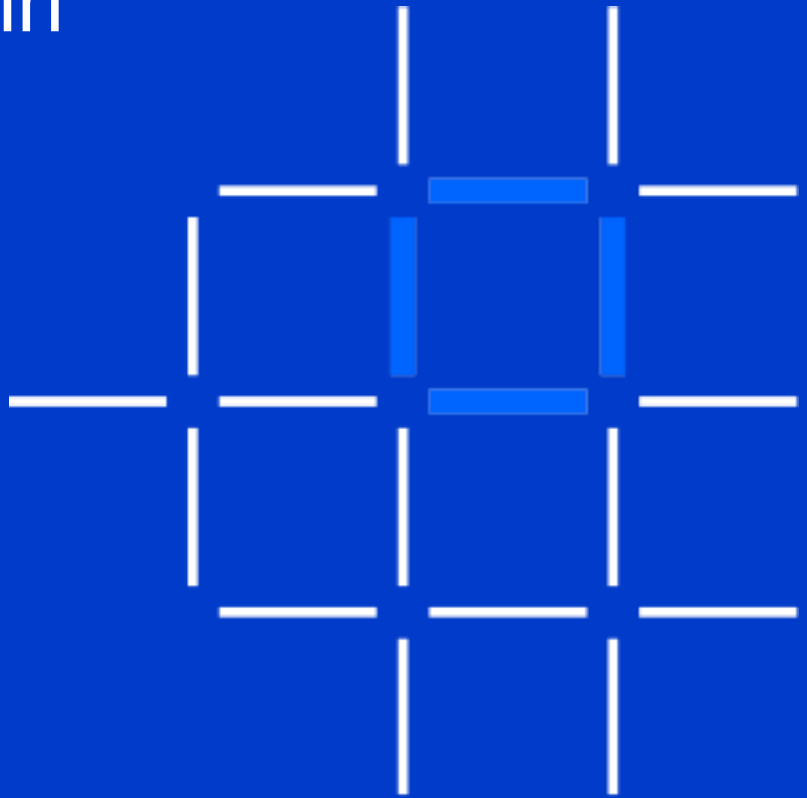
Create and Deploy a Blockchain App with the IBM Blockchain Platform - Demo



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San Francisco
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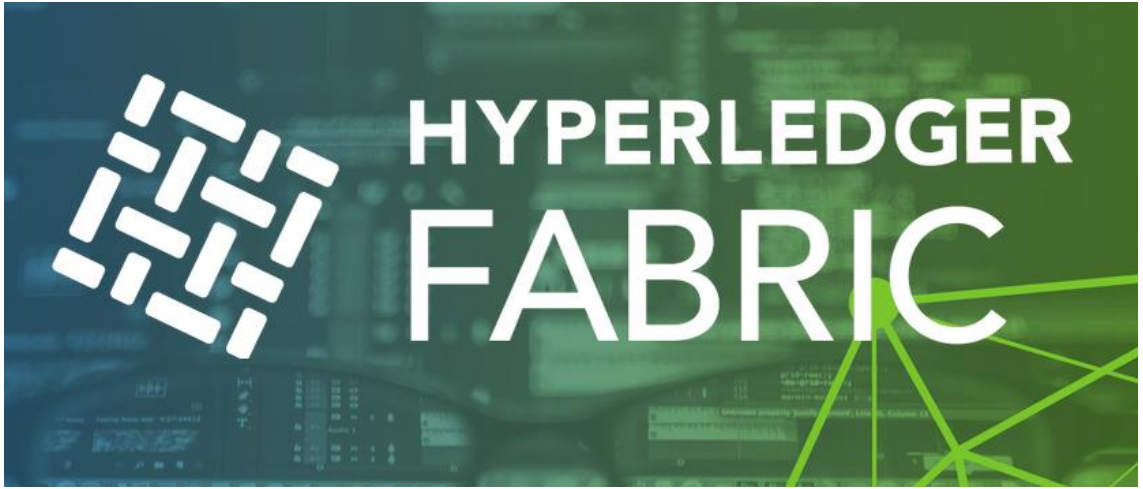
V1 26 April 2018

IBM **Blockchain**

IBM

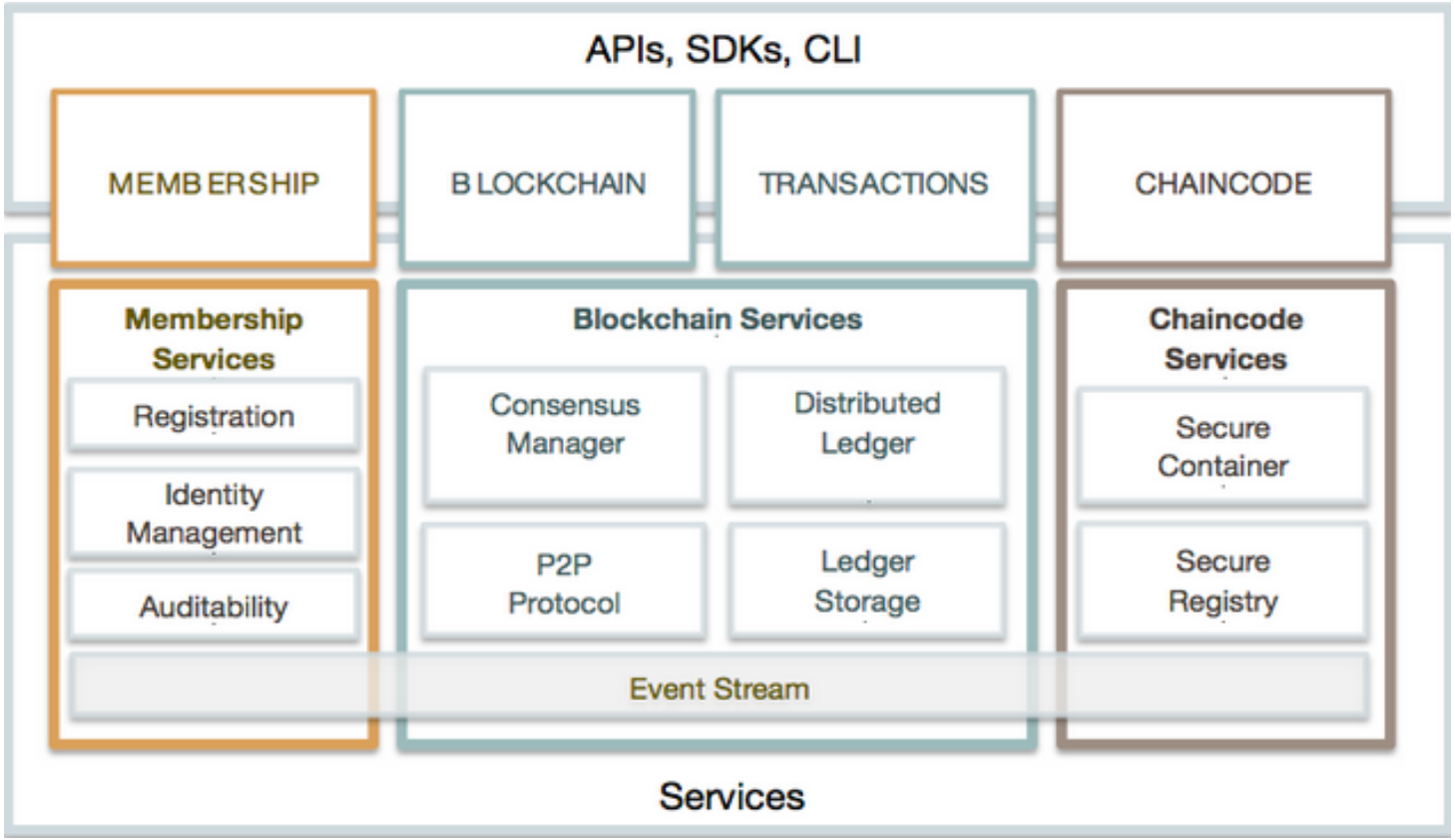


THE LINUX FOUNDATION

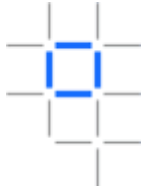
- Hyperledger Fabric is an **open source blockchain framework implementation** hosted by The Linux Foundation.
- Hyperledger Fabric allows components, such as consensus and membership services, to be **plug-and-play**.
- Hyperledger Fabric leverages **container technology** (Docker) to host **smart contracts called "chaincode"** that comprise the application logic of the system.
- Chaincode is like Stored Procedures in the traditional database world.

https://www.hyperledger.org/projects/fabric
https://github.com/hyperledger/fabric
https://hyperledger-fabric.readthedocs.io/en/release-1.1/

Hyperledger Fabric Overview



A Blockchain is:

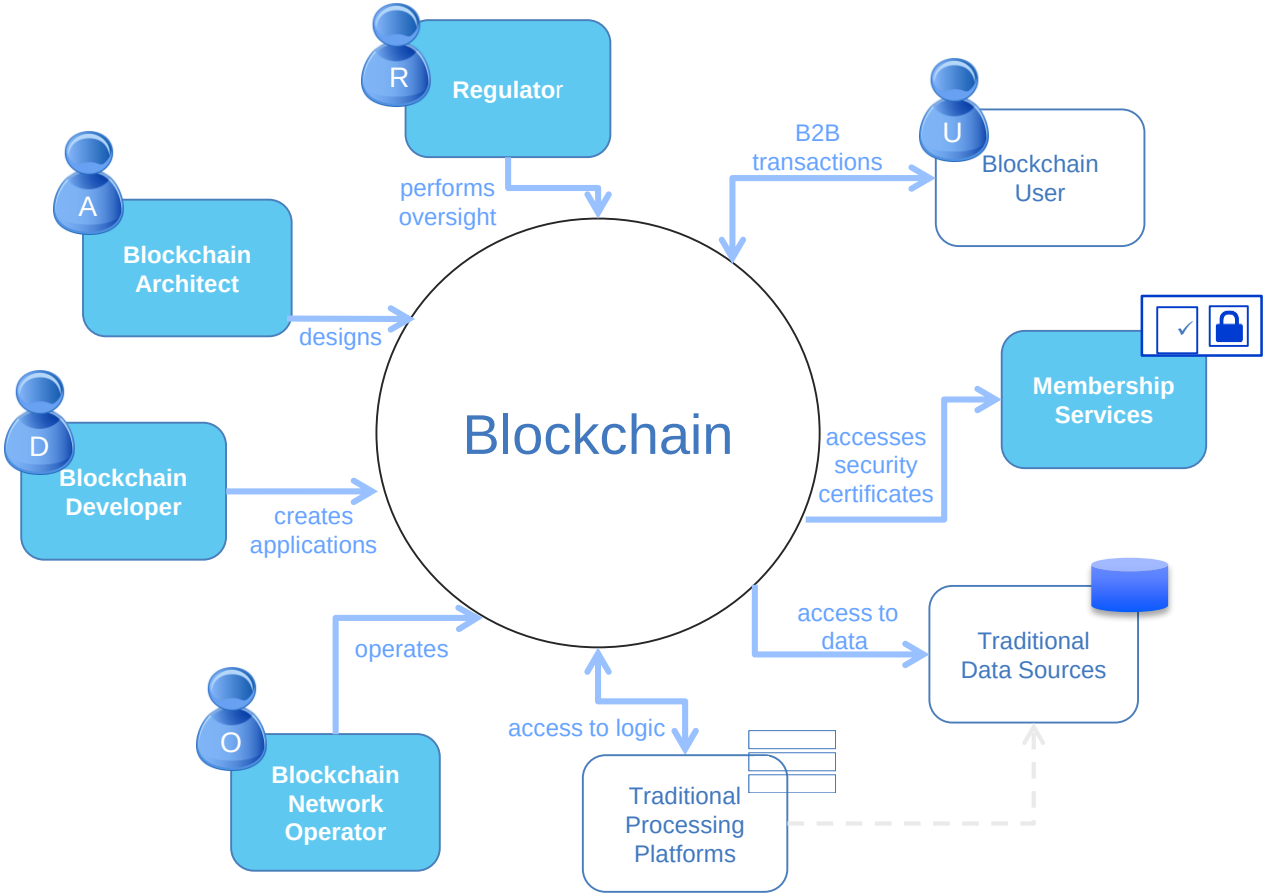


- A **decentralized virtual ledger** for recording transactions **without central authority** through a **distributed cryptographic protocol**.

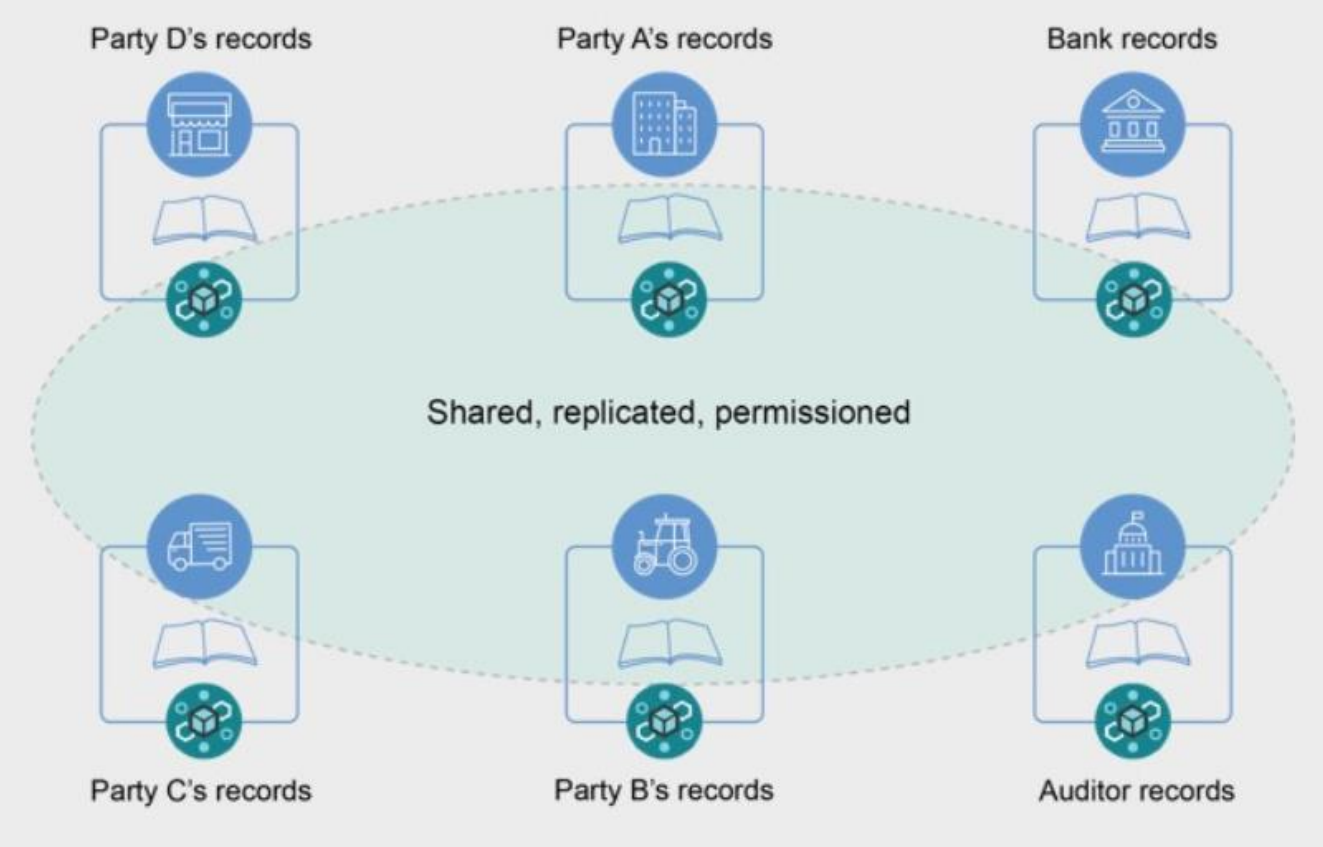
- It is made up of three technologies
  - cryptographic algorithms,
  - a distributed protocol, (gRPC)
  - and replicated data which combined provide a trustworthy service to a group of nodes that do not fully trust each other.

- Source: https://www.zurich.ibm.com/dccl/papers/cachin_dccl.pdf

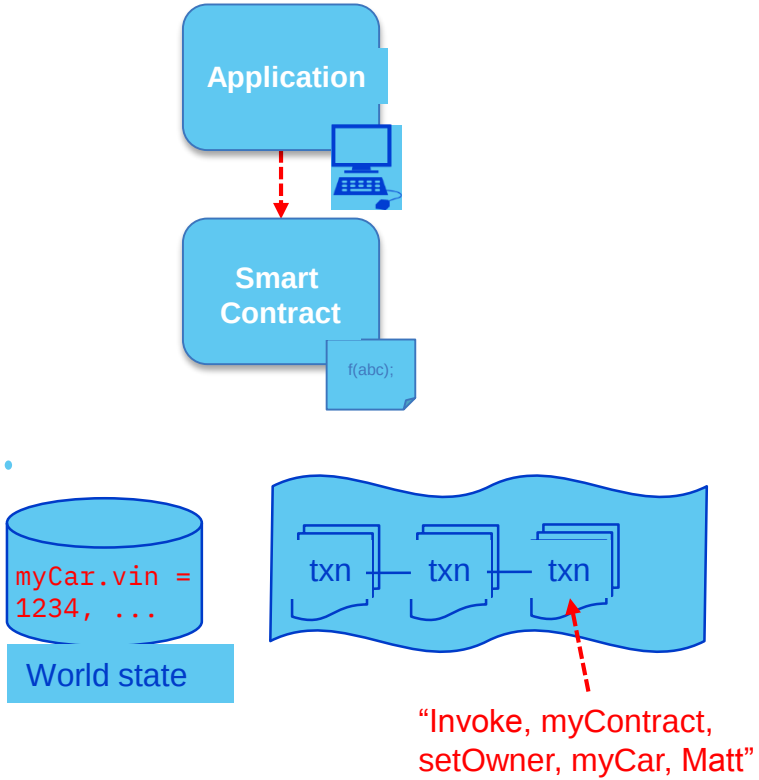
Actors in a Blockchain solution



The shared Ledger



Working with the ledger example: a change of ownership transaction



Transaction input - sent from application

```
invoke(myContract, setOwner,
       myCar, Matt)
…
```

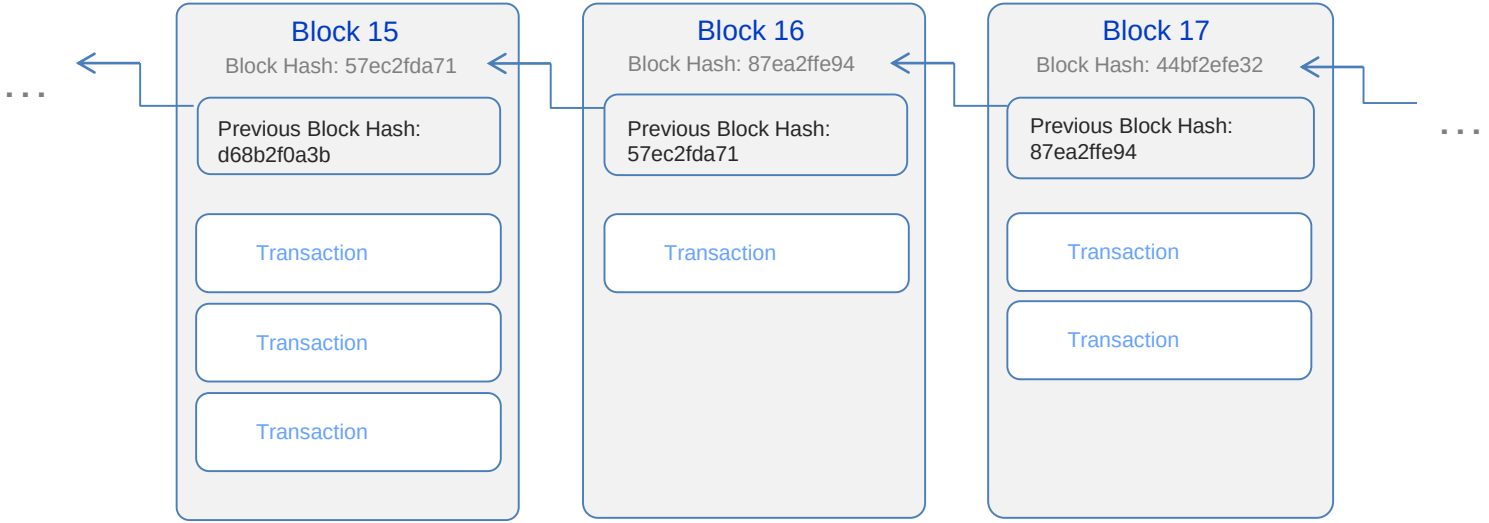
Smart contract implementation

```
setOwner(Car, newOwner) {
   set Car.owner = newOwner
}
```

