# IoT and Blockchain

## Combined impact on Trade and Supply chains

## A Use Case

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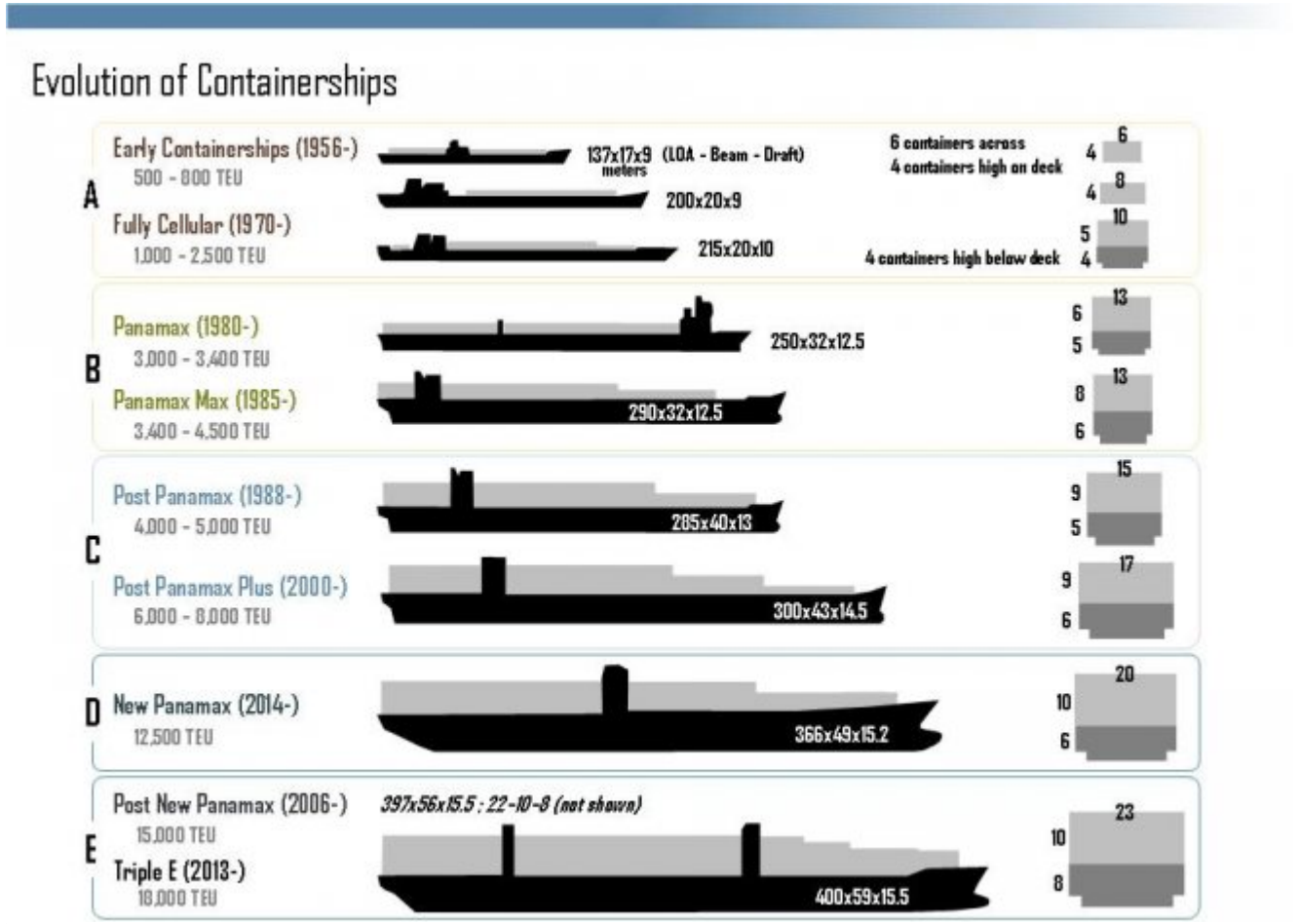
# Context




*Source: https://www.porttechnology.org/news/containerships_then_and_now*

# Context

- Global container shipment (Container port traffic  in TEU) volume (2016) exceeds 700 Million units, up from 472 Million in 2009.
- Global seaborne container trade is accounts for approximately 60 percent of all world seaborne trade
- Valued at around 12 trillion U.S. dollars in 2017.
- Quantity of goods carried by containers has risen from around 100 million metric tons in 1980 to about 1.7 billion metric tons in 2015.
- Vessels have increased their capacity -- between 1980 and 2016, the deadweight tonnage of container ships has grown from about 11 million metric tons to around 244 million metric tons.

