



Physical Blockchain: A blockchain use case for the physical internet

Yari Borbon Galvez, PhD
Director of CRISTI-Inclusive Science Technology & Innovation Centre, A.C.
yari@cristi.ngo www.cristi.ngo

Prof. Fabrizio Dallari
Director of Center for Logistics, Transportation, Supply Chain & Operations Management.
Universita' Carlo Cattaneo – LIUC (Italy),
fdallari@liuc.it www.liuc.it

IPIC 2018 - 5th International Physical Internet Conference

June 18-22, 2018 | University of Groningen, the NETHERLANDS

Conclusions 1

- The current state of the art of the present system handles a Physical Blockchain based Mezcal crate cross-border trade from Mexico to Germany.
- The system is based on the Hyperledger Fabric, an architecture comprised of data models, smart contracts and access controls for blockchains participants.

Conclusions 2

- The full system consists of three blockchains:
 1. A mainchain of the Physical Internet cross-border logistics and payouts across participants
 2. A sidechain for auctions where goods, Incoterms, and additional transport and delivery specifications are described; and where the transfer of funds from the customer to the mainchain occurs
 3. A sidechain for chain of custody where information is produced and transfer to the mainchain in exchange of transfer of funds from the mainchain

- To do list:
 1. The first mainchain: will be extended to include in payouts penalties and rewards based on service level KPIs, such as: fill rates, order accuracy, lead time, etc.
 2. The second sidechain: will be upgraded to include in the auction algorithm non-physical goods/assets, and futures markets.
 3. The third sidechain: will be extended to include π _nodes, π _transport, and π _containers where orders are located, as well as the status of the cargo, such as in unloading/loading bays, crossdocking, (de/re)consolidation, sorting, storage, inspection, quarantine, transport, etc

Why a Physical Blockchain?

A piece of which world do we want?

- Do we need to stress the need for the importance of the PI?
 - Economies of scale, scope, speed, and space.
 - Standardized π -containers; π -nodes, π -transport/routes
 - Optimization, synchronization, automation
- Do we need to stress the technological possibilities of the Blockchain?
 - Blockchain 1.0: cryptocurrencies
 - Blockchain 2.0: Smart contracts and “black letter” rules.
 - Blockchain 3.0 & X.0: scalability; interchain operability; cloud & big data; on&off operability, security & governance; digitalization and IoT

