Hyperledger Fabric v1.4

Everything you wanted to know…

HYPERLEDGER

BLOCKCHAIN TRAINING ALLIANCE
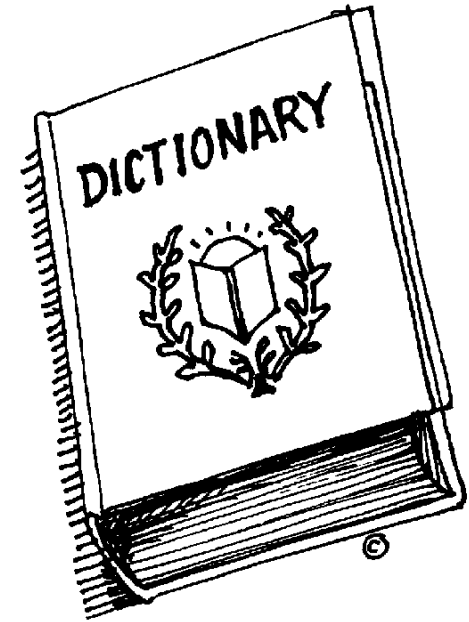
Introduction

- Who am I?
  - Kris Bennett, #BlockchainBeardGuy
  - Chief Learning Officer, Blockchain Training Alliance
- What is Blockchain Training Alliance?
  - Blockchain Training and Certification
    - Partnered with Pearson VUE testing centers
    - Exclusive Blockchain content provider
  - Workshops and Consulting Services
    - Help making your ideas a reality

Introduction to Hyperledger Fabric 1.4

- Blockchain Basic Terms
  - Immutable
    - Cannot be changed, edited, or deleted. Permanent record.
  - Append-Only
    - A system in which data can only be read or added. No deletes or edits are possible.
  - Ledger
    - A log or historical record of events for a particular item.
  - Consensus
    - The truth is assumed to be whatever the majority of participants believe it to be.
- What is Blockchain?
  - An immutable, append-only ledger.
  - Multiple copies of this ledger are stored on nodes (computers) across a network.
  - Nodes attempt to reach consensus on the contents of the ledger.

Introduction to Hyperledger Fabric 1.4

- ## History of Blockchain
  - ### Bitcoin – 2009
    - Ledger used to track the history of one asset – Bitcoin
    - Single, shared ledger
    - Blockchain 1.0 – Just a ledger, nothing more…
    - Anonymous and fully-transparent
    - Primary Focus: A ledger to enable and facilitate digital payments

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A Bitcoin Transaction

Transaction View information about a bitcoin transaction

967c3d317cf2ccbee6e7f902bfc25ea0f433ec12985dd073552cf4aad0384a0e

17QrQKaWKxwauF1RsPGsMWyo4GeX1yJnRX → 1C4iGmwpCoLL8ub57W6j3hTqSzQJUkZdrP   0.04848376 BTC

| 4 Confirmations | 0.04848376 BTC |

Summary

Size	191 (bytes)
Weight	764
Received Time	2019-05-22 15:33:26
Included In Blocks	577257 (2019-05-22 15:43:51 + 10 minutes)
Confirmations	4
Visualize	View Tree Chart

Inputs and Outputs

Total Input	0.04989428 BTC
Total Output	0.04848376 BTC
Fees	0.00141052 BTC
Fee per byte	738.492 sat/B
Fee per weight unit	184.623 sat/WU
Estimated BTC Transacted	0.04848376 BTC
Scripts	Show scripts & coinbase

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Introduction to Hyperledger Fabric 1.4

- History of Blockchain
  - Ethereum – July 2015
    - Ledger used to track the history of Ether
    - Ledger can also be used to track ANY other asset, not just Ether!
    - Single, shared ledger
    - Blockchain 2.0 - Smart Contracts and the EVM
      - Program your own logic for how events should be handled
      - Blockchain as a workflow / BPM solution
    - ERC20 token standard
      - Standard architecture for tokenizing any type of asset
    - Anonymous and fully-transparent
    - Primary Focus: A platform to build consumer applications on

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Introduction to Hyperledger Fabric 1.4

An Ethereum (financial) Transaction

Overview   State Changes `New`   Comments

Transaction Hash:	0x831fd26634e7dad3852797a1d3358e70619f9a0e451ce77fa3899261614d1d1d
Status:	✓ Success
Block:	7810580 3 Block Confirmations
Timestamp:	⏱ 1 min ago (May-22-2019 03:59:45 PM +UTC)
From:	0xc24cb5d8890d2e0bdbce4d91f73e2d243c4a890c
To:	0x219466a5a45ada2be276e0fa3e7e2c706ca832bc
Value:	4.90047421 Ether ($1,257.02)
Transaction Fee:	0.000378 Ether ($0.10)

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An Ethereum (non-financial) Transaction

Introduction to Hyperledger Fabric 1.4

- History of Blockchain
    - Hyperledger – December 2015
        - No native token model (yet)
        - Ledger can be used to track any kind of asset
        - Multiple ledgers
        - Blockchain 2.0 – Chaincode (aka Smart Contracts)
        - Identity and Permissioning
        - Primary Focus: A platform for building cross-organizational enterprise applications on
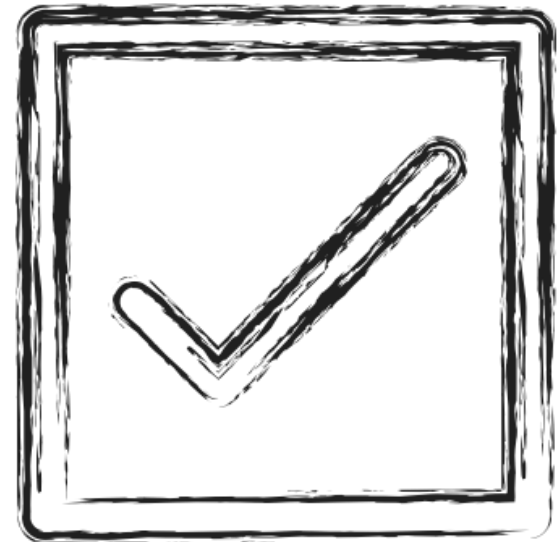
HYPERLEDGER

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Introduction to Hyperledger Fabric 1.4

A Hyperledger Fabric (Composer) Transaction

```json
{
  "$class": "org.hyperledger.composer.system.AddParticipant",
  "resources": [
   {
     "$class": "org.acme.vehicle.auction.Member",
     "balance": 0,
     "email": "alice@abc.com",
     "firstName": "Alice",
     "lastName": "Johnson"
   }
  ],
  "targetRegistry": "resource:org.hyperledger.composer.system.ParticipantR
  "transactionId": "f01890fd-8b01-49b3-adf9-1b3533119ecf",
  "timestamp": "2019-05-22T17:39:52.673Z"
}
```