World state: new contents

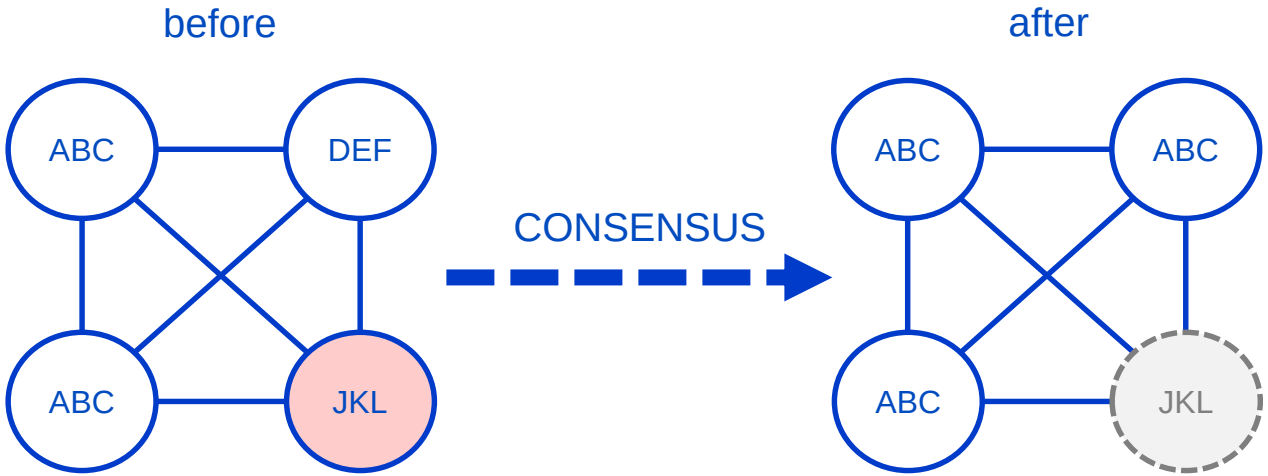
```
myCar.vin = 1234
myCar.owner = Matt
myCar.make = Audi
…
```

Block detail (simplified)



- A blockchain is made up of a series of blocks with new blocks always added to the end
- Each block contains zero or more transactions and some additional metadata
- Blocks achieve immutability by including the result of a hash function of the previous block
- The first block is known as the “genesis” block

Consensus: The process of maintaining a consistent ledger



peer

LEDGE
R

Keep all peers up-to-date
Fix any peers in error
Ignoring all malicious nodes

Some examples of consensus algorithms

Proof of work

Proof of stake

Solo /
No-ops

Kafka /
Zookeeper

Proof of
Elapsed Time

PBFT
based

Practical Byzantine Fault Tolerance

Consensus algorithms have different strengths and weaknesses

Proof of work

Require validators to solve difficult cryptographic puzzles
PROs: Works in untrusted networks
CONS: Relies on energy use; slow to confirm transactions
Example usage: Bitcoin, Ethereum

Proof of stake

Require validators to hold currency in escrow
PROs: Works in untrusted networks
CONS: Requires intrinsic (crypto)currency, ”Nothing at stake” problem
Example usage: Nxt

Proof of Elapsed Time

Wait time in a trusted execution environment randomizes block generation
PROs: Efficient
CONS: Requires processor extensions
Example usage: Hyperledger Sawtooth

Consensus algorithms have different strengths and weaknesses

Solo / No-ops

Validators apply received transactions without consensus
PROs: Very quick; suited to development
CONS: No consensus; can lead to divergent chains
Example usage: Hyperledger Fabric V1

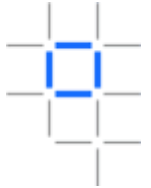
PBFT-based

Practical Byzantine Fault Tolerance implementations
PROs: Reasonably efficient and tolerant against malicious peers
CONS: Validators are known and totally connected
Example usage: Hyperledger Fabric V0.6

Kafka / Zookeeper

Ordering service distributes blocks to peers
PROs: Efficient and fault tolerant
CONS: Does not guard against malicious activity
Example usage: Hyperledger Fabric V1

Security: Encryption and Signing

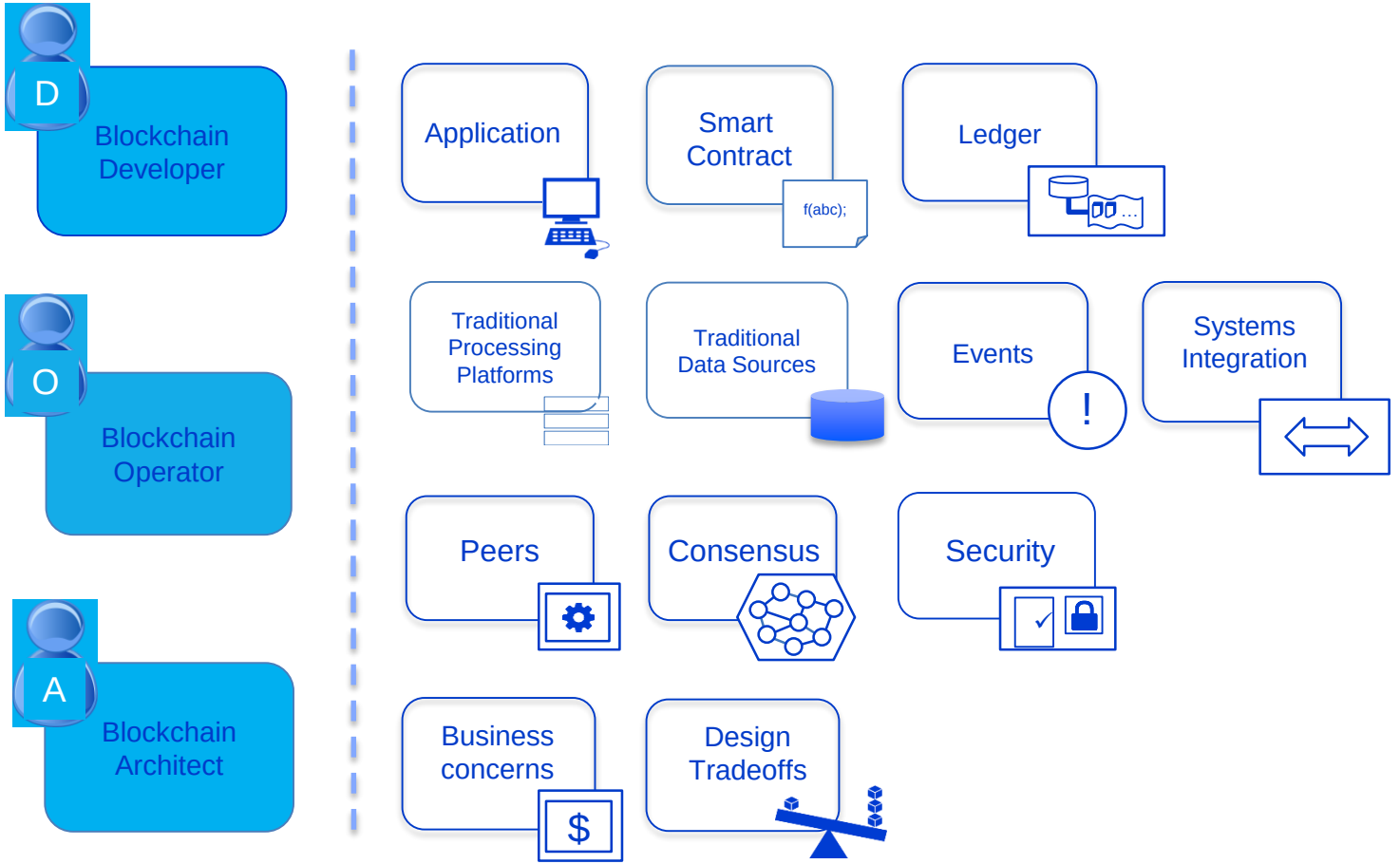


- Cryptography basics
  - Every member of the network has (at least) one public key and one private key
  - Assume that every member of the network knows all public keys and only their own private keys
  - Encryption is the process applying a transformation function to data such that it can only be decrypted by the other key in the public/private key pair
  - Users can sign data with a private key; others can verify that it was signed by that user

- For example
  - Alice can sign a transaction with her private key such that anyone can verify it came from her
  - Anyone can encrypt a transaction with Bob's public key; only Bob's private key can decrypt it

- In private, permissioned blockchains
  - **Transactions and smart contracts can be signed to verify where they originated**
  - **Transactions and their payloads can be encrypted such that only authorized participants can decrypt**