Lets get our hands dirty

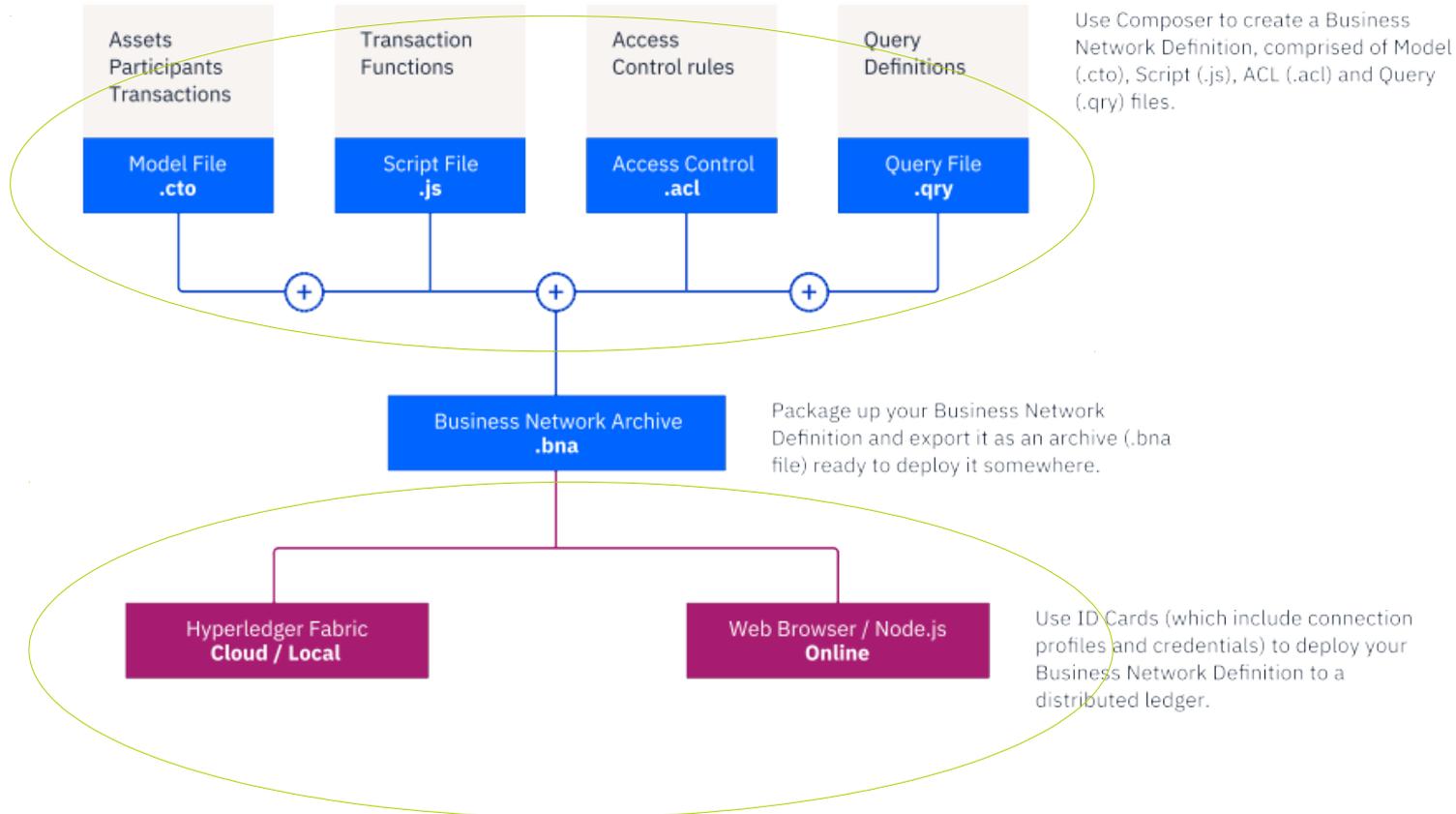
A classical physical internet

- Mexico supplies a Mezcal crate to Germany
 - Oaxaca, Mexico receives an purchase order from Germany
 -
 - The exporter places the Mezcal in π -packs and a π -box  
 -
 - The π -box is placed in a π -container and loaded in the LSP's π -transport
 -
 - The π -container passes through a regional π -node, and international π -node in Mexico for air transport to Germany 
 -
 - The π -container arrives to an international π -node in Germany and passes through a regional π -node, and a last mile delivery π -node in Hamburg. 