Introduction to Hyperledger Fabric 1.4

- Properties of a Blockchain (public, open, permissionless):
  - Decentralized ledger
    - Can store any type of data
    - Shared ledger
  - Immutable
  - Anonymous
  - Fully-Transparent
  - Group Consensus
    - Nodes only verify data was recorded correctly
    - No ability to verify truth of the data itself
  - Smart Contracts
    - Ability to automate processes
    - Blockchain as workflow / BPM

Introduction to Hyperledger Fabric 1.4

- Properties of an *enterprise blockchain?*
  - Decentralized ledger
    - Can store any type of data
    - Shared ledger
  - Immutable
  - Anonymous
  - Fully-Transparent
  - Group Consensus
    - Nodes only verify data was recorded correctly
    - No ability to verify truth of the data itself
  - Smart Contracts
    - Ability to automate processes
   - Blockchain as workflow / BPM
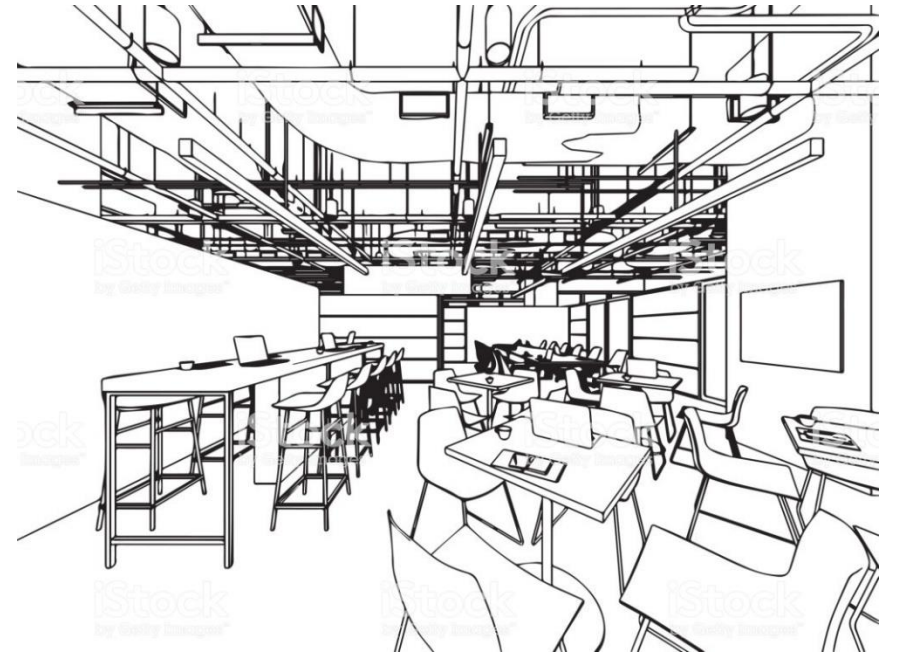
Hyperledger Fabric Key Concepts

- Things to address for enterprise use:
  1. Ledger should not be shared with everyone
     - *I don't want to share all of my data with every participant.*
  2. Users should not be anonymous
     - *I want to know who my users are. Anonymity does not benefit me.*
  3. Users should not have full transparency
     - *I want to control which users can see which parts of my data.*
  4. Group Consensus should be replaced by Participant Consensus
     - *I don't need the entire network to validate transactions, I can simply have the participants validate their own transactions.*

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Hyperledger Fabric Key Concepts

- Problem: Ledger should not be shared with everyone
  - *I don't want to share all of my data with every participant.*

- Solution: Channels
  - Channels offer a way to create multiple ledgers, each of which can have a unique set of participants and permissions.


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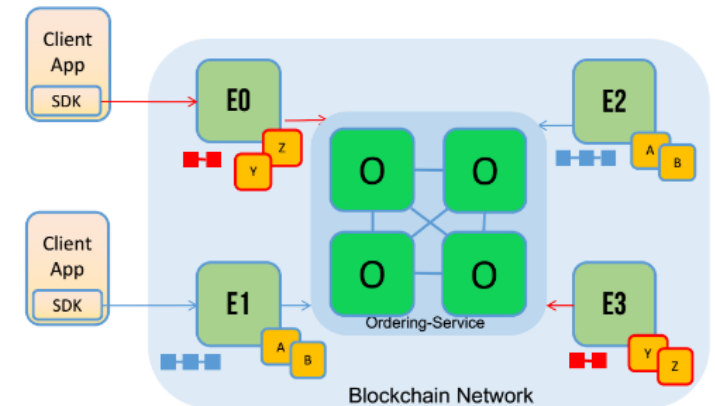
Hyperledger Fabric Key Concepts

- An example:
  - Alice manufactures consumer electronic devices.
    - Alice's products are sold in many retail stores.
  - Bob owns a chain of retail electronic stores in Europe and North America.
    - Bob's stores sell many electronic devices.
  - Alice does business with many stores, Bob is only one. Bob does business with many manufacturers, Alice is only one.
    - Bob has negotiated a special low price with Alice.
    - Alice and Bob wish to keep their negotiated price confidential.
  - If there was only one ledger…
    - Every retail store would know the price Alice was charging every other retail store
    - Every manufacturer would know the price Bob was paying every other manufacturer for their products
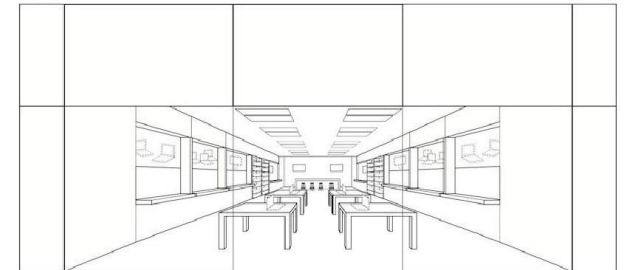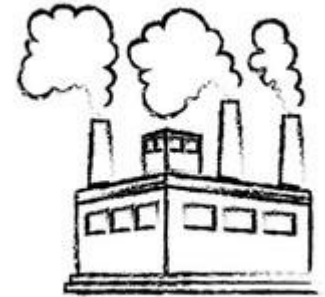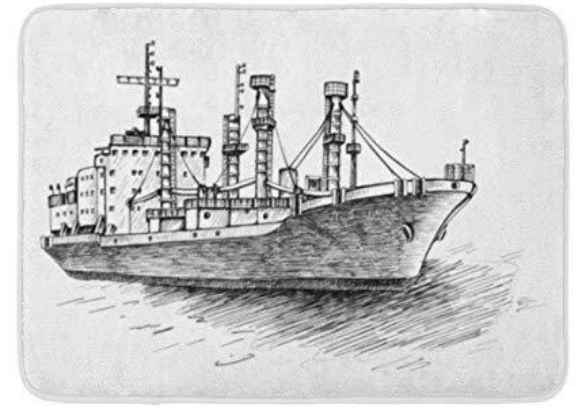
Hyperledger Fabric Key Concepts