# Glossary of Terms

- Distributed Ledger Technology (DLT) and Blockchain are used interchangeably
- Refrigerated Container: Reefer
- IoT: Internet of Things
- Smart Contract: *Immutable* stored programs on DLT that act on data received by DLT

IoT based solution

Currently, *more than 59% of claims* stem from “malfunctioning reefer units, poor supplier handling of off-power periods and wrong temperature set points”, ... All of these issues – most of which are outside the company’s direct control as its reefer boxes traverse the maritime transport system – can “*either be partially avoided or mitigated proactively with live data*.”

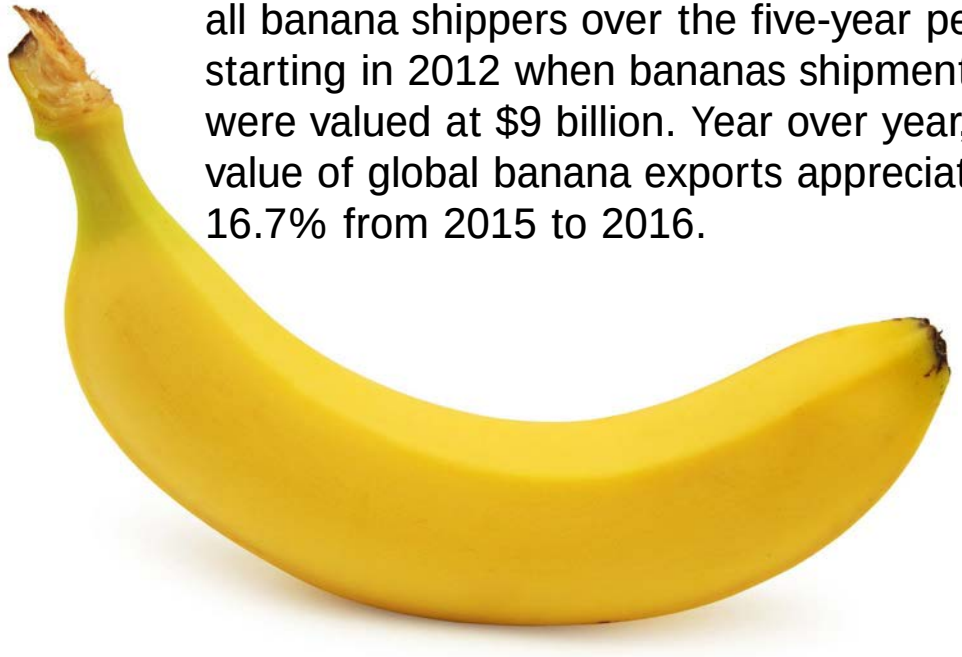
- Maersk Line CCO, Vincent Clerc

Blockchain based solution

# Use Case

- Planter **P** grows and exports bananas, which need to be maintained in a controlled temperature range during transport.
- **G**, a grocery chain purchases a consignment of bananas from **P**, and asks it to be shipped to their agent **A**.
- **L** is the Logistics and Shipping company used by **P**.
- **L** employs trucking company **T** and shipping company **S**
- Multiple Banks: **{B}**

Banana exports by country totalled US$11.8 billion in 2016, up by an average 30.9% for all banana shippers over the five-year period starting in 2012 when bananas shipments were valued at $9 billion. Year over year, the value of global banana exports appreciated by 16.7% from 2015 to 2016.