Lets get our hands dirty

A hyperledger fabric architecture to handle the physical internet



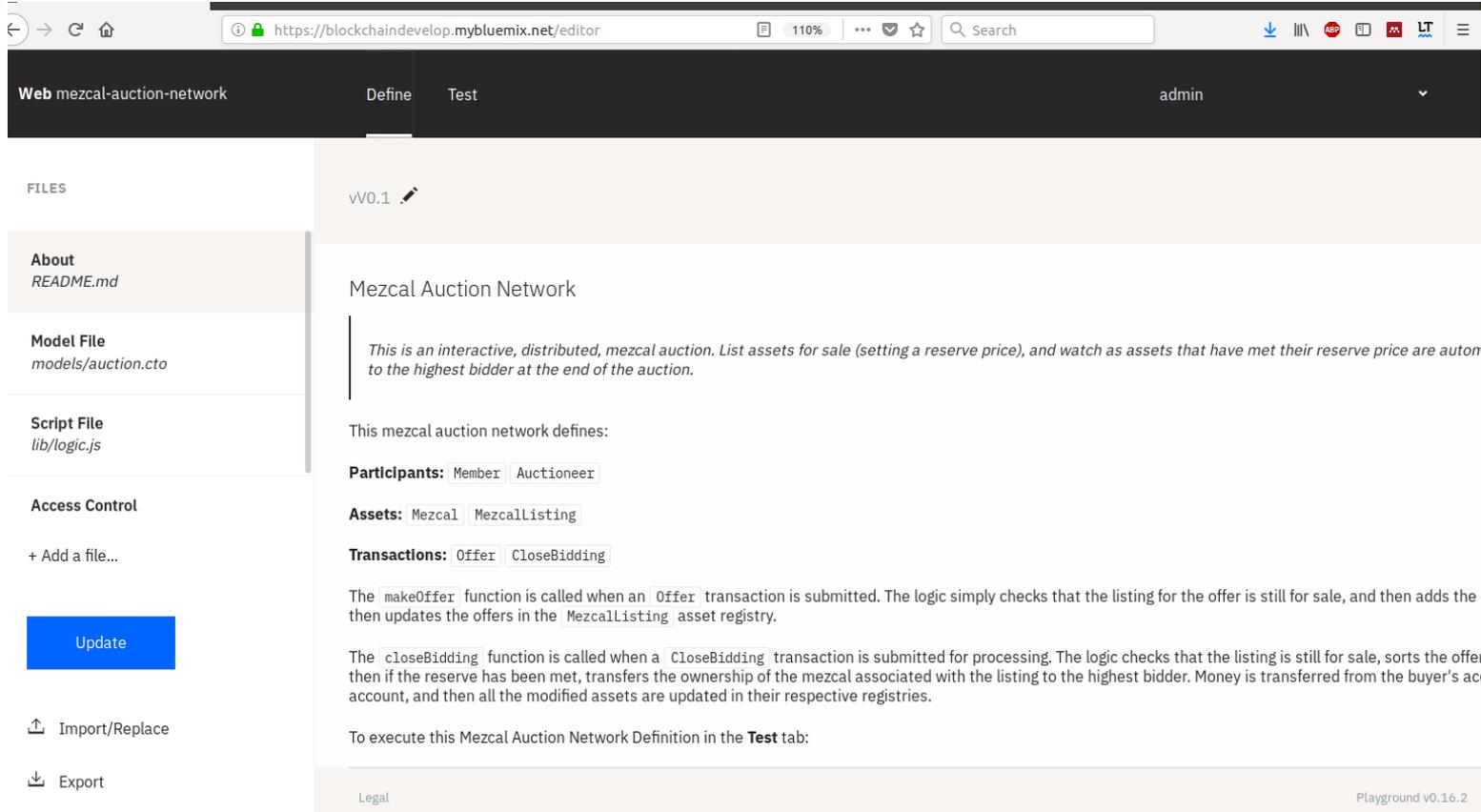
Lets get our hands dirty

A hyperledger fabric architecture to handle the physical internet

Network definition

Execution

IDs and Timestamps



The screenshot shows a web browser at `https://blockchaindevelop.mybluemix.net/editor` displaying the Hyperledger Playground editor. The interface is divided into several sections:

- Header:** Shows the network name "Web mezcal-auction-network", tabs for "Define" and "Test", and a user profile "admin".
- Files Panel (Left):** Lists files including "About README.md", "Model File models/auction.cto", and "Script File lib/logic.js". There is an "Update" button and "Import/Replace" and "Export" options at the bottom.
- Main Editor (Right):** Displays the network definition for "v0.1".
 - Title:** Mezcal Auction Network
 - Description:** *This is an interactive, distributed, mezcal auction. List assets for sale (setting a reserve price), and watch as assets that have met their reserve price are automatically the highest bidder at the end of the auction.*
 - Definition:** "This mezcal auction network defines:"
 - Participants:** Member, Auctioneer
 - Assets:** Mezcal, Mezcallisting
 - Transactions:** Offer, CloseBidding
 - Logic:**
 - makeOffer:** The `makeOffer` function is called when an `Offer` transaction is submitted. The logic simply checks that the listing for the offer is still for sale, and then adds the then updates the offers in the `Mezcallisting` asset registry.
 - closeBidding:** The `closeBidding` function is called when a `CloseBidding` transaction is submitted for processing. The logic checks that the listing is still for sale, sorts the offer then if the reserve has been met, transfers the ownership of the mezcal associated with the listing to the highest bidder. Money is transferred from the buyer's account, and then all the modified assets are updated in their respective registries.
 - Execution:** "To execute this Mezcal Auction Network Definition in the **Test** tab:"
- Footer:** "Legal" on the left and "Playground v0.16.2" on the right.

Lets get our hands dirty

A hyperledger fabric architecture to handle the physical internet

Network definition

Execution

IDs and Timestamps

Web mezc-al-auction-network Define Test admin

Participant registry for org.acme.mezcal.auction.Member + Create New Participant

Participant Type	ID	Data	Actions
Member	fdallari@liuc.it	<pre>{ "\$class": "org.acme.mezcal.auction.Member", "balance": 5000, "email": "fdallari@liuc.it", "firstName": "Fabrizio", "lastName": "Dallari" }</pre>	 
MezcListing	rod@bestmans.ngo	<pre>{ "\$class": "org.acme.mezcal.auction.Member", "balance": 1000, "email": "rod@bestmans.ngo", "firstName": "Rod", "lastName": "Frankois" }</pre>	 
	sergio@mezpirits.mx	<pre>{ "\$class": "org.acme.mezcal.auction.Member", "balance": 5500, "email": "sergio@mezpirits.mx", "firstName": "Sergio", "lastName": "Barbarito" }</pre>	 

[Submit Transaction](#)