Summary of Key Concepts

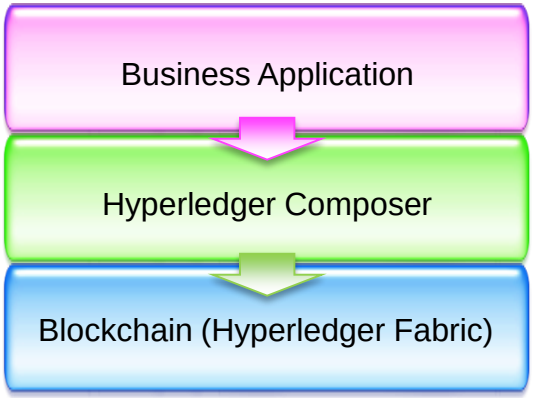


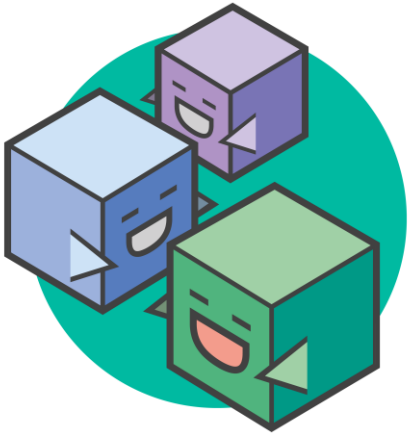
https://www.hyperledger.org/projects/composer

Hyperledger Composer: Accelerating time to value

https://hyperledger.github.io/composer/

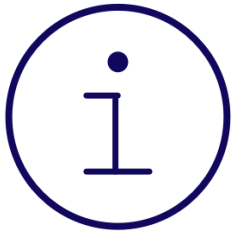
- A suite of high level application **abstractions** for business networks
- Emphasis on business-centric vocabulary for quick solution creation
- Reduce risk, and increase understanding and flexibility





- Features
  - Model your business networks, test and expose via APIs
  - Applications invoke APIs transactions to interact with business network
  - Integrate existing systems of record using loopback/REST
- Fully open and part of Linux Foundation Hyperledger
- Try it in your web browser now: http://composer-playground.mybluemix.net/

Benefits of Hyperledger Composer



Increases understanding

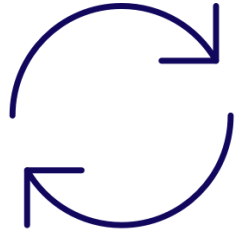
Bridges simply from business concepts to blockchain

Saves time

Develop blockchain applications more quickly and cheaply

Reduces risk

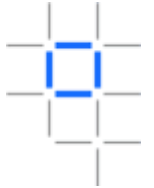
Well tested, efficient design conforms to best practice

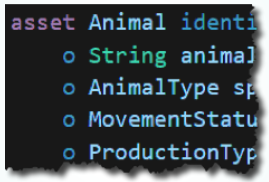


Increases flexibility

Higher level abstraction makes it easier to iterate

Extensive, Familiar, Open Development Toolset





Data modelling

JavaScript business logic

Web playground

Client libraries

Editor support

CLI utilities

Code generation

Existing systems and data

What is Hyperledger Composer?

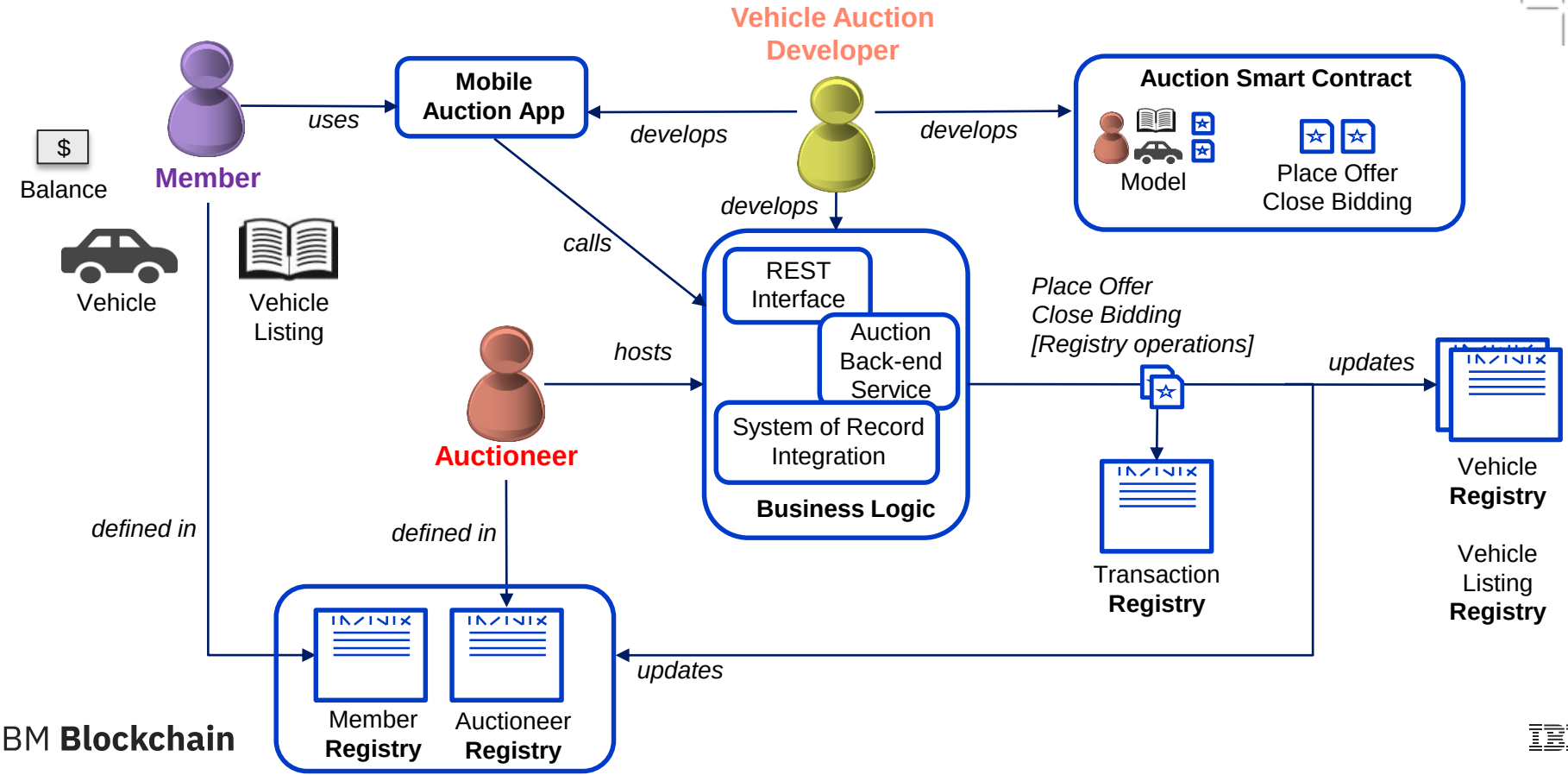
Application Development

Writing the application
Modeling the business network

Effective Administration

Deploying to a blockchain
Interacting with systems of record

Key Concepts for a Vehicle Auction Developer



Deploy at IBM Blockchain Platform in the IBM Cloud

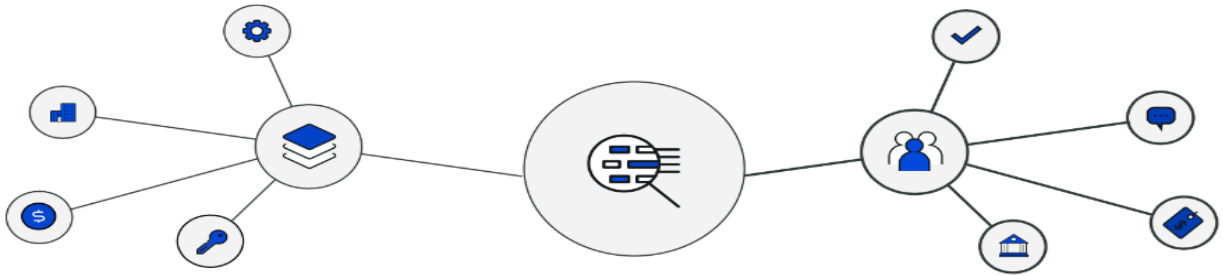
IBM Blockchain Starter Plan Beta

Blockchain /

Blockchain-BostonWed

Location: US South **Org:** Developer Advocacy **Space:** dev

Welcome back, alf



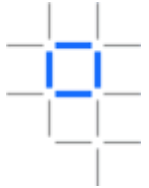
Use the Network Monitor to view and add network nodes, create channels, install chaincode applications, and test confidential transactions.

Enter Monitor

IBM

IBM

Overview



Overview

View and manage network resources for your organization. You can stop or start your resources and view the log file of the resource by selecting View Logs under "Actions". Learn more

Connection Profile

TYPE	NAME	STATUS
Orderer	orderer	Running
CA	org1-ca	Running
Peer	org1-peer1	Running

Members

View and manage the members (organizations) of the network on the Members tab. You can invite other organizations to the network or add more organizations in addition to the two organizations that you own by default. You can also view and manage admin certificates that are associated to your organizations on the Certificates tab. **Learn more**

Members **Certificates**

Add Member

MEMBERS (2/16)	MSP ID	REQUESTER	STATUS	ACTION
Company A alf@us.ibm.com	org1	--	Joined	
Company B alf@us.ibm.com	org2	--	Joined	

Channels

You must have a channel to propose a transaction. If you're not a member of any channels, you can create one by clicking "Request Channel". Learn more

Search Channels

Request Channel

ID	TIME CREATED	BLOCK HEIGHT	PEERS	ACTIONS
defaultchannel	04/18/18 10:39 PDT	23	org1-peer1	⋮

* Channels created with the SDK cannot be edited here (yet)

APIs

Interact with the network by using APIs in the Swagger UI. You can also use the network credentials and integrate the APIs to your own application. Learn more

API reference list

Use the Swagger UI to try out the available catalog of REST APIs against the network.