Multiple parties – P, G, A, L, T, S, {B}


# Transportation & Storage

- During long distance transport, bananas must be kept in the pre-climacteric state, so that ripening can later be induced artificially in the 'ripening rooms'.
- Cavendish bananas can be kept at +13,2°C up to approx. 28 days in regular packs and up to 40 days in 'Banavac' packaging. Sensor
    - This consists of polyethylene bags 0.4 mm thick, in which the carbon dioxide content is raised to 5% and the oxygen content is reduced to 2% ("modified atmosphere"). The ethylene which arises is absorbed by adding potassium permanganate. Sensor
- Acceleration and Deceleration should be controlled to avoid damage to boxes.Skin abrasions result from skin scuffing against other fruits or surfaces of handling equipment or shipping boxes.
- Sensor
- When exposed to low (<90%) relative humidity conditions, water loss from scuffed areas is accelerated and their colour turns brown to black. Sensor

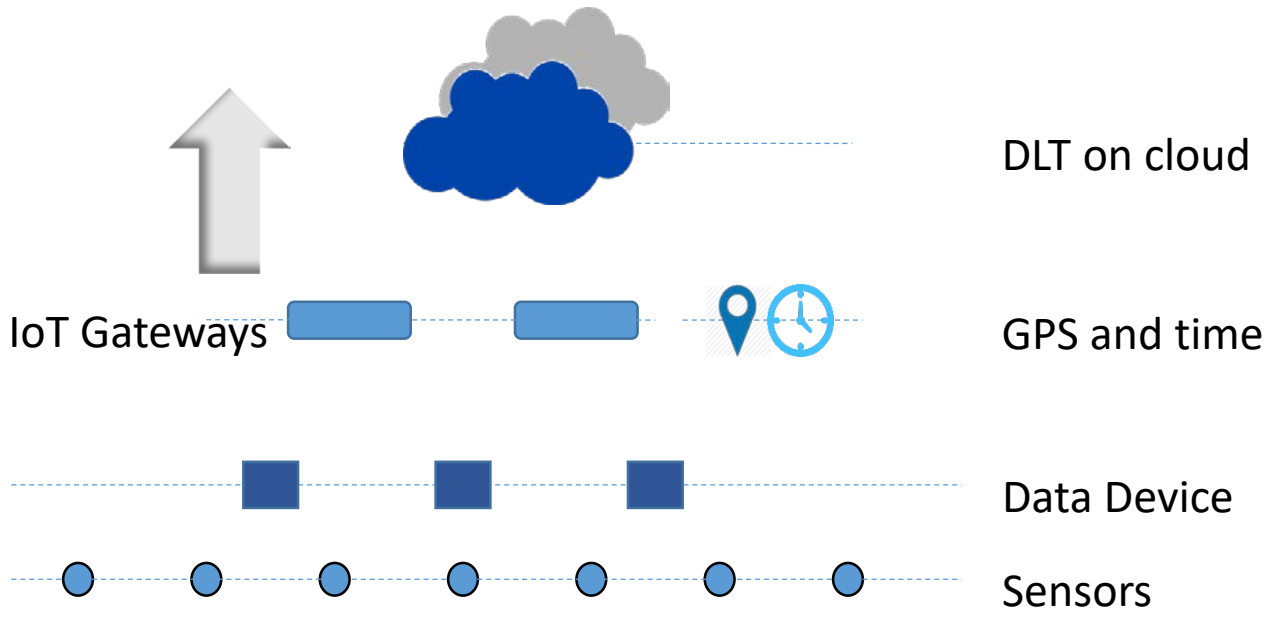
## Refrigerated Container (Reefer)

