social media

# Customs Agencies must master three strategies to thrive...

1. Customer oriented processes



*Facilitation*  
*Control*  
*Efficiency*



2. Intelligence led risk based supervision



3. Co-ordinated digital clearance processes



# Emerging technologies can supercharge these strategies



## Blockchain

Trusted, distributed ledger  
Shared business processes

TradeLens

Mutual recognition



## Data and AI

Understand | Reason | Learn

Cognitive Object Detection Assistant

Rulings Assistant



## IOT and Crypto

Connected sensors

ZKPs

Customs Transit monitoring

Secure trade lanes

Automatic Number Plate Recognition



# Trade supply chains have 3 core modern era challenges



Data Visibility



Process Optimization



Demand Management

... and despite progress in all three areas, end-to-end inefficiencies remain

- Administrative costs are twice the cost of physically shipping the container
- Fraud in global trade is \$600B
- Worldwide cargo losses exceeds \$55B
- Non-tariff trade barriers suppress global trade by ~15% (WEF)

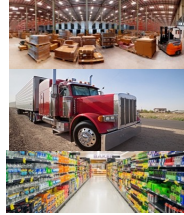
# Industry Supply Chain Use Cases

## Supply Chain Workflow



Blockchain solution to manage and track the paper trail of tens of millions of shipping containers across the world by digitizing the supply chain process

## Supply Chain Visibility



Blockchain technology provides visibility to all the participants involved in moving goods by tracking the purchase order and shipment status

## Supply Chain Accountability



Blockchain holds the history of many items through entire supply chain providing traceability of raw materials

## Manufacturing Provenance



Blockchain holds complete provenance details of each component part, accessible by each manufacturer in the production process

## Supply Chain Financing



Blockchain solution creates a consolidated and detailed view of transactions visible to all parties resulting in a reduction in # disputes, dispute cycle time, and improvement in use of working capital

## Regulatory and Insurance



Blockchain captures information about shipments, risk and liability, and helps firms comply with insurance regulations

# BLOCKCHAIN: WELL SUITED FOR SUPPLY CHAINS

Blockchain addresses the underlying challenges inherent in collaborating across a distributed, fragmented supply chain ecosystem



## SHARED LEDGER

**Append-only distributed system of record shared across business network**

A network of industry participants maintains a distributed, permissioned ledger with copies of document filings, relevant supply chain events, authority approval status, and full audit history; every change results in a new, immutable block



## SMART CONTRACT

**Shared business logic governing what transactions may be written to the ledger**

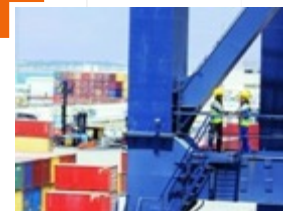
Cross-organizational business processes, such as cargo title transfer, are pre-programmed and built into Blockchain and distributed to and executed on the network, preventing any member from changing the business logic



## PRIVACY

**Ensuring appropriate visibility; transactions are secure, authenticated and verifiable**

Cryptography enables permissioned access so only the parties participating in a specific shipment can submit, edit or approve related data



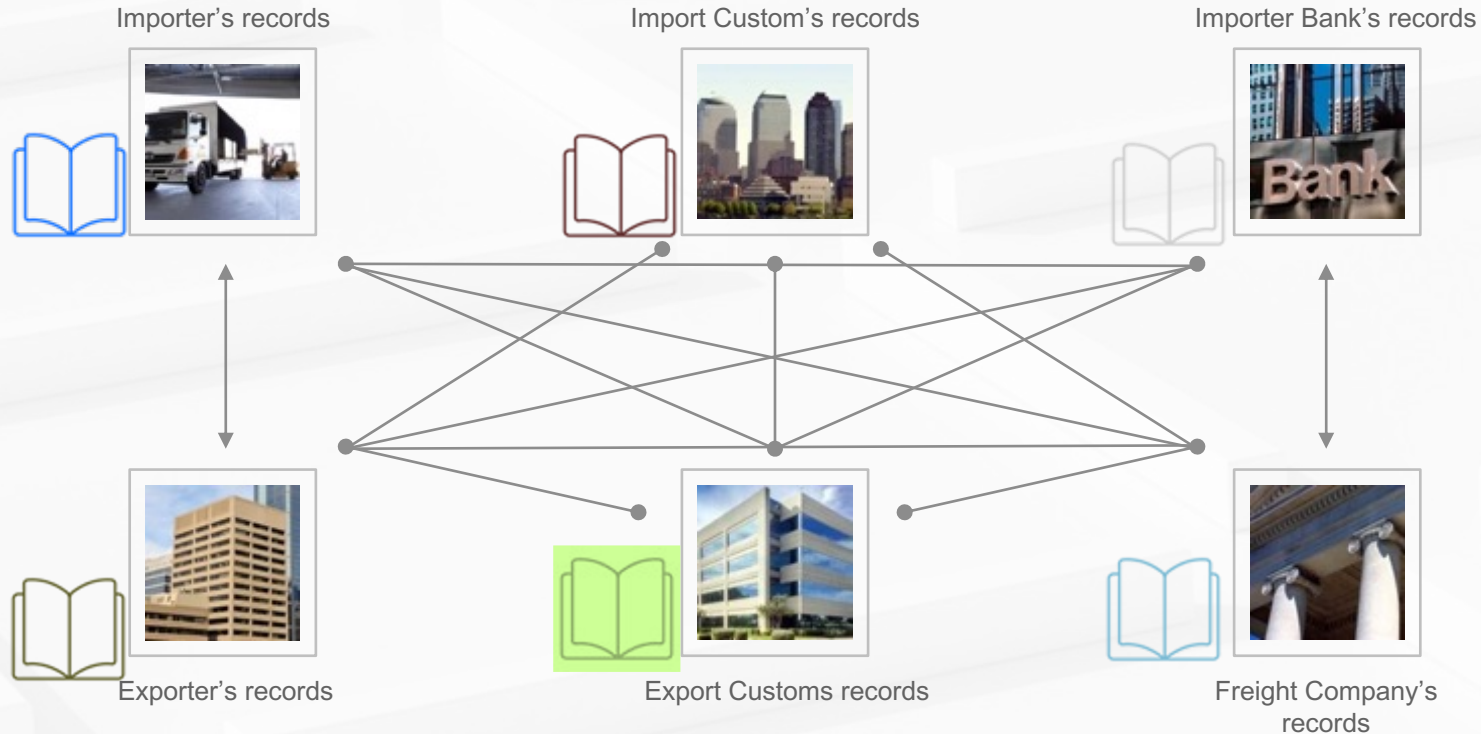
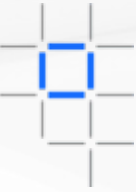
## TRUST