Lets get our hands dirty

A hyperledger fabric architecture to handle the physical internet

Network definition

Execution

IDs and Timestamps

Web mezcac-auction-network Define Test admin

PARTICIPANTS

Auctioneer

Member

ASSETS

Mezcal

Mezcallisting

TRANSACTIONS

All Transactions

Submit Transaction

Date, Time	Entry Type	Participant	
2018-04-18, 23:25:34	UpdateBusinessNetwork	admin (NetworkAdmin)	view record
2018-04-18, 23:22:52	UpdateBusinessNetwork	admin (NetworkAdmin)	view record
2018-04-18, 23:04:27	CloseBidding	admin (NetworkAdmin)	view record
2018-04-18, 23:03:43	Offer	admin (NetworkAdmin)	view record
2018-04-18, 23:01:46	Offer	admin (NetworkAdmin)	view record
2018-04-18, 23:00:10	AddAsset	admin (NetworkAdmin)	view record
2018-04-18, 22:57:51	AddAsset	admin (NetworkAdmin)	view record

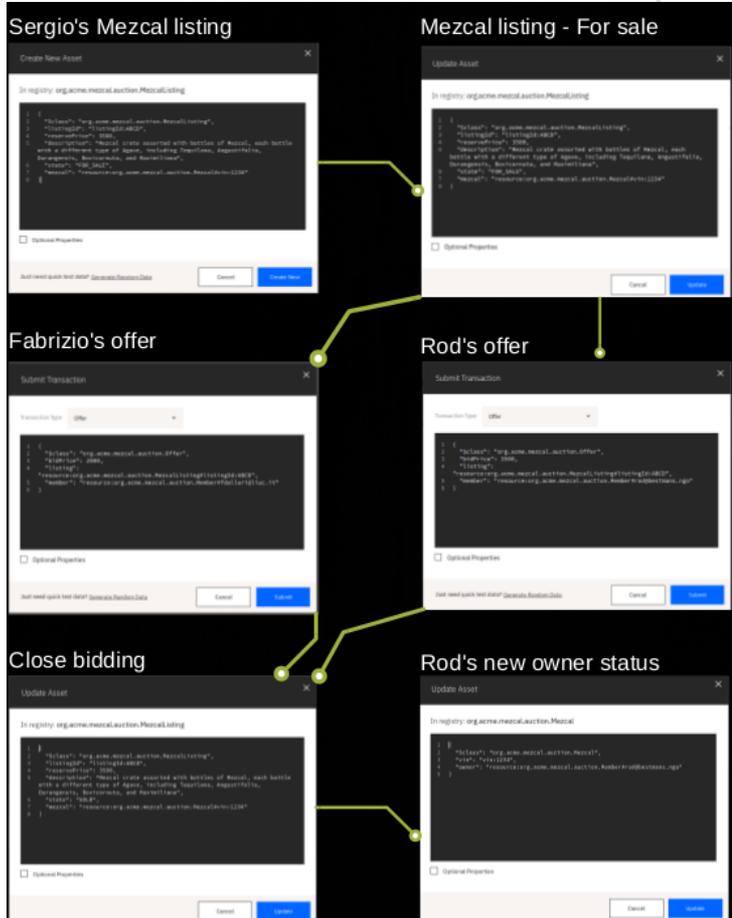
Lets get our hands dirty

3 Blockchains

Mezcal crate auction

Export & Payouts

Block(chain) of custody



Lets get our hands dirty

3 Blockchains

Mezcal crate auction

Export & Pavouts

Block(chain) of custody

Crate a Smart Contract Rod-Sergio-Maya

```

    "id": "rod-sergio-maya",
    "type": "Mezcal_crate",
    "contract": "rod-sergio-maya",
    "status": "open",
    "location": "Mexico",
    "weight": 10,
    "volume": 10,
    "description": "Rod-Sergio-Maya Mezcal crate",
    "created": "2018-04-20T12:17:25Z",
    "updated": "2018-04-20T12:17:25Z",
    "contract": "rod-sergio-maya"
  }

```

Crate a Shipment for Maya

```

    "id": "maya-shipment",
    "type": "Mezcal_crate",
    "contract": "rod-sergio-maya",
    "status": "open",
    "location": "Mexico",
    "weight": 10,
    "volume": 10,
    "description": "Maya Mezcal crate",
    "created": "2018-04-20T12:17:25Z",
    "updated": "2018-04-20T12:17:25Z",
    "contract": "rod-sergio-maya"
  }