Swagger UI

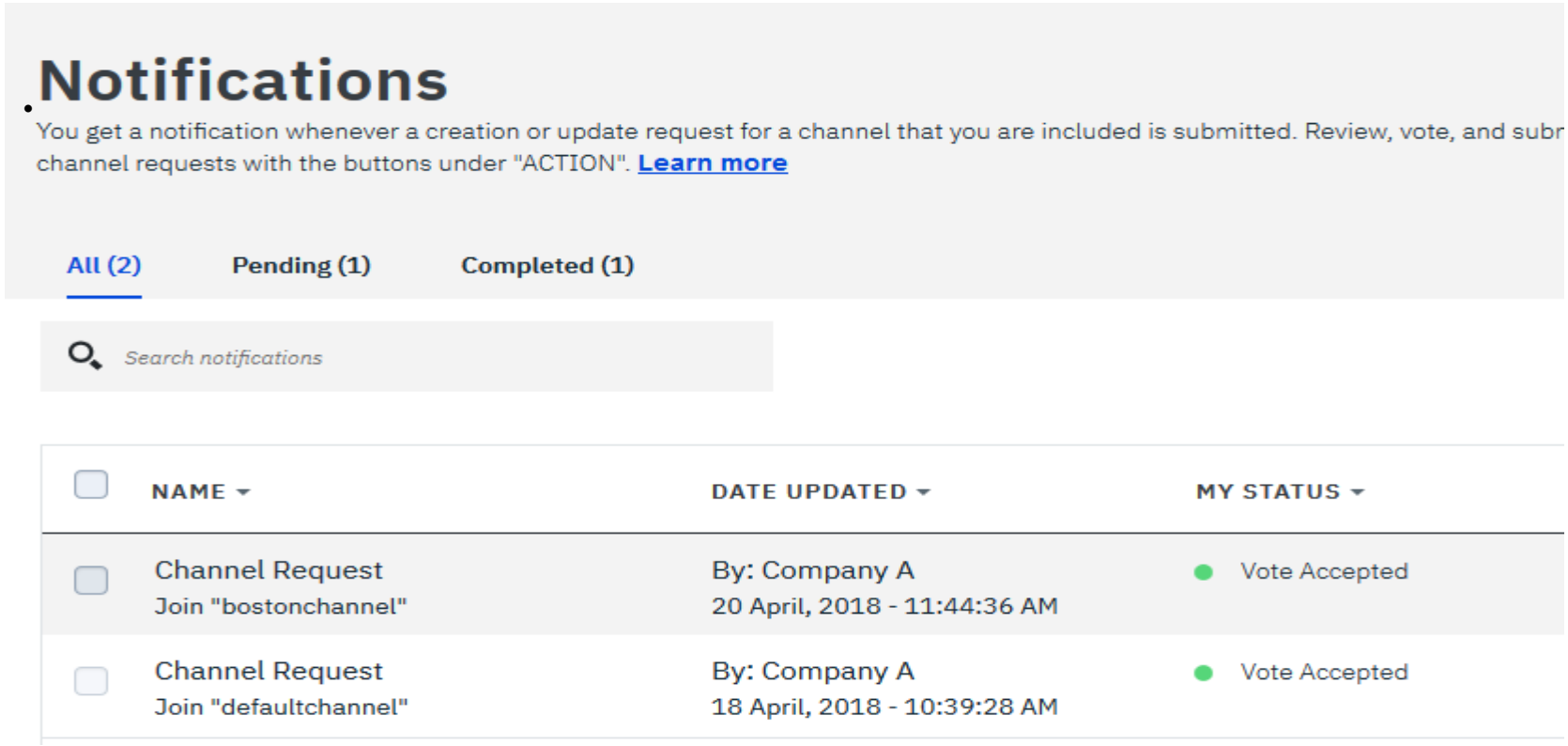
Network credentials

Use these network credentials to access the resource endpoints that your application needs to. Use "key" as your "Username" and "secret" as your "Password" when you authorize your APIs in the Swagger UI.


```
{
  "url": "https://ibmblockchain-starter.ng.bluemix.net",
  "network_id": "nabbe2cb650394e3794e233bd1b5153c3",
  "key": "org1",
  "secret":
}
```


Show secret

Notifications



Write code

You can develop your blockchain use case with IBM Blockchain Platform development environment, and then deploy the use case back to this network. **Learn more.**

Develop code

The IBM Blockchain Platform provides a free development environment based on industry standard tools and technologies (Hyperledger Composer, Javascript, Docker, Yeoman, and more) that you can use to model and code a ready-to-deploy use case.

You can trial this environment online or install it on your local machine. Learn more and download the tools at our website.

Visit website

Deploy code

After you create your blockchain use case, you can deploy it to this network in the cloud platform following the Deployment Guide.

Deployment guide

Install code

Chaincode must be installed on a peer. Select a peer and then install a chaincode on it. After you install the chaincode, you can request to instantiate it on a channel by clicking the Instantiate button under "Actions" for that chaincode. Clicking elsewhere on the chaincode will show you what channels the chaincode is instantiated on. Learn more. Do you already have a .bna file to deploy? See our deployment guide.

Choose peer...

Install Chaincode

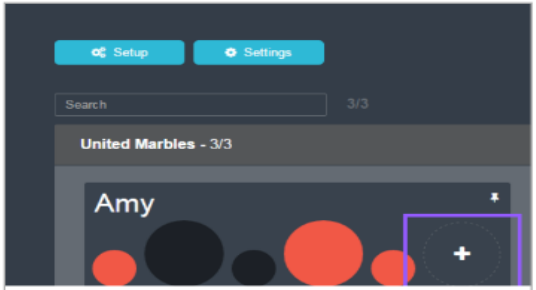
CODE ID	VERSION	ACTIONS
marbles_sample	3a30a0df1829	

Try samples

Sample applications provide you a better understanding of blockchain networks. You can also develop your own apps by installing our developer tools. This sample deployment approach leverages IBM Cloud Toolchains and helps to deploy sample applications, including chaincode, front-end apps, and a dev-ops pipeline in a single step. **Learn more**

Cloud Toolchain. Each sample deployment comes with source control, deployment pipeline, and the "chaincode" running on your blockchain network.

After you deploy the sample, any changes you push to the source control are automatically deployed to your Blockchain Platform service via the deployment pipeline.



Marbles

Deployed on 04/20/18

Toolchain Management

Remove

Launch

Vehicle Manufacture

- Track a new car from order to delivery
- Composer model and javaScript
- Angular web app

Deploy via Toolchain

View on GitHub

Build Proposal

The invocation needs to be signed and packaged as a proposal. This is done here, in the Marbles application.

Endorsement

Next, we send the transaction proposal to our peer for endorsement. The peer will simulate the transaction, verify the proposal, and then sign the proposal. It is then sent back to Marbles.

Ordering

Then Marbles will send our endorsed proposal to the orderer. The orderer will sequence transactions from throughout the network including ours.

Validate & Commit

The block containing our transaction is sent from the orderer to our peer. Finally it is validated by the peer and then committed to the peer's ledger.

* Note the speed of this process is slowed down for demonstration purposes

Invoke Complete

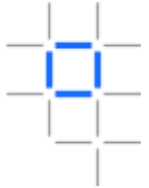
Close

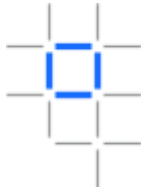
Support

Get help with your blockchain network. Learn more

Support | Release Notes

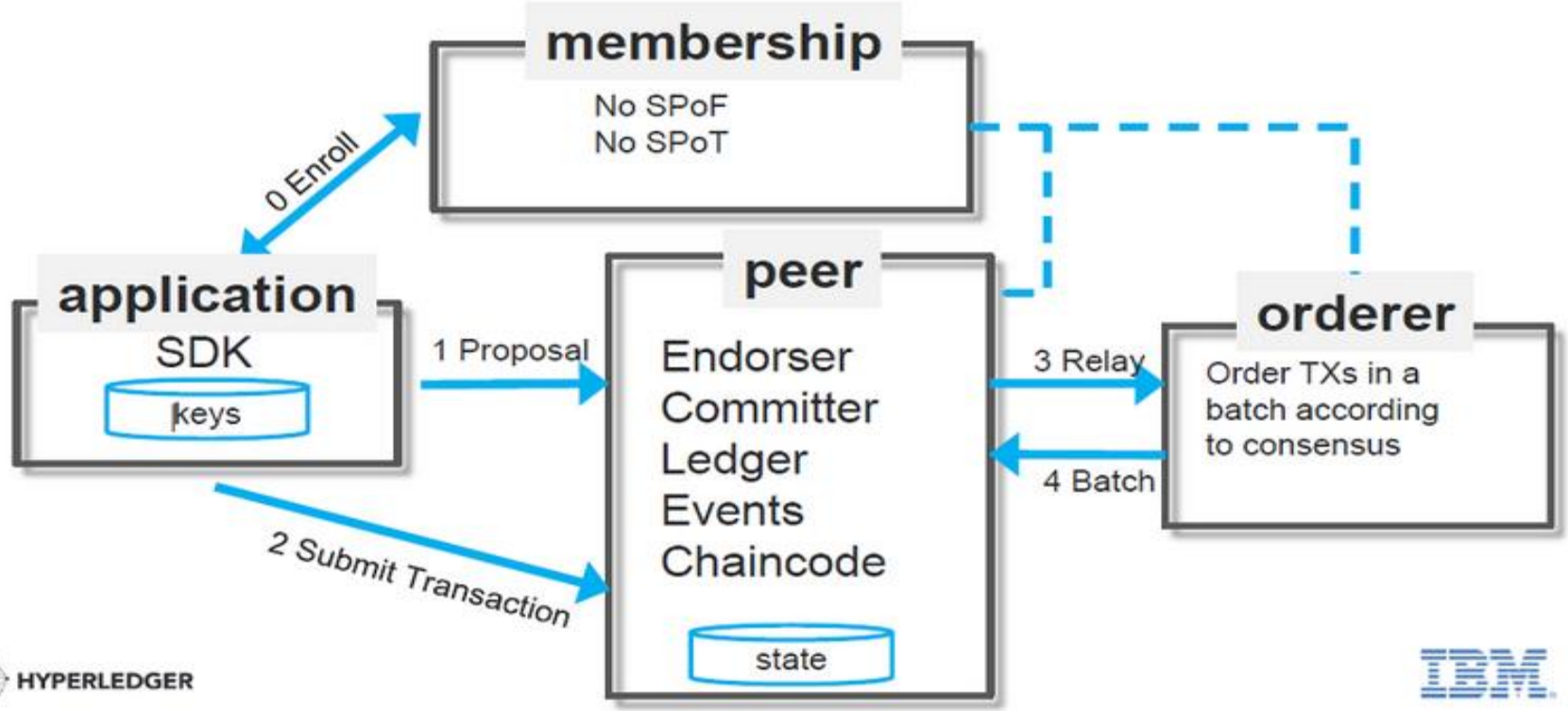
- GETTING STARTED
- COMMUNITY HELP
- SUPPORT TICKET
- BLOCKCHAIN SAMPLE APPLICATIONS
- HYPERLEDGER FABRIC
- HYPERLEDGER COMPOSER





Appendix

Fabric v1.0 Architecture



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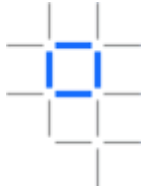
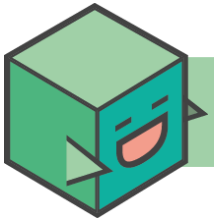


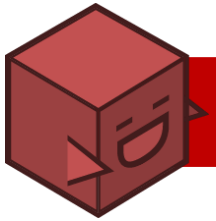
- A distributed ledger is a type of database that is **shared, replicated, and synchronized** among the members of a network.
- The distributed ledger **records the transactions, such as the exchange of assets or data, among the participants in the network**.
- Participants in the network **govern and agree by consensus** on the updates to the records in the ledger.
- **No central, third-party mediator, such as a financial institution or clearinghouse**, is involved.
- Every record in the distributed ledger has a timestamp and **unique cryptographic signature**, thus making the ledger an auditable history of all transactions in the network.