**Transactions are endorsed by relevant participants**

Information such as documentation filings and authority approvals can only be changed if endorsed by the parties taking part in the shipment; full audit history maintained on the Blockchain

# Problem

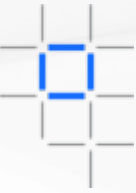
inefficient, expensive, vulnerable



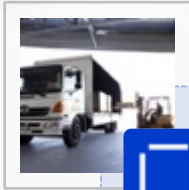


# Solution

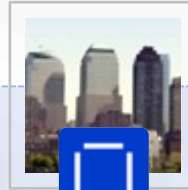
A shared, replicated, permissioned ledger...  
...with consensus, provenance, immutability and finality



Importer's records



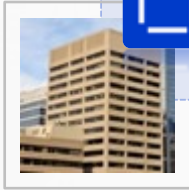
Import Custom's records



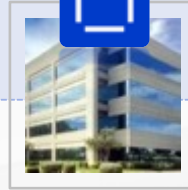
Importer Bank's records



Blockchain



Exporter's records




Export Customs records



Freight Company's records

# Different types of blockchain

- All blockchains aim to provide **irrefutable proof** that a set of transactions occurred between participants
- Different types of blockchain exist:

 **bitcoin** is an example of an unpermissioned, public blockchain

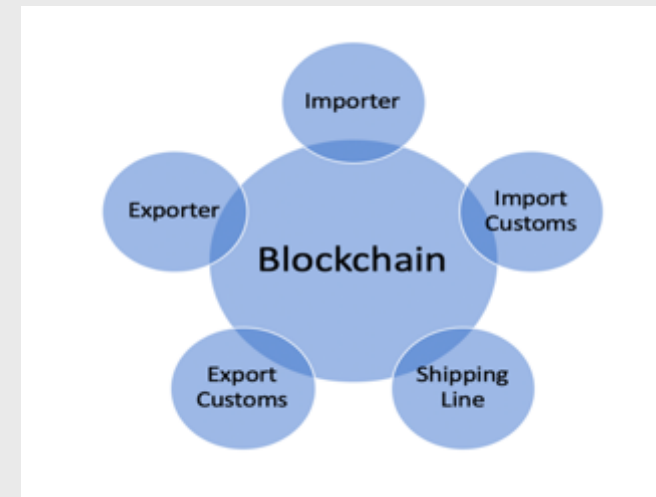
- The first blockchain application
- Defines a shadow-currency and its ledger
- Resource intensive

- Blockchains for business generally prioritize
  - **Assets** over cryptocurrency; **Identity** over anonymity; **Selective endorsement** over proof of work

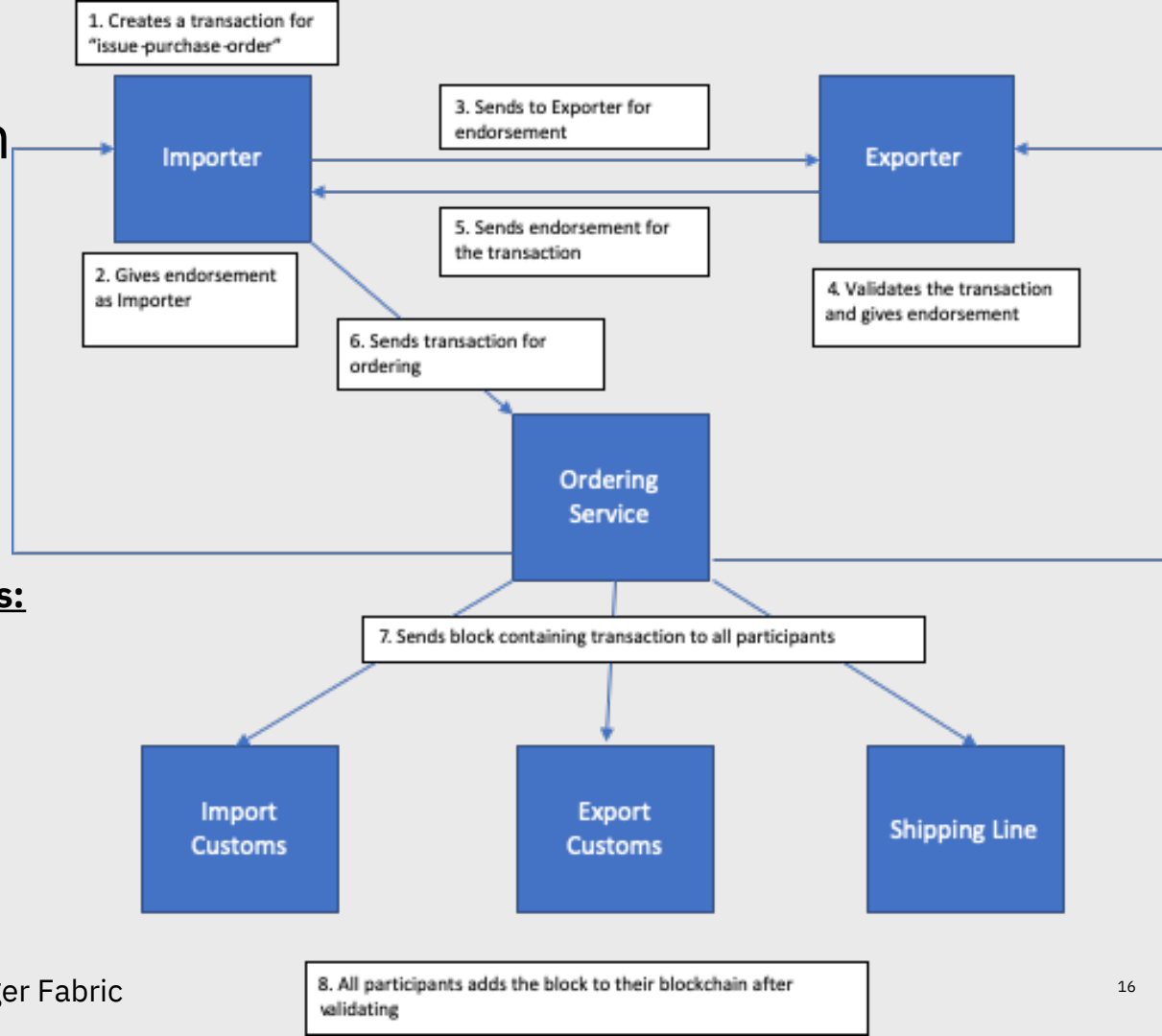


# A simple cross-border trade example

- We consider trade documents and associated events as objects in cross-border trade
- We first describe a basic example blockchain network that will be our running example
- We also take a sample event from the Buy-Ship-Pay\* model like issuing a purchase order that gives rise to one document and one event that we will persist and have to be recognized on the blockchain
- Other documents and events can similarly be considered