- ## What if?
  - ### Alice could have many ledgers, and only one of them was shared with Bob?
  - ### Bob could have many ledgers, and only one was shared with Alice?
- ## Alice and Bob can share a channel together
  - ### A channel provides:
    - #### A ledger
    - #### A collection of Smart Contracts
    - #### A set of permissions
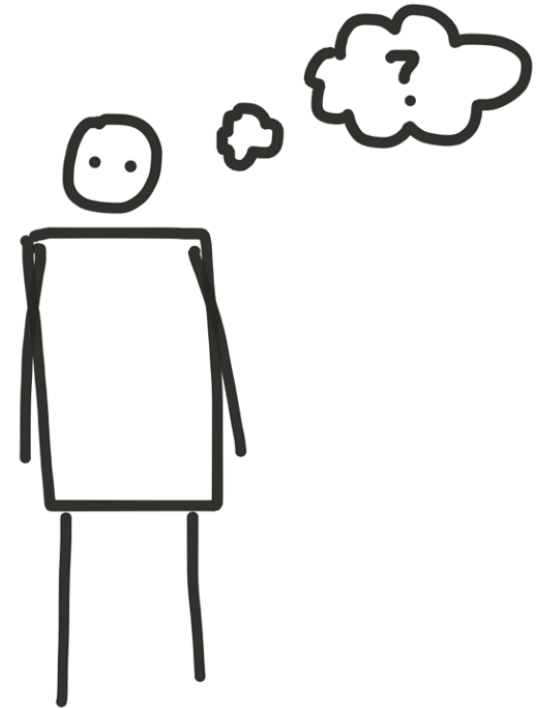
Hyperledger Fabric Key Concepts

- In order for Alice's products to get to Bob's stores, we need some help...
  - **Charlie** runs the shipping company that ships products all around the world.
    - Charlie only needs to know what's being shipped and where it's going.
  - **Diane** is the banker that financed Bob's purchase of Alice's products.
    - Diane only needs to know the price Bob paid to Alice as well as Bob's sales figures.

Hyperledger Fabric Key Concepts

- In order for Alice's products to get to Bob's stores, we need some help…
  - **Evelyn** works for the customs agency in the receiving market.
    - Evelyn only needs to know what's in those shipping containers.
  - **Frank** runs an advertising agency that helps Bob sell more items.
    - Frank only needs to know when the shipment has arrived in the local market and is headed for the retail stores.

U.S. Customs and Border Protection

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Hyperledger Fabric Key Concepts

- Channel 1 – Alice and Bob
  - Contains all the details of Alice's and Bob's transactions together.
  - This channel feeds data to channels 2-5
- Channel 2 – Charlie
  - Contains only information about shipments leaving Alice's factory for Bob's stores.
  - What is being shipped?
  - Where is it going?
- Channel 3 – Diane
  - Contains Bob's purchase info from Alice
  - Contains Bob's store sales records
- Channel 4 – Evelyn
  - Contains Bills of Lading and Shipping Manifests
- Channel 5 – Frank
  - Contains arrived status (yes/no)

Hyperledger Fabric Key Concepts

- Problem: Users should not be anonymous
  - *I want to know who my users are. Anonymity does not benefit me.*
- Solution: Membership Service Provider
  - A pluggable component to a Hyperledger Fabric Network
  - One per organization
  - Contains list of all known human and system identities
  - Gives all participants on a Fabric network an identity
  - LDAP, Active Directory, oAuth are common
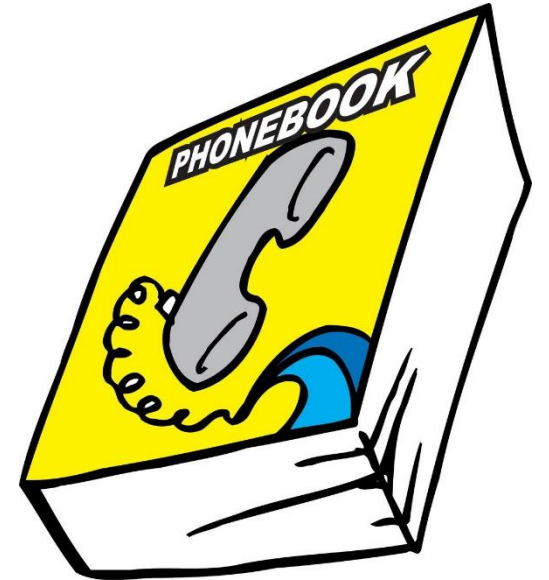
Hyperledger Fabric Key Concepts

- Problem: Users should not have full transparency
  - *I want to control which users can see which parts of my data.*

- Solution: Channel Permissions and ACLs
  - ACL == Access Control Listing
  - Permissions made possible via identity (MSP)
  - Permissions can be applied at the channel level

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Hyperledger Fabric Key Concepts

- Problem: Group Consensus should be replaced by Participant Consensus
  - *I don't need the entire network to validate transactions, I can simply have the participants validate their own transactions.*

- Solution: Endorsement Policies
  - Once identity is known, group consensus can be replaced by participant consensus.
  - If you and I have a transactions, and we both agree on the outcome of that transaction why do we need anybody to help validate it?
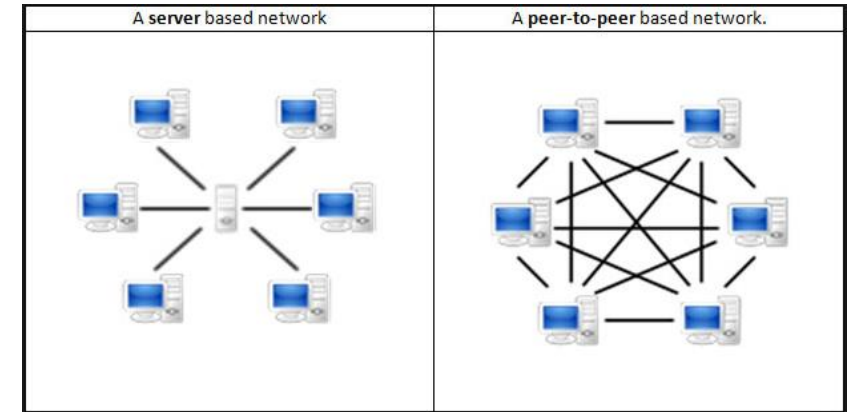
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Hyperledger Fabric Key Concepts

- Points to consider:
  - Channels and Endorsement Policies give us a way to deploy the same business process to two different participants with two different sets of rules.
    - Business with family friend vs stranger
  - This architecture allows for democratic and disproportional voting scenarios on the same infrastructure.
    - Wal-Mart > Supplier
    - Wal-Mart = Supplier
    - Wal-Mart < Supplier
  - On a channeled platform, there is no one single place where ALL the data is stored.
    - An attacker could never obtain a "*God-Mode View*"


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Hyperledger Fabric Core Components

- Classic network computing relies on a client-server architecture.
  - Clients request information from servers. Servers return information to clients.
- Public blockchains typically run on a peer-to-peer architecture.
  - Every node (computer) is a *peer* to every other node.
  - There are no clients and no servers. Each node is both a client and a server.
  - P2P scales well, is extremely fault tolerant, and is relatively immune to DDoS attacks.
  - Bottlenecked at ~10 Transactions per Second
    - Visa = 70,000 tps
    - Facebook = 175,000 tps

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Hyperledger Fabric Core Components

- Each blockchain node performs three functions:
    1. Keep a redundant copy of the ledger (or ledgers)
    2. Execute any requested Smart Contract code
    3. Keep all copies of the ledger in-sync
        - Same data
        - Same order!