The Business Service Provider develops three components



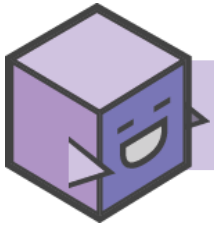
Smart Contracts

- Implements the logic deployed to the blockchain
  - **Models** describe assets, participants & transactions
  - **Transaction processors** provide the JavaScript implementation of transactions
  - **ACLs** define privacy rules
  - May also define events and registry queries



Business Logic

- **Services** that interact with the registries
  - Create, delete, update, query and invoke smart contracts
  - Implemented inside business applications, integration logic and REST services
- Hosted by the Business Application Consumer



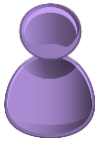
Presentation Logic

- Provides the **front-end** for the end-user
  - May be several of these applications
- Interacts with business logic via standard interfaces (e.g. REST)
- Composer can generate the REST interface from model and a sample application

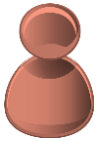
Assets, Participants and Transactions

Vehicle

Vehicle Listing



Member



Auctioneer

Place Offer
Close Bidding

```
asset Vehicle identified by vin {
  o String vin
  --> Member owner
}
```

```
asset VehicleListing identified by listingId {
  o String listingId
  o Double reservePrice
  o String description
  o ListingState state
  o Offer[] offers optional
  --> Vehicle vehicle
}
```

```
abstract participant User identified by email {
  o String email
  o String firstName
  o String lastName
}

participant Member extends User {
  o Double balance
}

participant Auctioneer extends User {
}
```

```
transaction Offer {
  o Double bidPrice
  --> VehicleListing listing
  --> Member member
}

transaction CloseBidding {
  --> VehicleListing listing
}
```

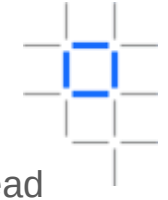
Transaction Processors

```
/**
 * Close the bidding for a vehicle listing and choose the
 * highest bid that is
 * @param {org.acme.ve
 * @transaction
 */
function closeBidding(
    var listing = clos
    if (listing.state
```

```
/**
 * Make an Offer for a VehicleListing
 * @param {org.acme.vehicle.auction.Offer} offer - the offer
 * @transaction
 */
function makeOffer(offer) {
    var listing = offer.listing;
    if (listing.state !== 'FOR_SALE') {
```

IBM **Blockchain**

Access Control



```
rule EverybodyCanReadEverything {
    description: "Allow all participants read access to all resources"
    participant: "org.acme.sample.SampleParticipant"
    operation: READ
    resource: "org.acme.sample.*"
    action: ALLOW
}
```

```
rule OwnerHasFullAccessToTheirAssets {
    description: "Allow all participants full access to their assets"
    participant(p): "org.acme.sample.SampleParticipant"
    operation: ALL
    resource(r): "org.acme.sample.SampleAsset"
    condition: (r.owner.getIdentifier() === p.getIdentifier())
    action: ALLOW
}
```

```
rule SystemACL {
  description:  "System ACL to permit all access"
  participant: "org.hyperledger.composer.system.Participant"
  operation: ALL
  resource: "org.hyperledger.composer.system.**"
  action: ALLOW
}
```

- It is possible to restrict which resources can be read and modified by which participants
  - Rules are defined in an .acl file and deployed with the rest of the model
  - Transaction processors can also look up the current user and implement rules programmatically
- ACL rules can be simple (e.g. everybody can read all resources) or more complex (e.g. only the owner of an asset can do everything to it)
- Application supplies credentials (userid/secret) of the participant when connecting to the Fabric network
  - This also applies to Playground!
  - Remember to grant System ACL all access if necessary

Events and Queries

- Events allow applications to take action when a transaction occurs
  - Events are **defined** in models
  - Events are **emitted** by transaction processor scripts
  - Events are **caught** by business applications
- Caught events include transaction ID and other relevant information

```
event SampleEvent {
  --> SampleAsset asset
  o String oldValue
  o String newValue
}
```

```
// Emit an event for the modified asset.
var event = getFactory().newEvent('org.acme.sample', 'SampleEvent');
event.asset = tx.asset;
event.oldValue = oldValue;
event.newValue = tx.newValue;
emit(event);
```

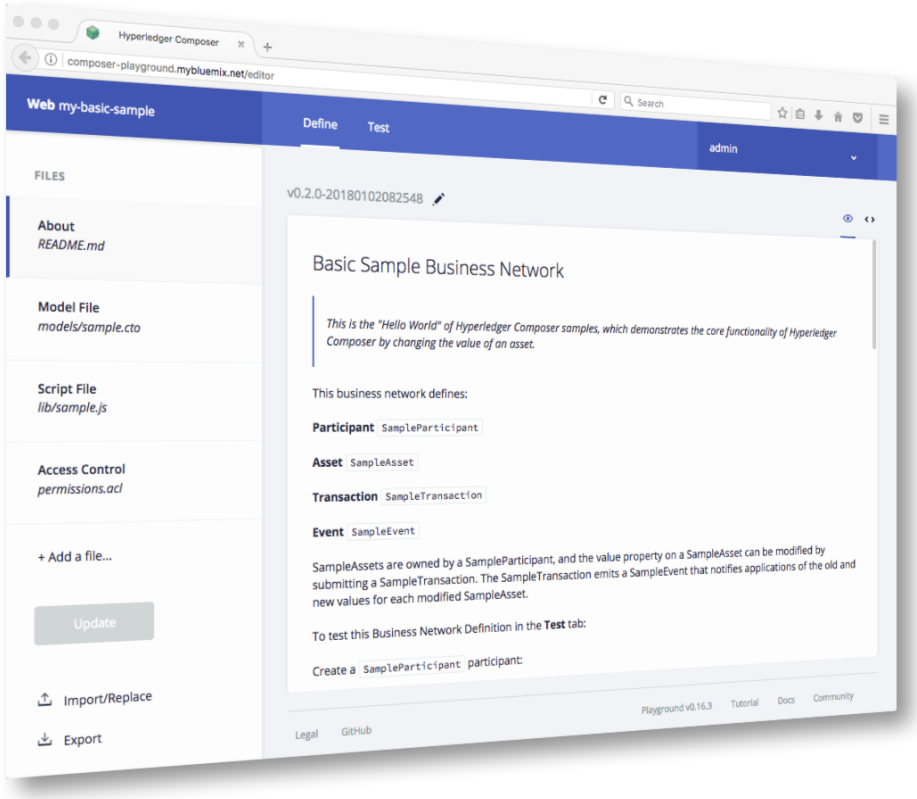
```
businessNetworkConnection.on('SampleEvent', (event) => {
    console.log(event);
}
```

- Queries allow applications to perform complex registry searches
  - They can be statically defined in a separate .qry file or generated dynamically by the application
  - They are invoked in the application using *buildQuery*() or *query*()
  - Queries require the blockchain to be backed by CouchDB

```
query selectCommoditiesWithHighQuantity {
  description: "Select commodities based on quantity"
  statement:
      SELECT org.acme.trading.Commodity
          WHERE (quantity > 60)
}
```

```
return query('selectCommoditiesWithHighQuantity', {})
```

Smart Contract Development: Composer Playground



- Web tool for defining and testing Hyperledger Composer models and scripts
- Designed for the application developer
  - Define assets, participants and transactions
  - Implement transaction processor scripts
  - Test by populating registries and invoking transactions
- Deploy to instances of Hyperledger Fabric V1, or simulate completely within browser
- Install on your machine or run online at http://composer-playground.mybluemix.net

General purpose development: Visual Studio Code

- Composer extension available for this popular tool

- Features to aid rapid Composer development
  - Edit all Composer file types with full syntax highlighting
  - Validation support for models, queries and ACLs
  - Inline error reporting
  - Snippets (press Ctrl+Space for code suggestions)
  - Generate UML diagrams from models

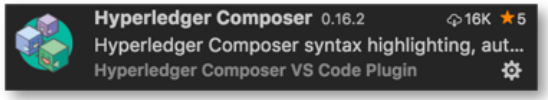
- Install directly from Code Marketplace