# Technical flow of our blockchain transaction



## Principles of blockchain transactions:

- Identity
- Endorsement
- Authentication and Authorization
- Smart Contracts
- Immutability

Note: Current example is based on Hyperledger Fabric



# Technical flow of our sample blockchain transaction

- Importer creates a transaction to invoke “issue-purchase-order” function from smart contract
- This transaction is signed by Importer and sent to Importer and Exporter for endorsement (i.e. as per the scheme for this transaction)
- Importer gives the endorsement and sends to Exporter
- After validating this, Exporter gives Endorsement
- Endorsement is given back to Importer
- The transaction is then sent to the ordering service to order different transactions of the network
- Ordering service then sends the final transaction to all the nodes in the network
- Every node checks the validity of endorsements and stores the transaction into blockchain

# A private sector overview of trade blockchain initiatives



- **Trade Logistics**

- Tradelens, Bill of Lading (PIL), Global Shipping Business Network, Open Trade Blockchain

- **Payments**

- Ripple, SWIFT, Stellar (Worldwire)

- **Trade Finance**

- R3 Voltron, we.trade, eTradeConnect

- **Food supply chains and agricultural commodities**

- ADM-Bunge-Cargill-Dreyfuss-Cofco for commodity markets, IBM Food Trust with Walmart/others

# Further examples by (selected) industry



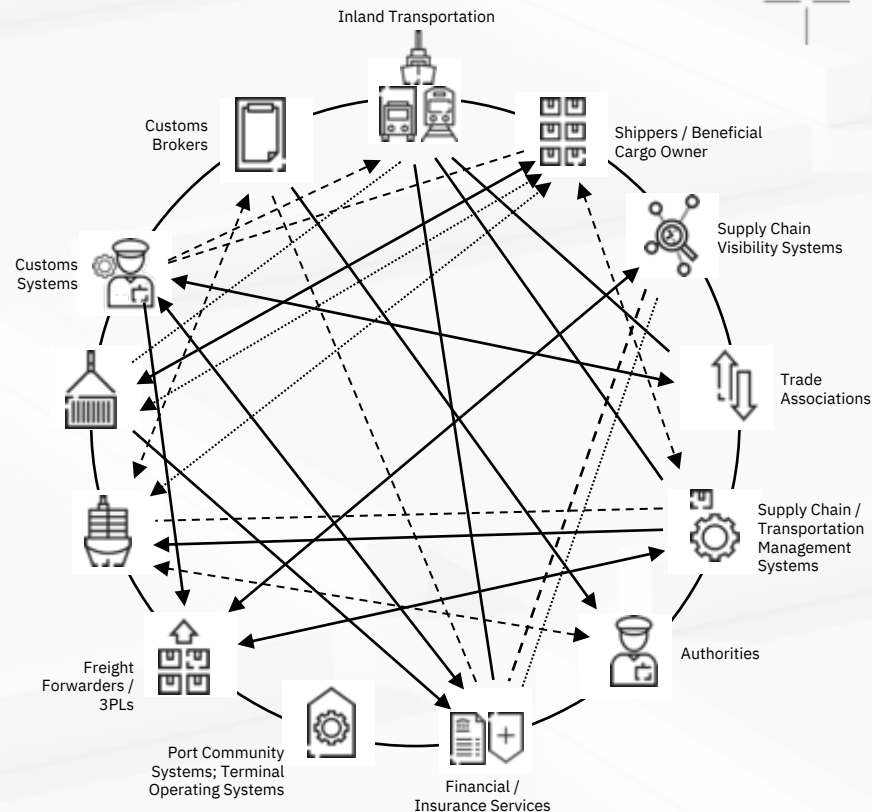
Financial	Public Sector	Retail	Insurance	Manufacturing
<ul style="list-style-type: none"><li>• Trade Finance</li><li>• Cross currency payments</li><li>• Mortgages</li><li>• Letters of Credit</li></ul>	<ul style="list-style-type: none"><li>• Asset Registration</li><li>• Citizen Identity</li><li>• Medical records</li><li>• Medicine supply chain</li></ul>	<ul style="list-style-type: none"><li>• Supply chain</li><li>• Loyalty programs</li><li>• Information sharing (supplier – retailer)</li></ul>	<ul style="list-style-type: none"><li>• Claims processing</li><li>• Risk provenance</li><li>• Asset usage history</li><li>• Claims file</li></ul>	<ul style="list-style-type: none"><li>• Supply chain</li><li>• Product parts</li><li>• Maintenance tracking</li></ul>

# TradeLens improves global trade efficiency

- TradeLens is an open, extensible platform for sharing shipping events, messages, and documents across all the actors and systems in the supply chain ecosystem.
- It provides shared visibility and shared state for container shipments

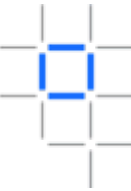
## Benefits

- Increase speed and transparency for cross border transactions through real time access to container events.
- Reduced cost and increased efficiency through paperless trade