```

Submit a Temperature Reading

Asset registry for org.acme.shipping.mezcal.Shipment

ID	Data
SHEP_005	<pre> { "id": "maya-shipment", "type": "Mezcal_crate", "contract": "rod-sergio-maya", "status": "open", "location": "Mexico", "weight": 10, "volume": 10, "description": "Maya Mezcal crate", "created": "2018-04-20T12:17:25Z", "updated": "2018-04-20T12:17:25Z", "contract": "rod-sergio-maya" } </pre>

Submit a Shipment Received

```

    "id": "maya-shipment",
    "type": "Mezcal_crate",
    "contract": "rod-sergio-maya",
    "status": "open",
    "location": "Mexico",
    "weight": 10,
    "volume": 10,
    "description": "Maya Mezcal crate",
    "created": "2018-04-20T12:17:25Z",
    "updated": "2018-04-20T12:17:25Z",
    "contract": "rod-sergio-maya"
  }

```

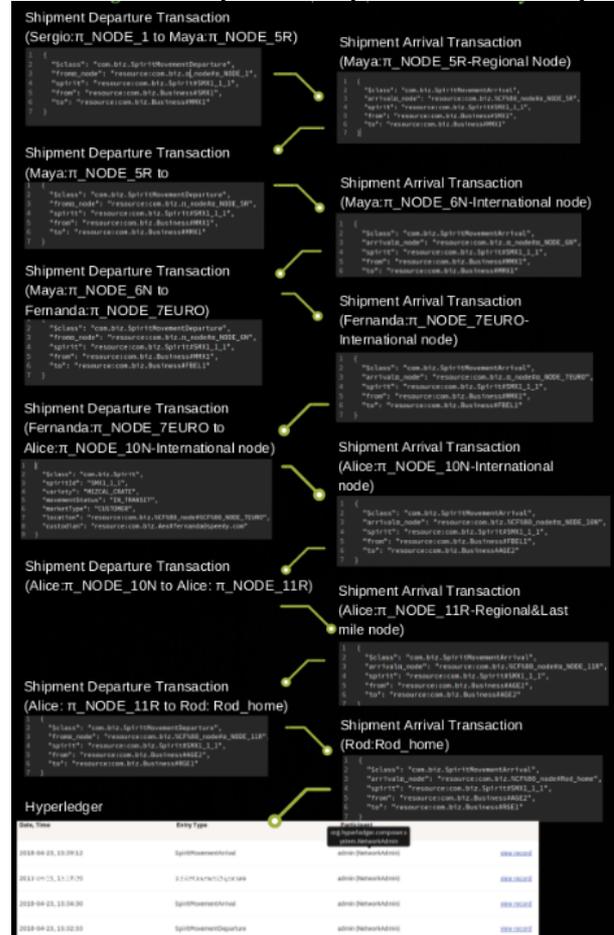
Source: Own elaboration

Lets get our hands dirty

3 Blockchains

Mezcal crate auction Export & Payouts

Block(chain) of custody



Final remarks

Physical Blockchain capability Requirements

- Decentralised Autonomous Organizations (DAOs) and smart devices
- Measurement and analytics
- Distributed marketplace
- Mainchain and sidechains integration
- Plugging-in non-blockchain systems
- Embedded optimisation algorithms in smart contracts
- Traditional, crypto, and virtual currencies and assets

Living labs?

- The full system consists of three blockchains:
 1. A mainchain of the Physical Internet cross-border logistics and payouts across participants
 2. A sidechain for auctions where goods, Incoterms, and additional transport and delivery specifications are described; and where the transfer of funds from the customer to the mainchain occurs
 3. A sidechain for chain of custody where information is produced and transfer to the mainchain in exchange of transfer of funds from the mainchain

- To do list:
 1. The first mainchain: will be extended to include in payouts penalties and rewards based on service level KPIs, such as: fill rates, order accuracy, lead time, etc.
 2. The second sidechain: will be upgraded to include in the auction algorithm non-physical goods/assets, and futures markets.
 3. The third sidechain: will be extended to include π _nodes, π _transport, and π _containers where orders are located, as well as the status of the cargo, such as in unloading/loading bays, crossdocking, (de/re)consolidation, sorting, storage, inspection, quarantine, transport, etc



Thank you!

Suggestions!

Lets talk!

Yari Borbon Galvez, PhD
Director of CRISTI-Inclusive Science Technology & Innovation Centre, A.C.
yari@cristi.ngo www.cristi.ngo

Prof. Fabrizio Dallari
Director of Center for Logistics, Transportation, Supply Chain & Operations Management.
Universita' Carlo Cattaneo – LIUC (Italy),
fdallari@liuc.it www.liuc.it

IPIC 2018 - 5th International Physical Internet Conference

June 18-22, 2018 | University of Groningen, the NETHERLANDS