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Hyperledger Fabric Core Components

- What if each function has its own node type?
  1. *Committing Node* - Keep a redundant copy of the ledger (or ledgers)
  2. *Endorsing Node* - Execute any requested Smart Contract code
  3. *Ordering Node* - Keep all copies of the ledger in-sync
     - Same data, in the same order!

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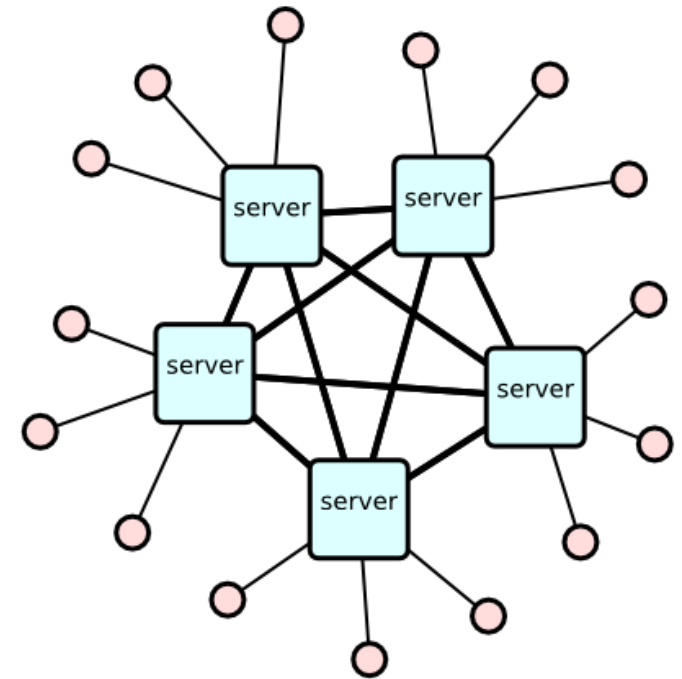
Hyperledger Fabric Core Components

- Transaction Flow
  1. An end user initiates a transaction.
  2. The network verifies the identity of the initiator using the appropriate Membership Service Provider.
     - Are you a valid user?
  3. The network verifies the identity of the initiator using public/private key cryptography.
     - Are you who you claim to be?
  4. The network verifies the user has permissions to perform the transaction.
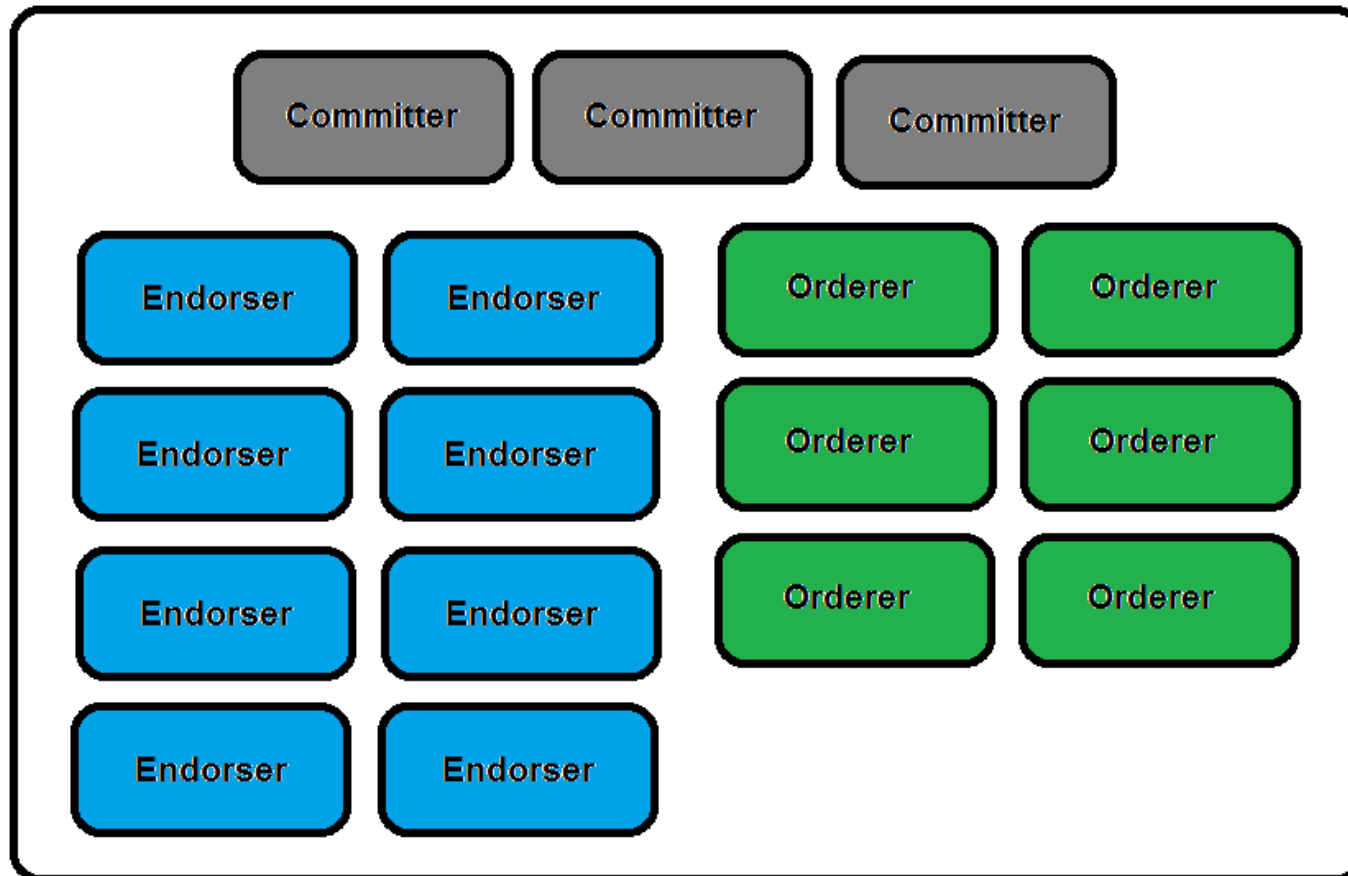
Hyperledger Fabric Core Components