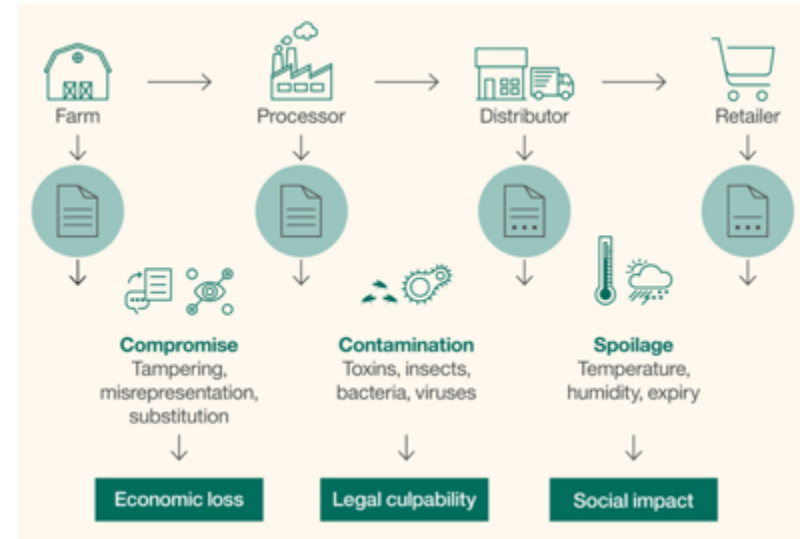
# IBM Food Trust for supply chain transparency



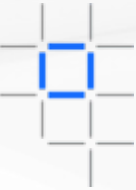
- IBM Food Trust is a set of modules providing traceability to improve food transparency and efficiency
- Blockchain is used to create a trusted connection with shared value for all ecosystem participants, including end consumers.

## Benefits

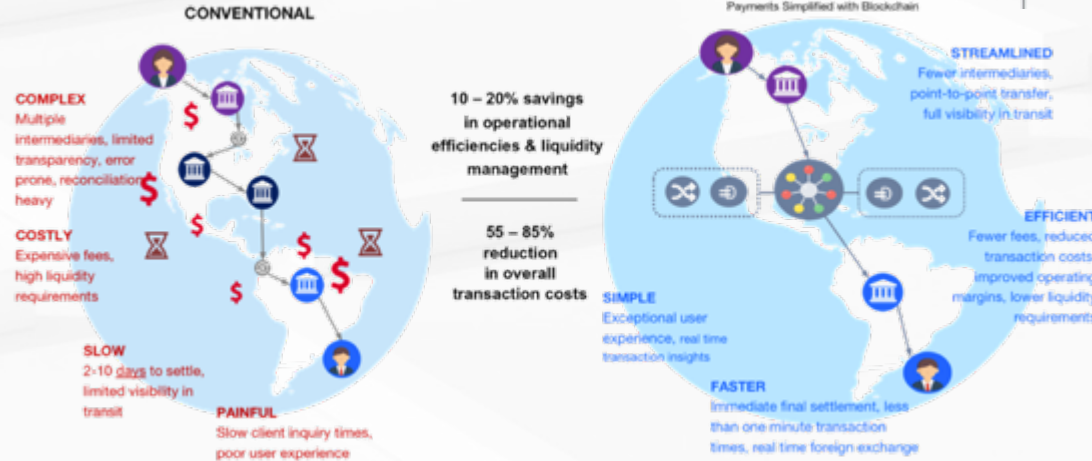
- Reduce impact of food recalls through instant access to end-to-end traceability data to verify history in the food network and supply chain.
- Help to address the 1 in 10 people sickened and 400,000 fatalities world wide which occur every year from food-born illnesses.



# World Wire is revolutionizing global payments



- World Wire is an integrated network for real-time clearing and settlement.
- Allows banks and financial institutions to send and settle payments around the globe with finality in a matter of seconds
- Eliminates enduring challenges that have long hampered the cross-border payments industry.



## Benefits

- Payment support regardless of size, origination, destination or asset type
- Higher visibility for streamlined transactions with reduced disputes and reconciliation needs
- Enhanced regulatory compliance through improved transparency
- Secure network with interaction and eligibility criteria as well as robust access controls

# Decentralized trusted identity

- Sovrin pushes identity to the edge of the network
- Cryptographic, point to point exchange of identity
- Based on Hyperledger Indy technology

## Benefits

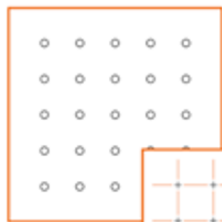
- A decentralized approach that establishes trust and puts the end user in control
- Every person, organization, and thing has a digital wallet to control the flow of their identity
- No PII is stored on the public ledger!



 **sovrin**  
identity for all

# THE TRADELENS SOLUTION

AN OPEN AND NEUTRAL BLOCKCHAIN-BASED PLATFORM THAT IS DIGITIZING THE GLOBAL SUPPLY CHAIN AND TRANSFORMING TRADE



## ECOSYSTEM

The foundation of TradeLens is its business network — shippers, freight forwarders, ports and terminals, ocean carriers, intermodal operators, government authorities, customs brokers and more. Each entity shares information that can be tracked, stored and actioned across the platform throughout a shipment's journey.



## PLATFORM

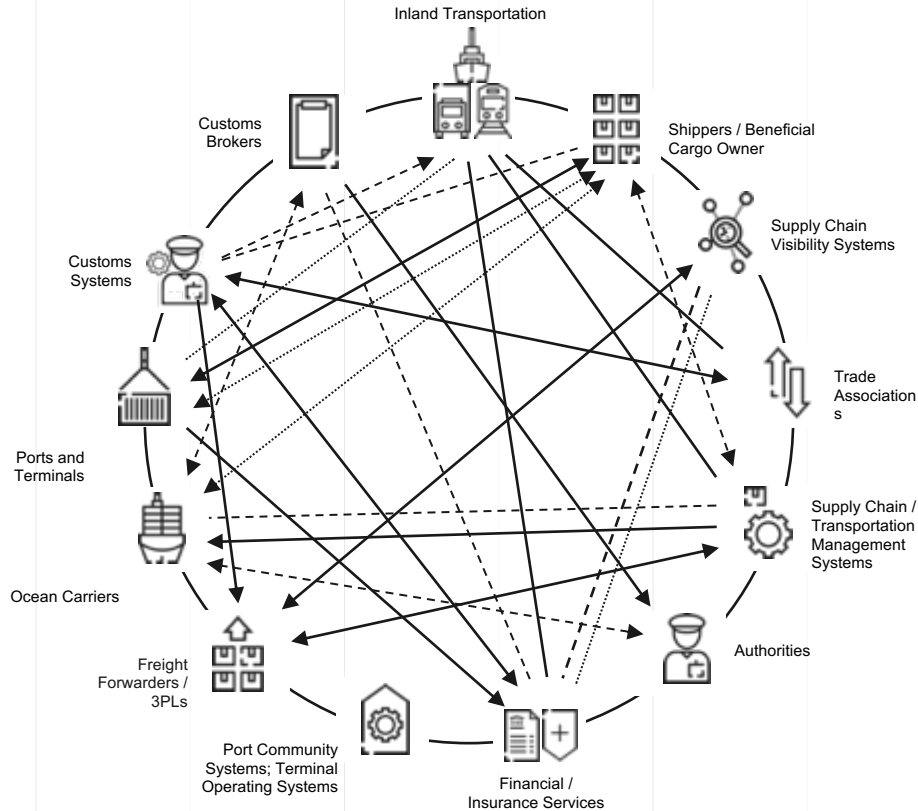
The TradeLens Platform is accessible via an open API and brings together the ecosystem through a set of open standards. Powered by Hyperledger Fabric blockchain technology and IBM Cloud, the platform enables the industry to share information and collaborate securely.