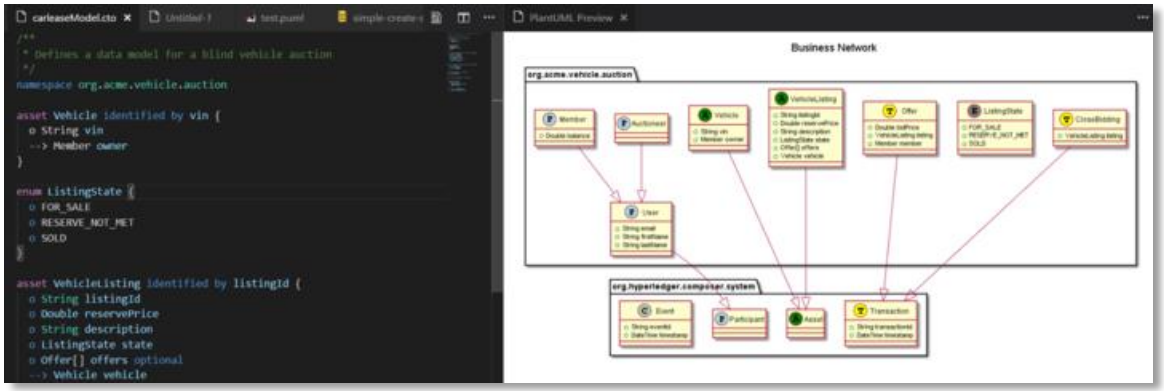
```
namespace org.acme.vehicle.lifecycle

import composer.base.Person
import composer.business.Business

participant PrivateOwner identified by email extends Person {
  o String email
}
```

```
[Composer] IllegalModelException: Could not find super type Pea
rson
participant PrivateOwner identified by email extends Pearson {
  o String email
}
```



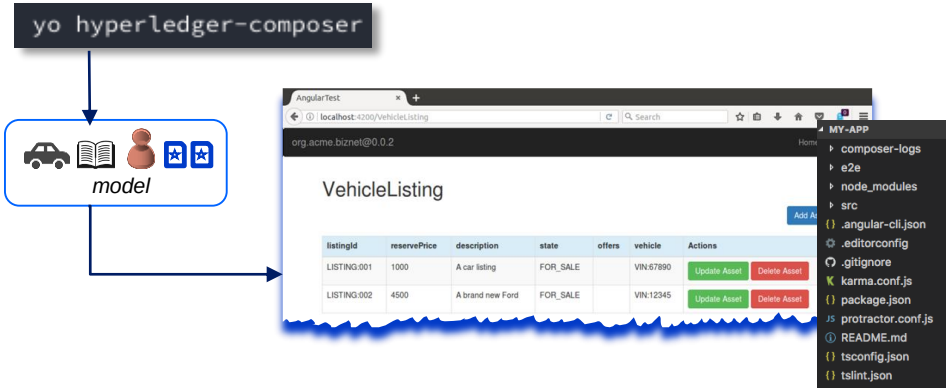


Creating the Business and End-User Applications

- JavaScript business applications *require*() the NPM “composer-client” module
  - This provides the API to access assets, participants and transactions
  - RESTful API (via Loopback) can also be generated… see later
- Command-line tool available to generate end-user command-line or Angular2 applications from model
  - Also helps with the generation of unit tests to help ensure quality code

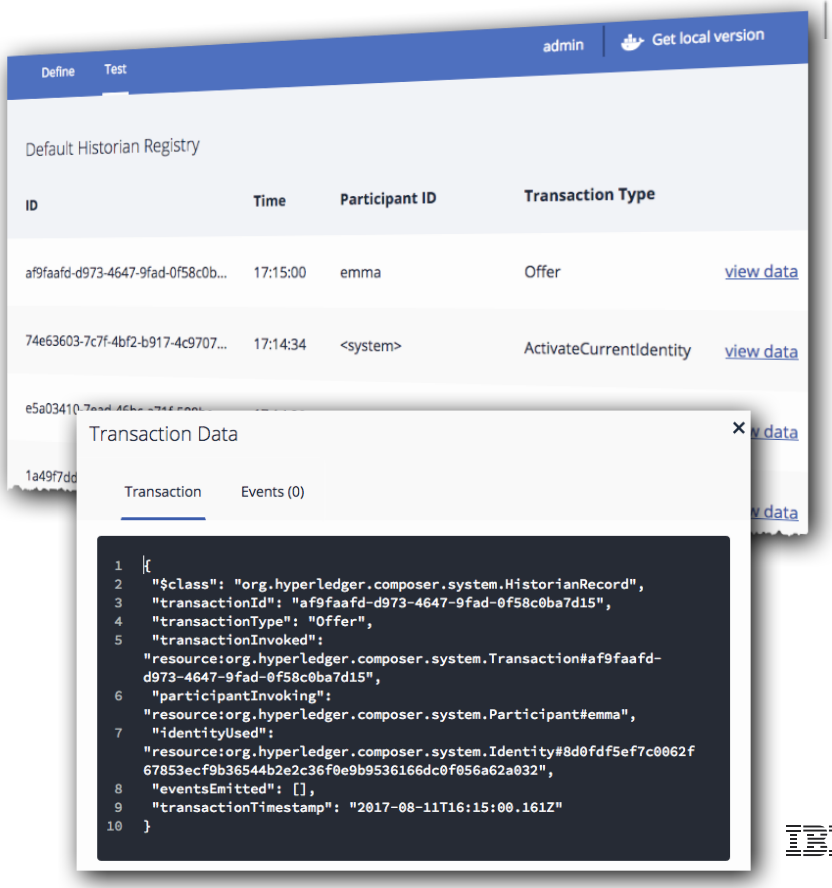
```
const BusinessNetworkConnection = require('composer-client')
                                  .BusinessNetworkConnection;
this.bizNetworkConnection = new BusinessNetworkConnection();
this.titlesRegistry = this.bizNetworkConnection.getAssetRegistry
                      ('net.biz.digitalPropertyNetwork.LandTitle')

let landTitle1 = factory.newResource
    ('net.biz.digitalPropertyNetwork', 'LandTitle', 'LID:1148');
landTitle1.owner = ownerRelation;
landTitle1.information = 'A nice house in the country';
this.titlesRegistry.add(landTitle1);
```



Debugging

- Playground Historian allows you to view all transactions
  - See what occurred and when
- Diagnostics framework allows for application level trace
  - Uses the *Winston* Node.js logging framework
  - Application logging using DEBUG env var
  - Composer Logs sent to stdout and ./logs/trace_<processid>.trc
- Fabric chaincode tracing also possible (see later)
- More information online: https://hyperledger.github.io/composer/problems/diagnostics.html



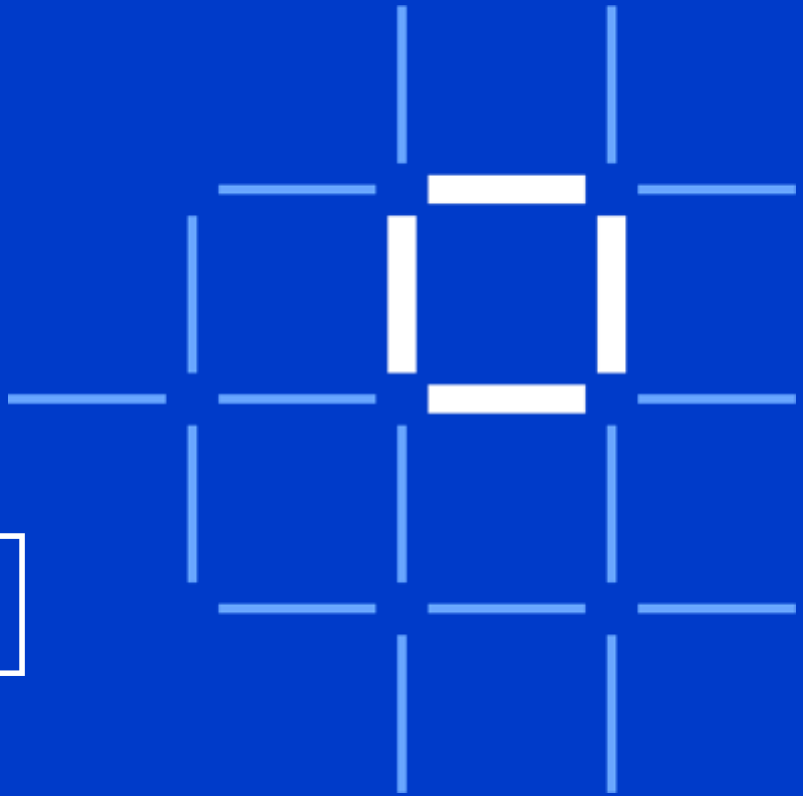
What is Hyperledger Composer?

Application Development

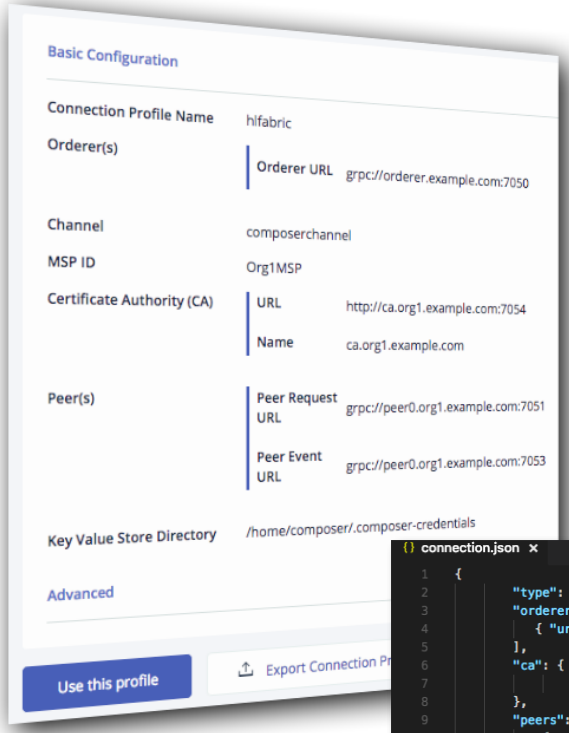
Writing the application
Modeling the business network

Effective Administration

Deploying to a blockchain
Interacting with systems of record



Connection Profiles to Hyperledger Fabric



- Use **connection profiles** to describe Fabric connection parameters
  - One connection profile required per channel
- Not necessary for web-based simulation

- Enrollment in Hyperledger Fabric network required (see later)
  - Issue Fabric identity from Composer participants

- Connection profiles currently used by Composer only
  - Plans to implement common connection profiles that can be used by both Fabric and Composer