- Transaction Flow
  5. The transaction is broadcast to all Endorsing nodes on the channel.
  6. Each Endorsing node executes Smart Contract code and returns their result to the client application.
  7. The client application checks to if consensus was reached by examining the returned results.
  8. The client application informs the Ordering Nodes that a new Transaction is to be recorded on the ledger.
  9. The Committing nodes (and the Endorsing nodes) record the transaction on their copy of the ledger.
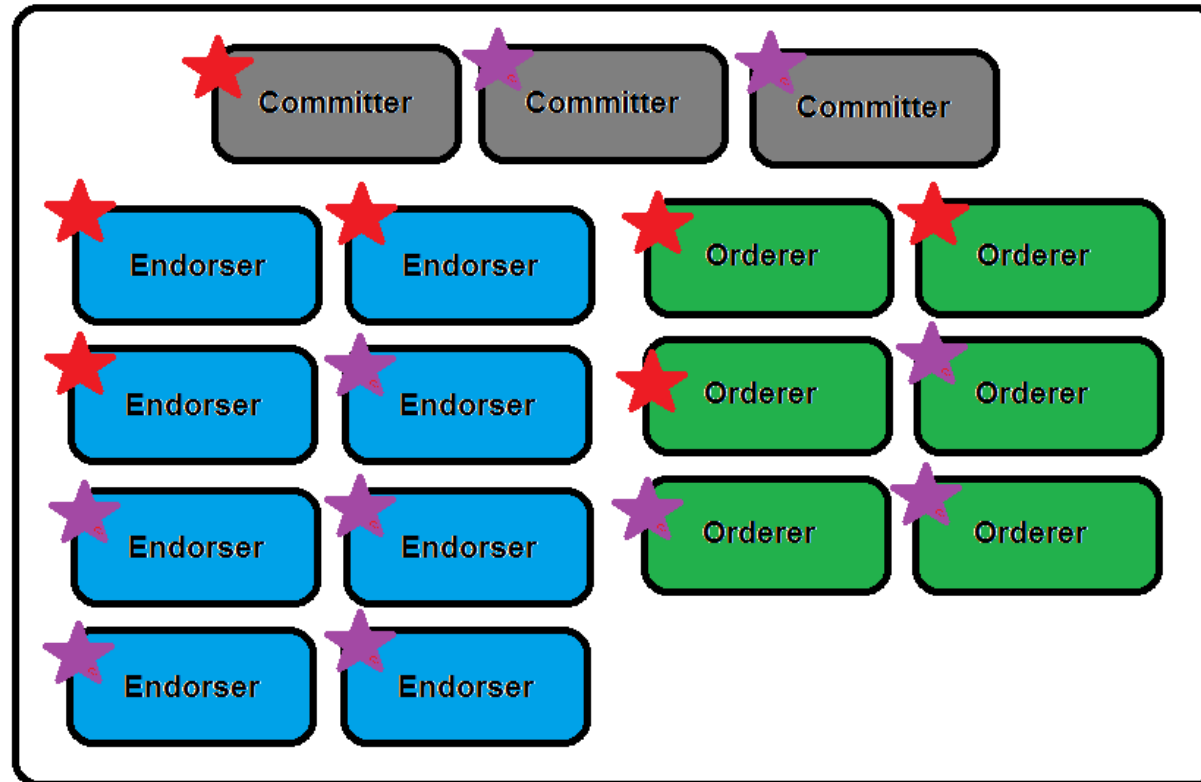
Hyperledger Fabric Core Components

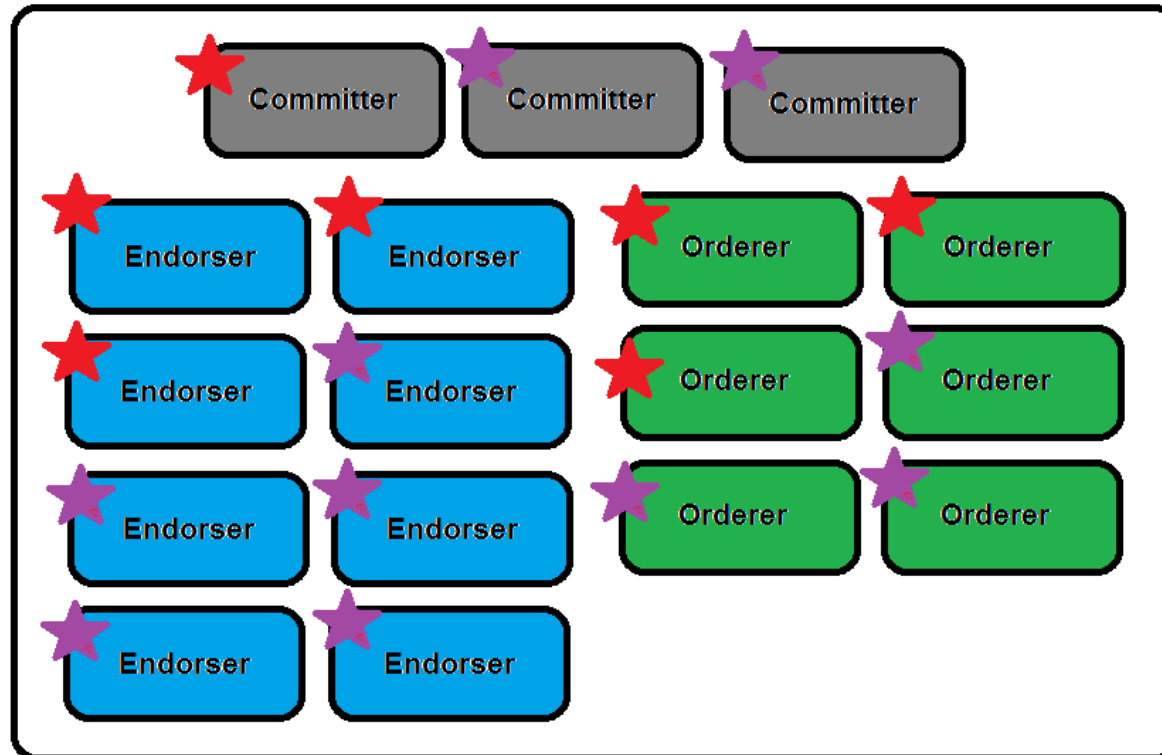A Sample Fabric Channel

Hyperledger Fabric Core Components

A Channel can have multiple owners

★ ALICE
★ BOB

Hyperledger Fabric Core Components

A Channel can be hosted many ways

Hyperledger Fabric Core Components

- ## What's New?
  - ### Fabric v1.4.1
  - ### RAFT Ordering Service
    - Faster, less energy intensive consensus and transaction ordering
  - ### The Operations Service
    - New services to monitor and manage network nodes
  - ### Enhanced support for Node.js and Java
  - ### Private Data Enhancements
    - Reconciliation
    - Client Access Control

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Hyperledger Fabric Core Components