## MARKETPLACE

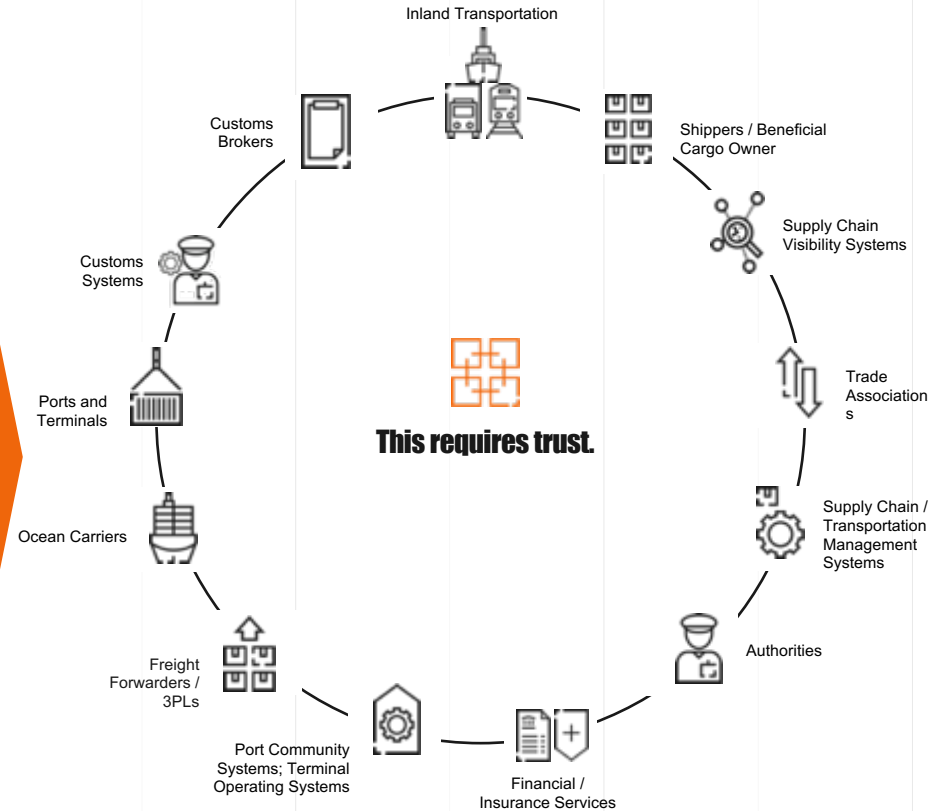
An open Applications and Services Marketplace allows both TradeLens and third parties to publish fit-for-purpose services atop the TradeLens platform, fostering supply chain innovation and value creation.

# VISION: SHIPPER-CENTRIC MODEL TO NETWORK MODEL



Connect the Ecosystem

Drive True Information Sharing



**This requires trust.**

Foster Collaboration and Trust

Spur Innovation



# ECOSYSTEM PARTICIPANTS

## NETWORK MEMBERS



### Ocean Carriers / NVOCCs

Provide the transportation plan, information about the status of shipments across the ocean leg, and critical documents such as the BoL; access end-to-end supply chain data in near real-time including events directly from shipper, intermodal, customs and 3PLs



### Ports / Terminal Operators

Provide information about the disposition of cargo within the boundaries of the port/terminal; access near real-time information to enrich port collaboration and improve terminal planning



### Intermodal Operators

Provide transportation plans and information on the disposition of shipments carried on trucks, rail, barges, etc.; improve planning and utilization of assets given near real-time access to end-to-end supply chain events for shipments



### Government Authorities

Provide information about the export and import clearance status for shipments into and out of the country; access end-to-end supply chain information for improved customs clearance and risk assessments

## TRADELENS CLIENTS



### Shippers/BCOs

Engage with the platform as a consumer of shipping information to improve supply chain management, as a means to collaborate with supply chain partners, and as a way to streamline clearance



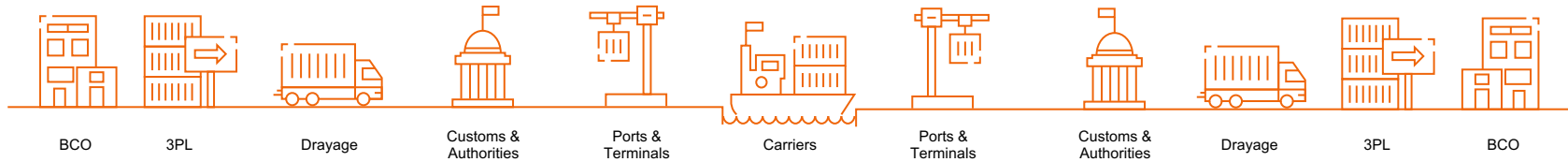
### Freight Forwarders / 3PLs

Engage with the platform as a consumer of shipping information, a means to collaborate with customers and supply chain partners, and a way to improve customs brokerage capabilities