Maintains bananas between13°C to 15°C

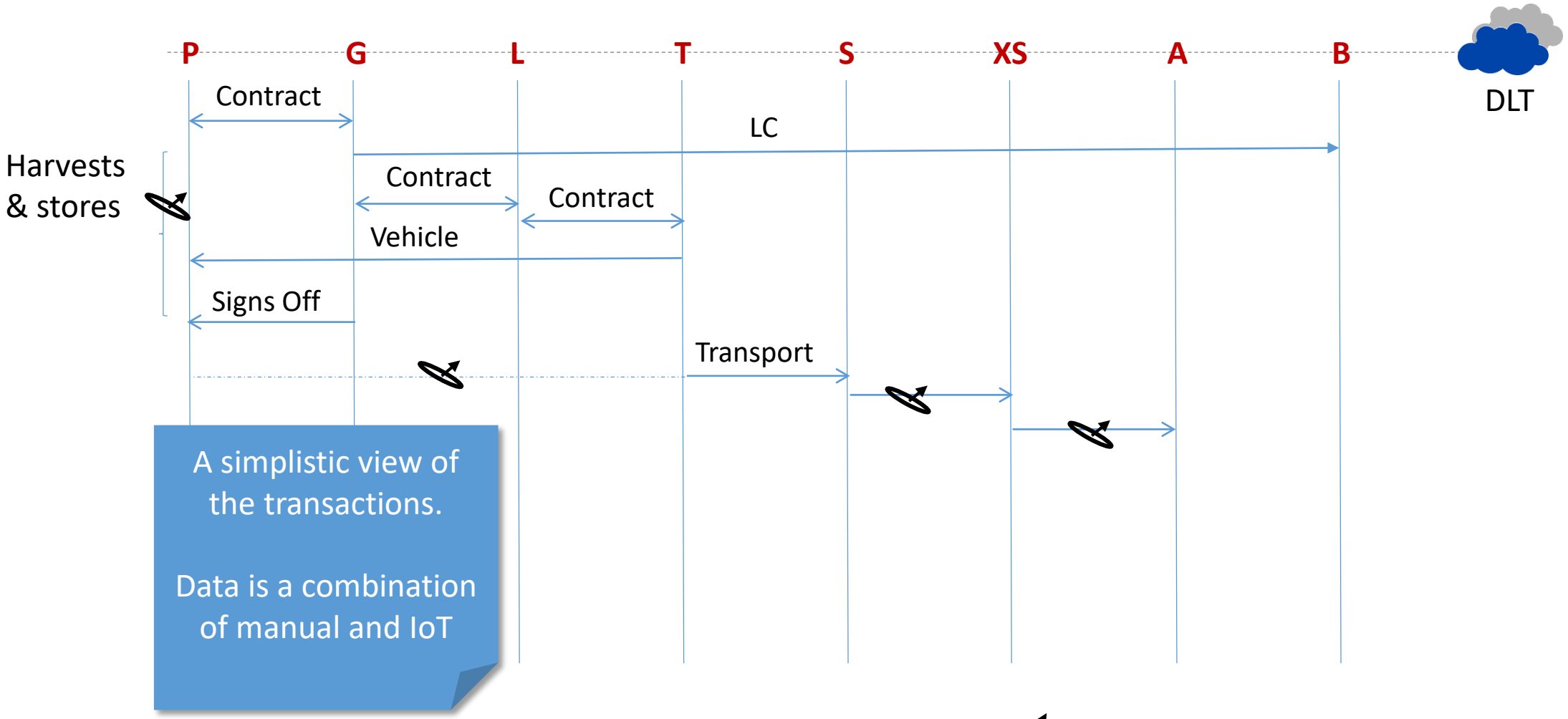
- *Temperature sensors* at multiple locations within the reefer to ensure reliable data
- *GPS* to track container movement and location
- *Accelerometer* and *Gyroscope* to monitor pallet movement within a container
- *Oxygen and $CO_2$ level sensors*
- *Humidity Sensors*
- Monitor power on-off conditions. Devices fall back to battery power
- Monitor *opening and closing of container*
- *Wireless device* to communicate with Internet -- typically 3G/4G + WiFi (IEEE 802.11 b/g/n)
- One or more *data loggers* and *data buffers*
- *Cameras*

# Data Flow

- Devices provisioned from DLT by respective owners. Visible to relevant participants
- Sensor data aggregated and sent by Data devices to DLT
- Smart contracts in DLT process data and generate BI, alerts and even stop/halt action.
- Smart contracts initiate automatic payments