- **What's Coming?**
  - Fabric v2.0 Alpha
    - NOT PRODUCTION!!
    - NO UPGRADE SUPPORT!!
  - Fabric Chaincode Lifecycle
    - Decentralized governance support:
      - Multiple organizations must agree to the parameters of a chaincode.
        - Endorsement Policy must be agreed upon before use.
      - Safer chaincode upgrade process.
        - Chaincode upgrade process only started after consensus reached.
      - Easier endorsement policy updates.
        - Change an endorsement policy without having to repackage or reinstall the chaincode.
      - Inspectable chaincode packages.
        - Chaincode packaged in easily to read files.
      - Start multiple chaincodes on a channel using one package.
        - Simplifies admin and maintenance

Hyperledger Fabric Core Components

- ## What's Coming?
  - ### FabToken
    - New token model and management system
    - Hyperledger Aries
      - *"A cryptographic wallet for secure storage…of cryptographic secrets and other information used to build blockchain clients."*
  - ### Alpine Linux
    - New container O/S, replaces Ubuntu Server
    - Security-focused O/S
    - Much lighter, smaller, faster

Hyperledger Fabric Use Cases

- How Do You Answer These 4 Questions? (y/n)
  1. Do I have one or more assets I want to track?
  2. Do I care about the evolution / lifecycle of an asset?
  3. Is the evolution / lifecycle of an asset governed by rules and well-defined processes?
  4. Am I the single voice of truth for questions about an asset?

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Hyperledger Fabric Use Cases

- How Do You Answer These 4 Questions? (y/n)
    1. Do I have one or more assets I want to track?
        - There's something I care about that I want to track. This thing can be physical or virtual. Bitcoin, digital music, food products, intellectual property, and usage of a service platform are all valid examples of an asset.

Hyperledger Fabric Use Cases

- How Do You Answer These 4 Questions? (y/n)
  2. Do I care about the evolution / lifecycle of an asset?
     - It is not enough for me to know the current state of an asset; it is important for me to be able to see the history of an asset and how it has evolved over time.

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Hyperledger Fabric Use Cases

- How Do You Answer These 4 Questions? (y/n)

  3. Is the evolution / lifecycle of an asset governed by rules and well-defined processes?

     - An asset in my business evolves over time according to rules and well-defined processes.

Hyperledger Fabric Use Cases

- ## How Do You Answer These 4 Questions? (y/n)

  4. Am I the single voice of truth for questions about an asset?

     - In most cases, as an asset evolves over time it passes through many hands. This means I am most likely but one of many custodians of an asset during certain parts of a larger, collectively-shared process.

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Hyperledger Fabric Use Cases

- A Good (potential) Fabric Use Case:
  1. Do I have one or more assets I want to track?
     - **YES**
  2. Do I care about the evolution / lifecycle of an asset?
     - **YES**
  3. Is the evolution / lifecycle of an asset governed by rules and well-defined processes?
     - **YES**
 4. Am I the single voice of truth for questions about an asset?
     - **NO**

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Hyperledger Fabric Use Cases

- Let's Review:

  1. Do I have one or more assets I want to track?

     - *There's something I care about that I want to track. This thing can be physical or virtual. Bitcoin, digital music, food products, intellectual property, and usage of a service platform are all valid examples of an asset.*

     - If **YES**, a shared immutable ledger of events affecting the assets you care about is likely of value.

     - If **NO**, you're likely trying to solve a business problem better suited to tools other than blockchain.

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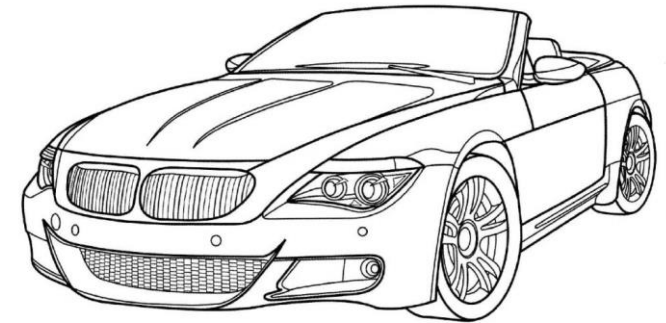
Hyperledger Fabric Use Cases

- Let's Review:

  2. Do I care about the evolution / lifecycle of an asset?

     - *It is not enough for me to know the current state of an asset; it is important for me to be able to see the history of an asset and how it has evolved over time.*

     - If **YES**, the permanent append-only ledger providing full version history of all assets and their related properties will likely be of significant value.

     - If **NO**, a database is likely a suitable data storage component.

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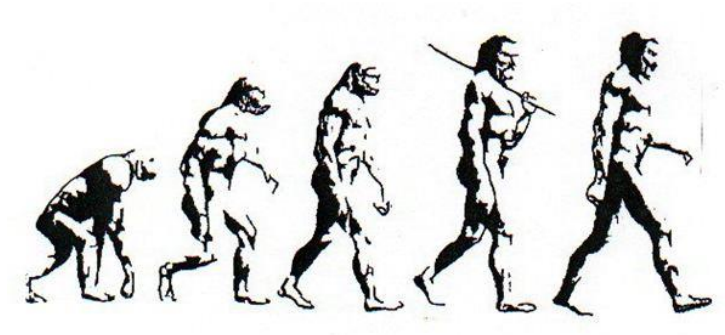
Hyperledger Fabric Use Cases

- Let's Review:
  3. Is the evolution / lifecycle of an asset governed by rules and well-defined processes?
     - *An asset in my business evolves over time according to rules and well-defined processes.*
     - If **YES**, Smart Contracts and the ability to automate business processes according to clearly defined rules will likely add significant value.
     - If **NO**, you're likely just looking to capture data rather than act on it. Technologies such as IPFS or no-SQL database platforms might provide greater value.

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Hyperledger Fabric Use Cases

- Let's Review:

    4. Am I the single voice of truth for questions about an asset?

        - *In most cases, as an asset evolves over time it passes through many hands. This means I am most likely but one of many custodians of an asset during certain parts of a larger, collectively-shared process.*

        - If **NO**, a centralized system acting as a single source of truth is likely not an ideal fit. A decentralized authoritative system which is shared and collectively managed by all members of a business network is likely a much better fit.

        - If **YES**, a database or other centralized authoritative system is likely acceptable as your organization is already the single voice of authority for questions around this particular asset.

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Hyperledger Fabric Use Cases

- Good Use Case Patterns:
  - Do not replace legacy systems, enhance them!
    - Find a system that works and already adds value, then layer Blockchain on top of it.
    - What opportunities or business capabilities open up when I can connect legacy systems to a larger ecosystem?

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Hyperledger Fabric Use Cases

- Good Use Case Patterns:
    - Databases are designed for rapidly storing and retrieving large volumes of data.
    - Blockchain is a designed as a transaction processing and logging engine.
    - All else being equal, keep your data in a database and use Blockchain to tell you *what happened* to your data.