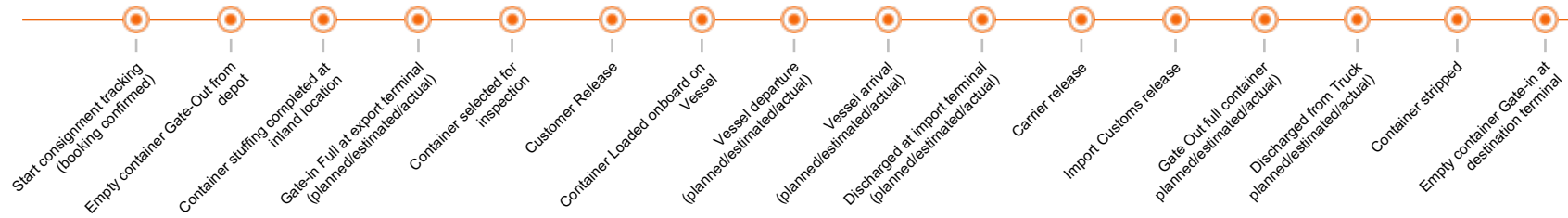


### Financial Services

Engage with the platform as a consumer of supply chain information for a variety of trade finance, insurance, and other purposes to reduce the risk of fraud and increase speed and flexibility to customers



### SHIPPING MILESTONES AND SHIPMENT DATA\*



### STRUCTURED AND UNSTRUCTURED DOCUMENTS\*



### TRADELENS BLOCKCHAIN BUSINESS NETWORK



\* Note: representative sample only of the data on the platform

# STANDARDS AND INTEROPERABILITY

**TradeLens is committed to the promotion and adoption of standards and interoperability of platforms.**

TradeLens is a neutral platform that is available to participants of any party to a shipment, anywhere in the world. The platform provides a way for all major logistics and permissioned participants to immediately contribute to and extract value from the TradeLens network.

## + Information standardization

TradeLens will work closely with the advisory board, ecosystem members and standards bodies to help the industry develop and adopt standard codes and data models. The TradeLens data model and access control scheme aligns with UN/CEFACT.

## + Interface standards

TradeLens is committed to openness, with all functionality surfaced via non-proprietary, publicly available APIs that are designed specifically for ease of integration.

## + Blockchain interoperability

The TradeLens platform has full intentions to follow blockchain-based standards evolving in the industry, inclusive of cross-ledger namespace and transfers or information between ledgers.

### Standards Data

Location: LOCODE, SMDG, Transport: IMO, NMFTA

Time: ISO8601, Business Objects: UNCEFACT SCRDM

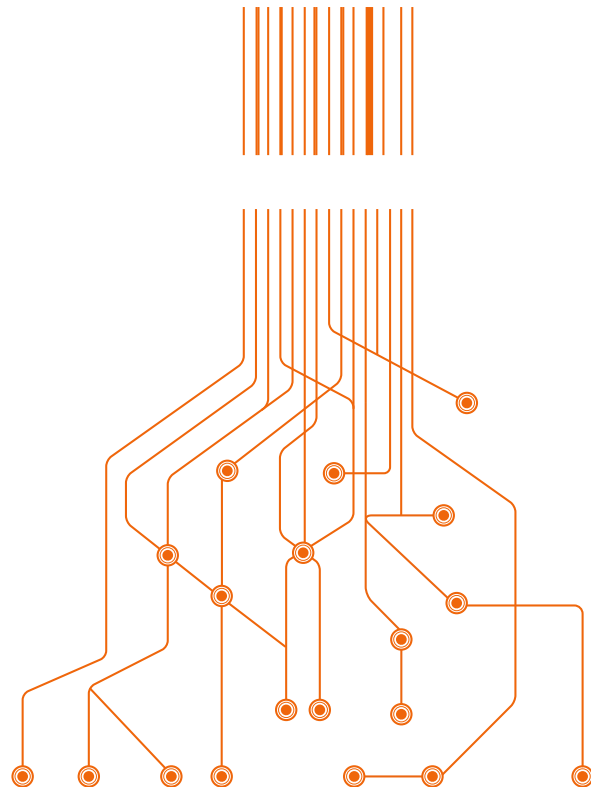
Identity: WCO Trader Identification Number

### Standards Organizations

Openshipping.org, DCSA\*

UN, WCO, GS1

ISO/TC 307



# DIGITIZED DOCUMENTS

TradeLens provides a framework for sharing documents among trade parties, with security, version control, and privacy. Authorized users with the required permissions can upload, download, view and edit documents. The TradeLens document store allows documents to be securely stored and viewed by various parties to a shipment.

## Digitized document benefits

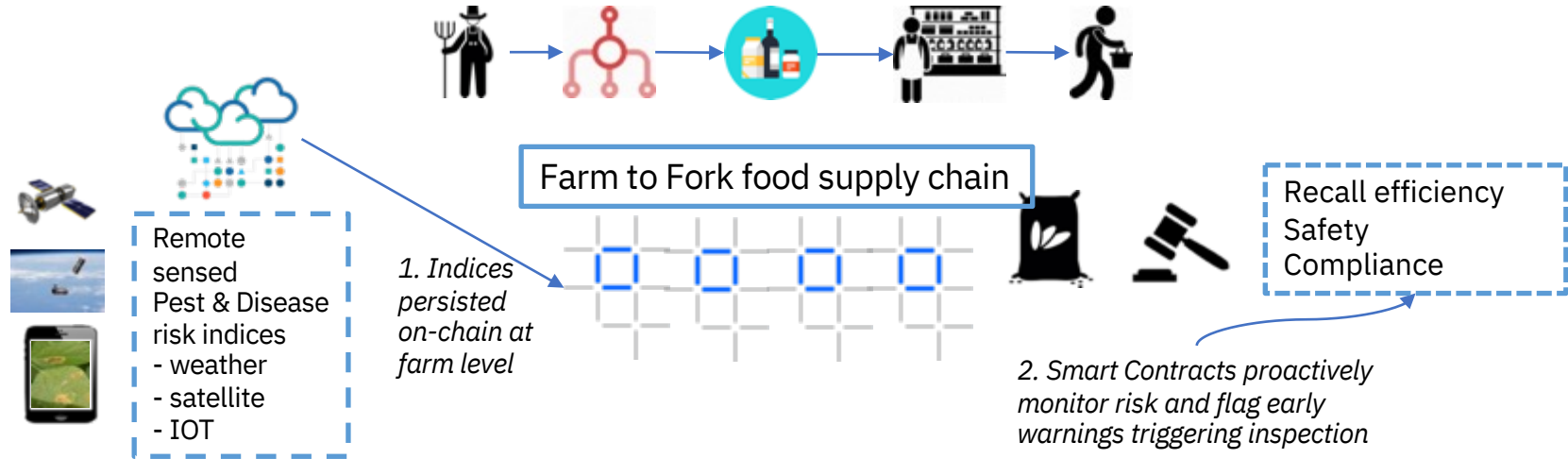
- |  |  |   |
|--|--|---|
| + Trade documents are associated with containers, and consignments in a distributed and shared repository, eliminating endless file, folder and email searching for information. | + TradeLens supports the use of structured documents. The information they contain can be easily analyzed and interpreted, allowing for greater automation and accuracy. | + Each time a document is edited or uploaded to the TradeLens platform, a new version of the document is created and added to the document store, eliminating multiple copies and the inconsistency of identifying the latest versions. |
| + TradeLens uses the Hyperledger Fabric permissioned blockchain to guarantee the immutability and traceability of trade documents.   | + Participants assigned to the consignment have default access rights based on a unified permissions model   | + Network participants assigned to a consignment can immediately access shared documents and data, never having to wait for a document to be sent.  |