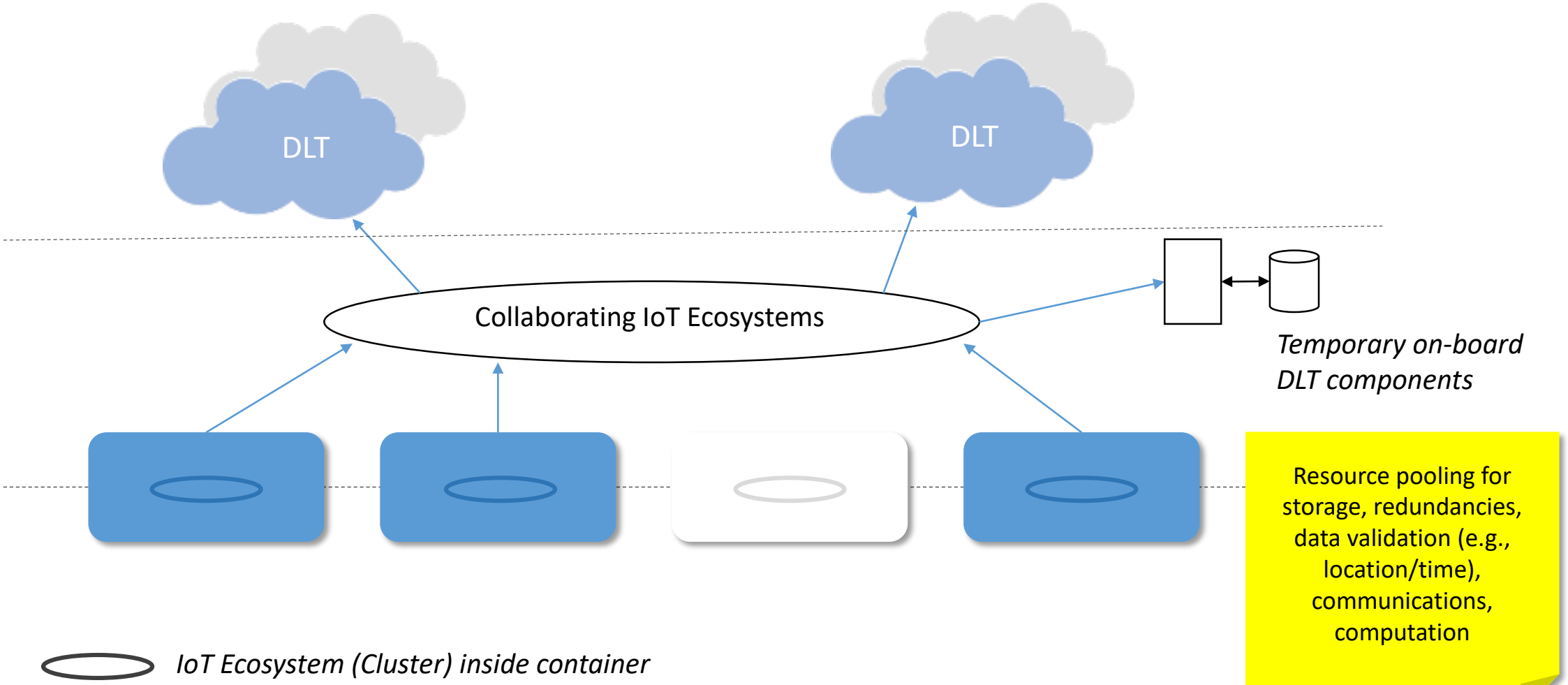


# Data Flow




IoT Data + Smart Contract monitor

# Envisioned Enhanced Ecosystem (on ship)



# Advantages and Challenges

- One single version of truth to all parties concerned
- Data visible to only relevant parties
- Digital certification and data encryption ensures (to a great extent) data source veracity, hence reliability.
- Multiple redundant devices used to ensure data correctness.
- IoT provides continuous and objective visibility to consignment environment and location
- Smart contracts ensure quick action based on data available, minimizing costly delays.
- Data auditability

- Communication to and from cloud can be disrupted
- Malicious device cloning
- Need for multi-party agreement
- DLT's ability to handle high volume-velocity-variety
- Service discovery and data exchange protocols between DLT and devices evolving

# Thank You