Hyperledger Fabric Use Cases

- Good Use Case Patterns:
  - But I need decentralized content storage too!
    - IPFS.io
      - Protocol, can be used in internet / intranet fashion
    - Storj.io

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Hyperledger Fabric Use Cases

- Good Use Case Patterns:
  - Persisting state across applications is difficult.
    - Distributed databases give often give no guarantee that ALL transactions will be processed.
    - This problem becomes even more difficult when applications / systems are owned by different participants.
      - How do I safely, accurately, and quickly communicate changes to the state of a business object from my CRM system to your ERP system?

Hyperledger Fabric Use Cases

- Good Use Case Patterns:
  - A common, shared, secure, immutable ledger is a great place to store state data for business objects!
  - Integrate systems across organizational boundaries.

Hyperledger Fabric Use Cases

Report: Blockchain Deployment Could Add $3 Trillion in International Trade by 2030

9143 Total views   336 Total shares   Listen to article   2:58
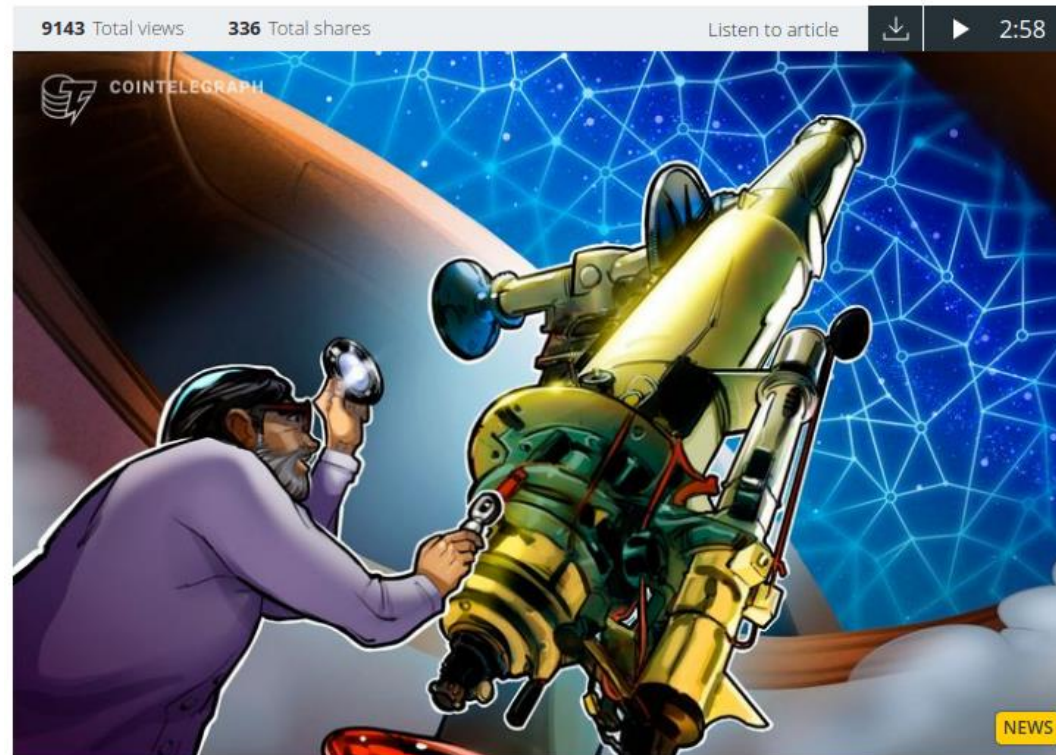
The World Trade Organization (WTO) released a report on blockchain technology's effect on international trade today, Nov. 27. Per the study, blockchain's economic value-add on a global scale could reach almost $3 trillion by 2030.

Hyperledger Fabric Use Cases

Hyperledger Fabric Use Cases

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IBM & Walmart Launching Blockchain Food Safety Alliance In China With Fortune 500's JD.com

Roger Aitken Contributor ⓘ

In further move to apply Blockchain technology for food traceability to support offline and online consumers, IBM, Walmart and Nasdaq-listed Chinese retailer JD.com together with Tsinghua University National Engineering Laboratory for E-Commerce Technologies have announced a

Hyperledger Fabric Use Cases

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Maersk and IBM Introduce TradeLens Blockchain Shipping Solution
Industry-wide collaboration announced in January advances as more than 90 organizations participate in the global trade solution. More than 154 million events captured on the platform and growing by one million per day.

COPENHAGEN, Denmark and ARMONK, N.Y., Aug. 9, 2018 /PRNewswire/ -- In a follow up to their January announcement, A.P. Moller –Maersk (MAERSKb.CO) and IBM (NYSE: IBM) today announced the creation of TradeLens, jointly developed by the two companies to apply blockchain to the world's global supply chain. TradeLens is the result of a collaboration agreement between Maersk and IBM, a blockchain-enabled shipping solution designed to promote more efficient and secure global trade, bringing together various parties to support information sharing and transparency, and spur industry-wide innovation.

As part of the TradeLens early adopter program, IBM and Maersk also announced that 94 organizations are actively involved or have agreed to participate on the TradeLens platform built on open standards. The TradeLens ecosystem currently includes:

- More than 20 port and terminal operators across the globe, including PSA Singapore, International Container Terminal Services Inc, Patrick Terminals, Modern Terminals in Hong Kong, Port of Halifax, Port of Rotterdam, Port of Bilbao, PortConnect, PortBase, and terminal operators Holt Logistics at the Port of Philadelphia, join the global APM Terminals' network in piloting the solution. This accounts for approximately 234 marine gateways worldwide that have or will be actively participating on TradeLens.

- Pacific International Lines (PIL) have joined Maersk Line and Hamburg Süd as global container carriers participating in the solution.

- Customs authorities in the Netherlands, Saudi Arabia, Singapore, Australia and Peru are participating, along with customs brokers Ransa and Güler & Dinamik.

- Participation among beneficial cargo owners (BCOs) has grown to include Torre Blanca / Camposol and Umit Bisiklet.

- Freight forwarders, transportation and logistics companies including Agility, CEVA Logistics, DAMCO, Kotahi, PLH Trucking Company, Ancotrans and WorldWide Alliance are also currently participating.

Hyperledger Fabric Use Cases

Mercedes-Benz Parent Company Launches a $110 Million Blockchain Pilot

🕒 June 28, 2017 3:47 pm

Daimler, one of the world's biggest car manufacturer and the parent company of Mercedes-Benz with some $175 billion yearly revenue, announced today the launch of a $110 million blockchain pilot.

"The entire transaction — from the origination, distribution, allocation and execution of the loan agreement to the confirmation of repayment and of interest payments — was digitally carried out via blockchain technology in cooperation with the IT subsidiaries TSS (Daimler) and Targens (LBBW)," a press release said.