## DOCUMENTS SUPPORTED ON THE PLATFORM

- + Sea Waybill\*
- + Commercial Invoice \*
- + Packing List \*
- + Booking Request
- + Booking Confirmation
- + Shipping Instructions
- + Export Declaration
- + Bill of Lading
- + Pro-Forma Invoice
- + Arrival Notice
- + Import Declaration
- + Health Certificate
- + Phytosanitary Certificate
- + Veterinary Certificate
- + Fumigation Certificate
- + Inspection Certificate
- + Certificate of Analysis
- + Certificate of Origin
- + Dangerous Goods Declaration

\* Structured support

# Example: AI-powered Indices on Blockchain



Consider **Corn**, **Spinach**, **Tomato** farmed across India and Indonesia is shipped to Singapore for packaging and distributed as **Mixed Salad** in stores across Singapore, Thailand, Malaysia



AI powered crop health indices rate safety and likelihood of contamination of ingredients.

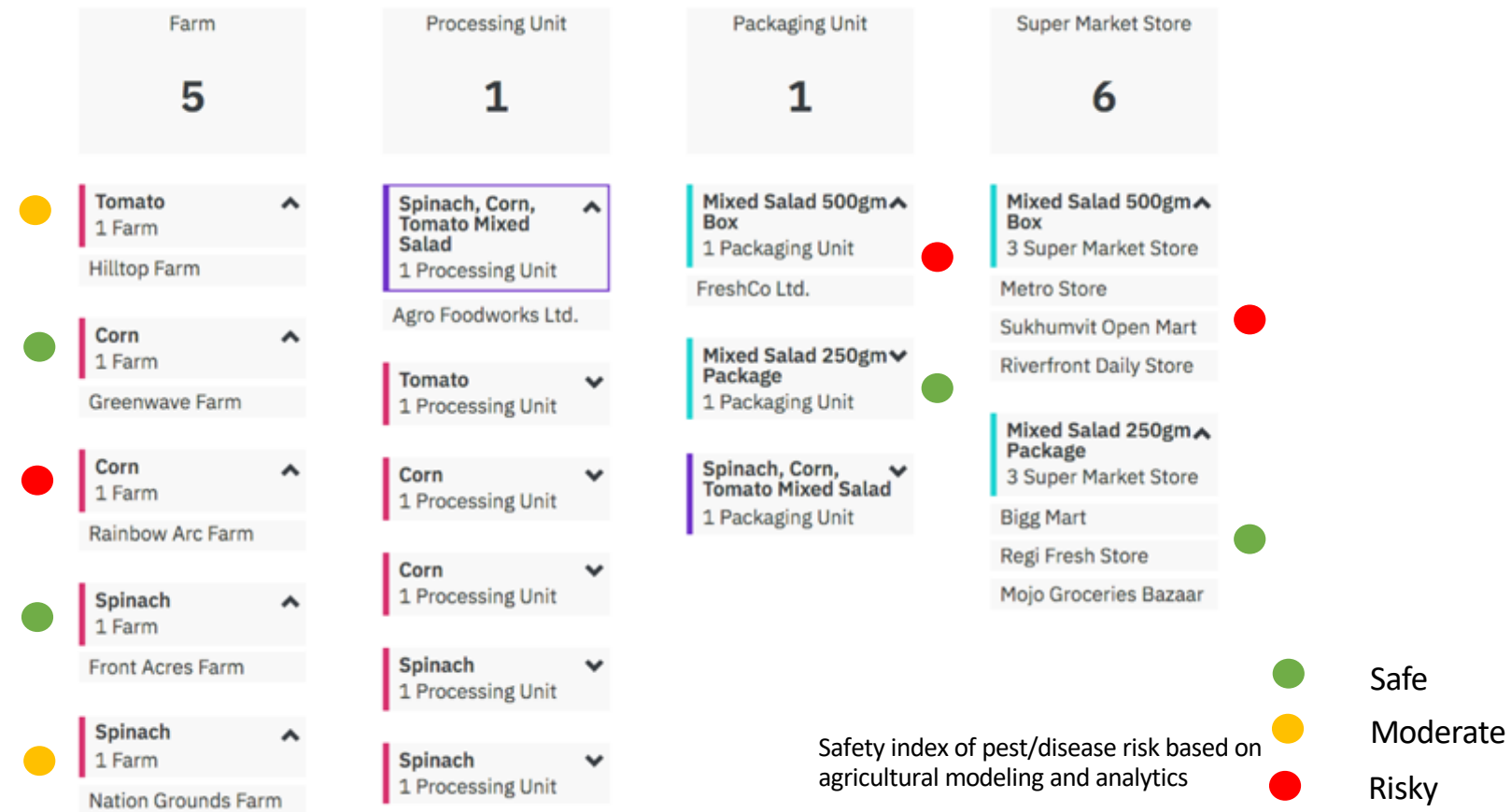
When risky components combine, the end product is riskier from a food safety perspective



## Flow of ingredients, their processing, packaging, and distribution

Farm	Processing Unit	Packaging Unit	Super Market Store
5	1	1	6
<b>Tomato</b> ^ 1 Farm Hilltop Farm	<b>Spinach, Corn, Tomato Mixed Salad</b> ^ 1 Processing Unit Agro Foodworks Ltd.	<b>Mixed Salad 500gm</b> ^ Box 1 Packaging Unit FreshCo Ltd.	<b>Mixed Salad 500gm</b> ^ Box 3 Super Market Store Metro Store Sukhumvit Open Mart Riverfront Daily Store
<b>Corn</b> ^ 1 Farm Greenwave Farm	<b>Tomato</b> v 1 Processing Unit	<b>Mixed Salad 250gm</b> v Package 1 Packaging Unit	<b>Mixed Salad 250gm</b> ^ Package 3 Super Market Store Bigg Mart Regi Fresh Store Mojo Groceries Bazaar
<b>Corn</b> ^ 1 Farm Rainbow Arc Farm	<b>Corn</b> v 1 Processing Unit	<b>Spinach, Corn, Tomato Mixed Salad</b> v 1 Packaging Unit	
<b>Spinach</b> ^ 1 Farm Front Acres Farm	<b>Corn</b> v 1 Processing Unit		
<b>Spinach</b> ^ 1 Farm Nation Grounds Farm	<b>Spinach</b> v 1 Processing Unit		

# Flow of ingredients, their processing, packaging, and distribution



Farm

5

Tomato

1 Farm

Hilltop Farm

Corn

1 Farm

Greenwave Farm

Corn

1 Farm

Rainbow Arc Farm

Spinach

1 Farm

Front Acres Farm

Spinach

1 Farm

Nation Grounds Farm

## ▼ Product Lot and Serial attachments

Corn

Lot131







Custom Payload 1



Custom Payload 1

Created: 07/06/2018

ID	Rainbow Arc Farm	
Crop	Corn	
Grade	C	
Insect Root Aphids Risk	Low	
Fungal Root Rot Risk	High	
Insect Ear Worm Risk	Medium	
Fungal Corn Smut Risk	Medium	
Average Humidity	70 %	
Acreage	150 m2	
Predicted Yield	1.6 T/h	
Average Precipitation	5 in	
Actual Yield	1.7 T/h	
Average Soil Moisture	32 %	

DATE/TIME	INPUT PRODUCT	INPUT QTY	INPUT LOT #	OUTPUT PRODUCT	OUTPUT QTY	OUTPUT LOT #
10/10/2018, 5:30 AM	Spinach Corn Tomato	1000 KGM 750 KGM 1000 KGM	Lot101 Lot121 Lot141	Spinach, Corn, Tomato Mixed Salad	2750 KGM	Lot1001
10/20/2018, 5:30 AM	Spinach Corn Tomato	1500 KGM 500 KGM 1000 KGM	Lot111 Lot131 Lot141	Spinach, Corn, Tomato Mixed Salad	3000 KGM	Lot2001

Farm  
5

Processing Unit  
1

Packaging Unit  
1

Super Market Store  
6



- Safe
- Moderate
- Risky

Lot contains  
high  
risk ingredients

FreshCo Ltd.

Singapore 

### Creating Lot

DATE/TIME	INPUT PRODUCT	INPUT QTY	INPUT LOT #	OUTPUT PRODUCT	OUTPUT QTY	OUTPUT LOT #
10/21/2018, 5:30 AM	Spinach, Corn, Tomato Mixed Salad	3000 KGM	Lot2001	Mixed Salad 500gm Box	6000 AB	Lot601

Risky combined lot of ingredients was turned into Mixed Salad and sent to many stores

*Inspection intervention recommended!*

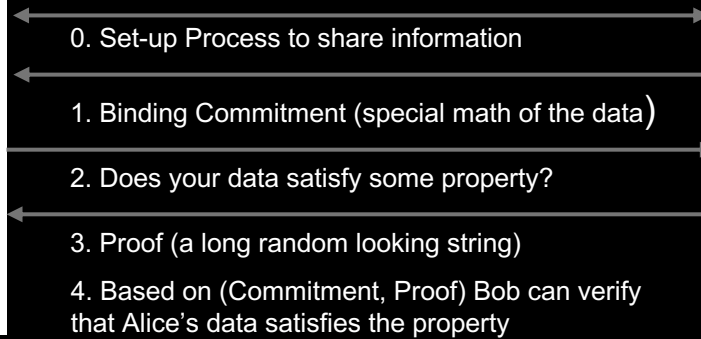
### Shipping

DATE/TIME	FROM	TO	PRODUCT	QTY	LOT #
10/22/2018, 5:30 AM	FreshCo Ltd.	Riverfront Daily Store	Mixed Salad 500gm Box	200 AB	Lot601
10/22/2018, 5:30 AM	FreshCo Ltd.	Metro Store	Mixed Salad 500gm Box	200 AB	Lot601
10/22/2018, 5:30 AM	FreshCo Ltd.	Sukhumvit Open Mart	Mixed Salad 500gm Box	200 AB	Lot601

Stores potentially affected



# Zero Knowledge Proofs – making them practical



## Challenges in adoption

- Costly set-up process for every new property that needs to be proved
- Or very costly proof generation step in case of one time set-up

## Innovation

- One-time set up process for basic operations
- Framework to specify properties
- Ability to efficiently generate commitments and proofs repeatedly with no overheads

# Framework for secret documents

```
{  
  "ShipperName": "Sony Inc.",  
  "From Address": "Singapore",  
  "To Address": "Bangalore",  
  "Item Name": "Television",  
  "Item Price": 2000,  
  "Quantity": 10,  
  "Item Amount": 20000,  
  "Tax": 2400,  
  "Total Amount": 24000,  
  "Priority Clearance": 0,  
  "Amount Paid": 24000  
}
```

**Document**

```
{  
  "ShipperName":  
  "From Address":  
  "To Address":  
  "Item Name":  
  "Item Price":  
  "Quantity":  
  "Item Amount":  
  "Tax":  
  "Total Amount":  
  "Priority Clearance":  
  "Amount Paid":  
}
```

**Structure: Public**

```
{  
  : "Sony Inc.",  
  : "Singapore",  
  : "Bangalore",  
  : "Television",  
  : 2000,  
  : 10,  
  : 20000,  
  : 2400,  
  : 24000,  
  : 0,  
  : 24000  
}
```

**Values: Secret**

- Document owner can compute one time commitment for the entire document
- Generate proofs for important properties that anyone can verify asynchronously
- Embed the proof verification in smart contracts
- Customs can verify that tax is computed correctly in a scalable, privacy-preserving manner

# Summary

- Significant technological advances are being made in the area of digitalization of trade
- Many of these are in step with regulatory and legal changes that need to also happen
- Hopefully this inspires you and removes any fear of technology
- The technical and regulatory/legal communities must work together to digitalize trade

Thank you