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FedEx CIO Rob Carter, middle, and FedEx CEO Frederick Smith, right, talk with Don Tapscott at the Consensus 2018 conference in New York City, May 15, 2018. PHOTO: STEVEN NORTON / THE WALL STREET JOURNAL

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Air France KLM is Evaluating MRO Potential for Blockchain

By **Woodrow Bellamy III** | October 3, 2017
Send Feedback | @WBellamyIIIAC

Blockchain, MRO

Photo courtesy of Air France KLM

Air France KLM's engineering and maintenance division is evaluating the potential for blockchain to become its new digital ledger for managing replacement parts on in-service airplanes. During a recent webinar, the airline's MRO division joined Microsoft and Ramco Aviation to discuss their research into future uses of blockchain in aircraft maintenance.

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Singapore Airlines' Blockchain-Based Loyalty Program Takes Off

Anna Baydakova ✉ 🐦 🔊
🕐 Jul 25, 2018 at 00:00 UTC

NEWS

Singapore Airlines has officially launched its blockchain-based loyalty program for frequent customers.

KrisPay, a digital wallet developed in partnership with KPMG and Microsoft, allows Singapore Airlines customers to turn travel miles into units of payment, which can be used with partner merchants in

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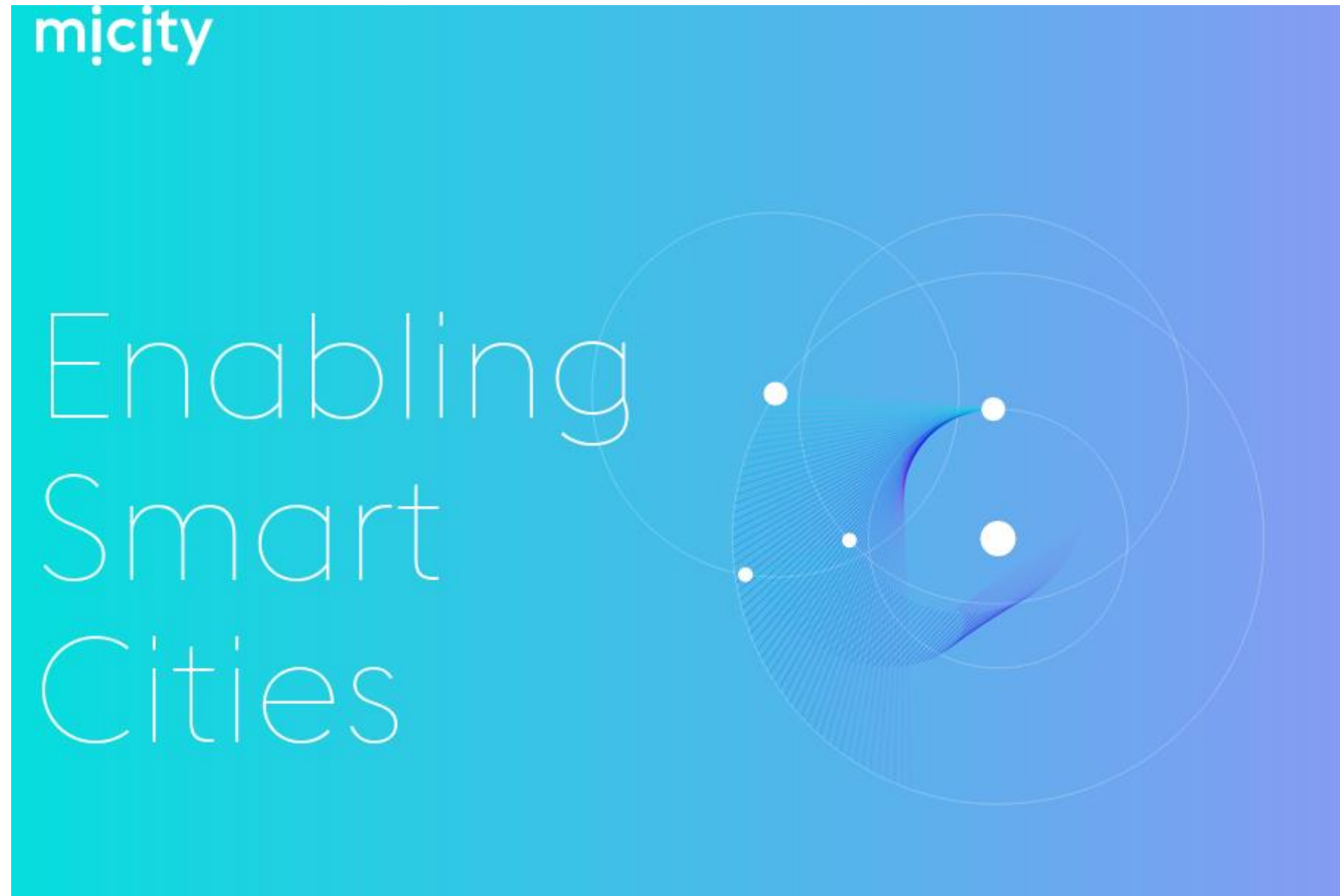
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Riyadh Municipality selects IBM for blockchain integration

IBM and Elm will develop blockchain solutions for Riyadh Municipality

Tags: Blockchain, Elm (www.elm.sa), IBM (www.ibm.com), Saudi Arabia

PRINT   E-MAIL   TEXT SIZE

By Mark Sutton
Published July 11, 2018

Riyadh Municipality has selected IBM as its strategic partner for the integration of blockchain technology.

IBM will work closely with Elm Company, the municipality's technology partner, to develop an implementation strategy to facilitate government services and transactions on blockchain.

IBM and Elm will collaborate on blockchain strategy and solutions for the Municipality.

The deployment of blockchain is
intended to serve customers digitally, and to support the transformational objectives of the Saudi Vision 2030.

BLOCKCHAIN TRAINING ALLIANCE

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Kerrygold faces US lawsuit over 'grass-fed cows' claim

Class-action suit filed in California alleges 'false advertising' by firm

Thu, Jul 26, 2018, 01:07

Mark Paul

Made with milk from grass-fed cows

Kerrygold is the second-best-selling butter brand in the US, where it grew 21% last year.

Kerrygold, Ireland's best-known global food brand, is facing a class-action lawsuit in the United States over its marketing claim that Irish dairy cows whose milk makes the butter are fed on grass.

A San Diego-based real-estate executive has filed the case in California against Ornua, formerly the Irish Dairy Board, the co-operative that owns the brand.

A closing thought...

In a few more weeks the world will mark the 500th anniversary of the death of Leonardo Da Vinci.

One of the powerful lasting figures of the Renaissance his cross-disciplinary genius gave us art, architecture and invention. Da Vinci was uniquely gifted and positioned in history to be present at a time when people's thinking around life moved from something that had to be short and brutish toward something that could be enjoyable.

The Renaissance was a time of education and study when people attempted to improve the world through the power of ideas. I do not think I am being too bold when I say that we are in such a time again. A boldness to innovate is at the center of the technology revolutions of big data, DLT and AI.

-- J. Christopher Giancarlo
      Chairman, U.S. Commodity Futures Trading Commission