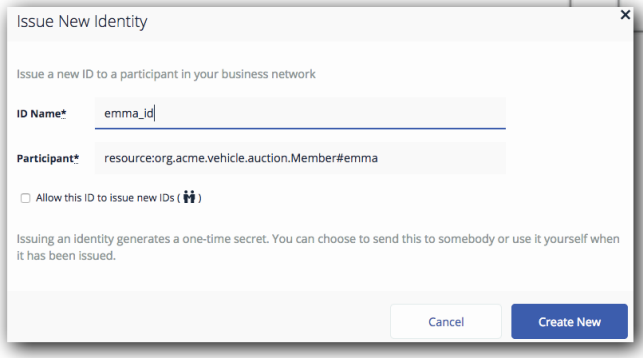
Participant Identity

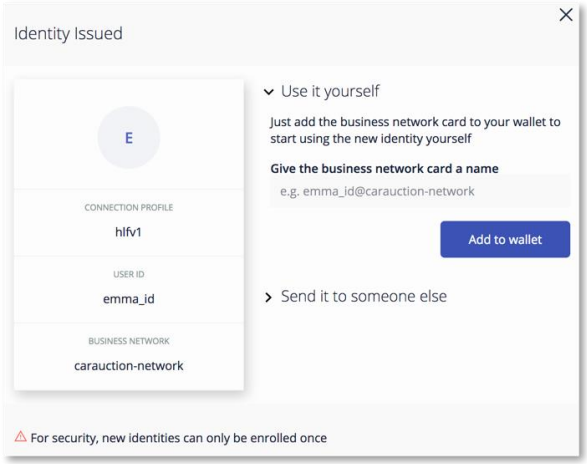
- The Network Service Consumer issues network participants with an **identity** in order to connect to Hyperledger Fabric
  - Issued as a Hyperledger Fabric userid/secret
  - Automatically swapped for a certificate on first use
  - Packaged in a Business Network Card and supplied when the client application connects

- Composer Participant to Fabric Identity mapping is stored on the blockchain in an *identity registry*

- Usually, only Business Service Consumers have a Fabric identity
  - End-users log in to the business application using a separately managed identity; blockchain transactions invoked by proxy

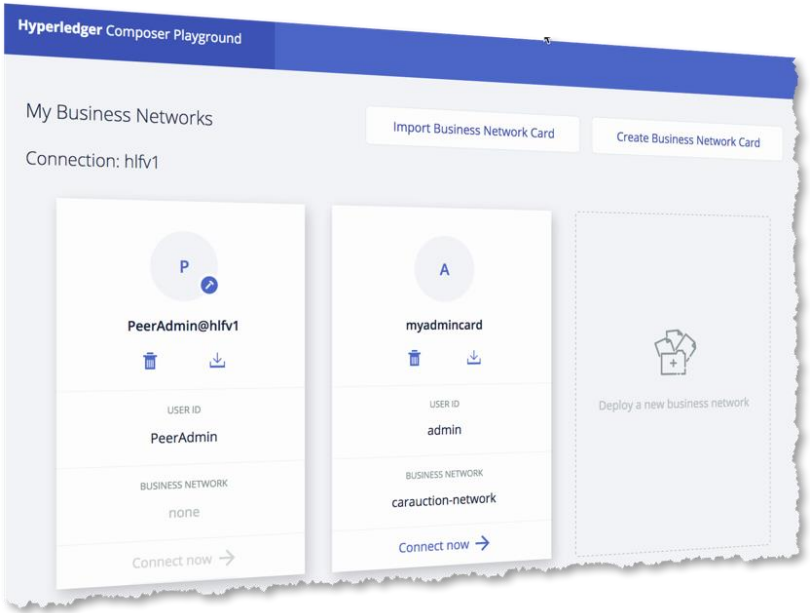
- Manage identity from Playground, Javascript, REST or command line
  - For example: Test connection, issue identity, bind an identity to a participant, revoke an identity, list identities

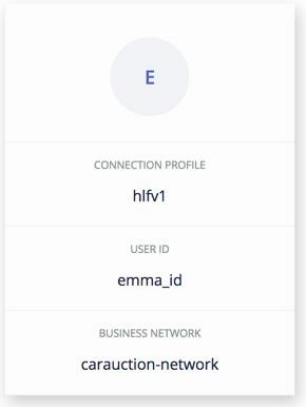




Business Network Cards

- Business Network Cards are a convenient packaging of *identity* and *connection profile*
  - Contains everything you need to connect to blockchain business network
  - Each card refers to a single participant and single business network
  - Analogous to an ATM card





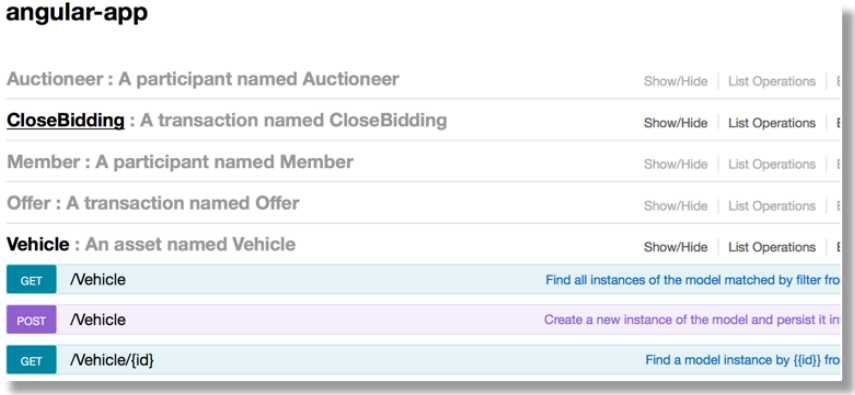
- Manage cards from both Playground and command-line
  - Create, delete, export, import, list
  - Create requires userid/secret or certificate/private key
- Use cards to connect to Fabric from Playground, command-line or from within your application

```
composer network deploy -a my.bna -c my.card
```

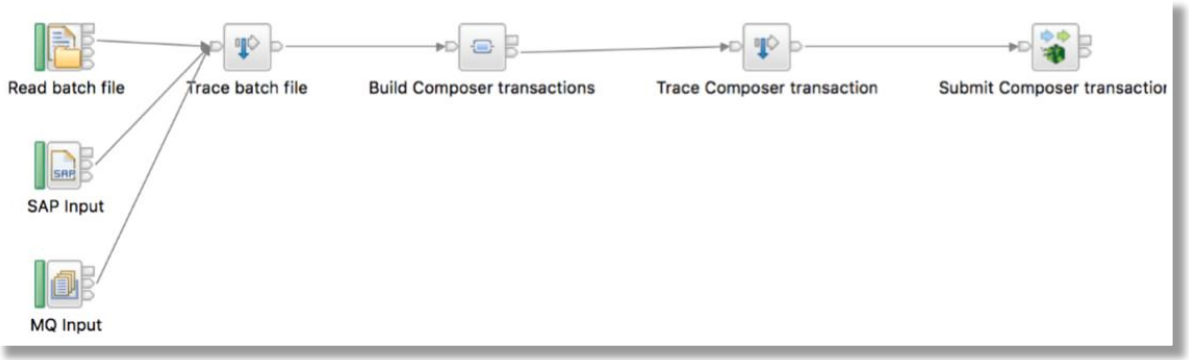
```
// Connect and log in to HLF
var businessNetwork = new BusinessNetworkConnection();
return businessNetwork.connect('cardName')
.then(function(businessNetworkDefinition){
    // Connected
});
```

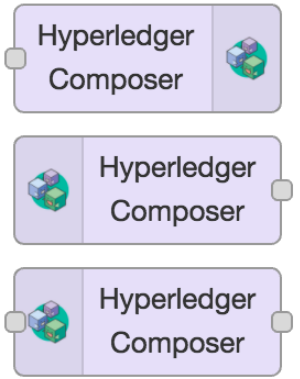
Systems of Record Integration

- Domain specific APIs very attractive to mobile and web developers. Resources and operations are business-meaningful
- Composer exploits Loopback framework to create REST APIs: https://loopback.io/
- Extensive test facilities for REST methods using loopback
- Secured using JS Passport, giving >400 options for authentication
- Composer provides back-end integration with any loopback compatible product
  - e.g. IBM Integration Bus, API Connect, StrongLoop
  - Outbound and Inbound (where supported by middleware)



Exploiting Loopback: Examples

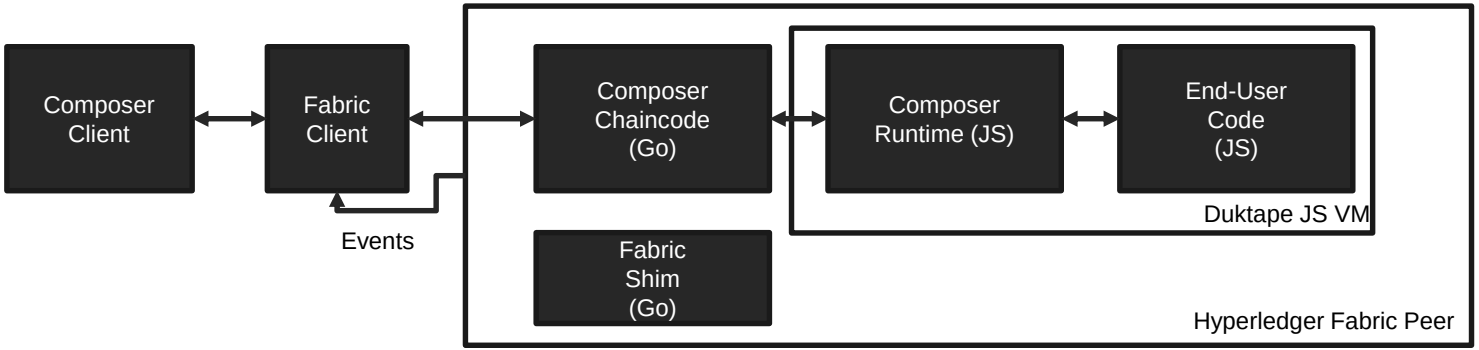




- **IBM Integration Bus**
  - IIB V10 contains Loopback connector
  - Example above takes input from file, SAP or MQ
  - Data mapping from CSV, BAPI/IDOC or binary form to JSON model definition

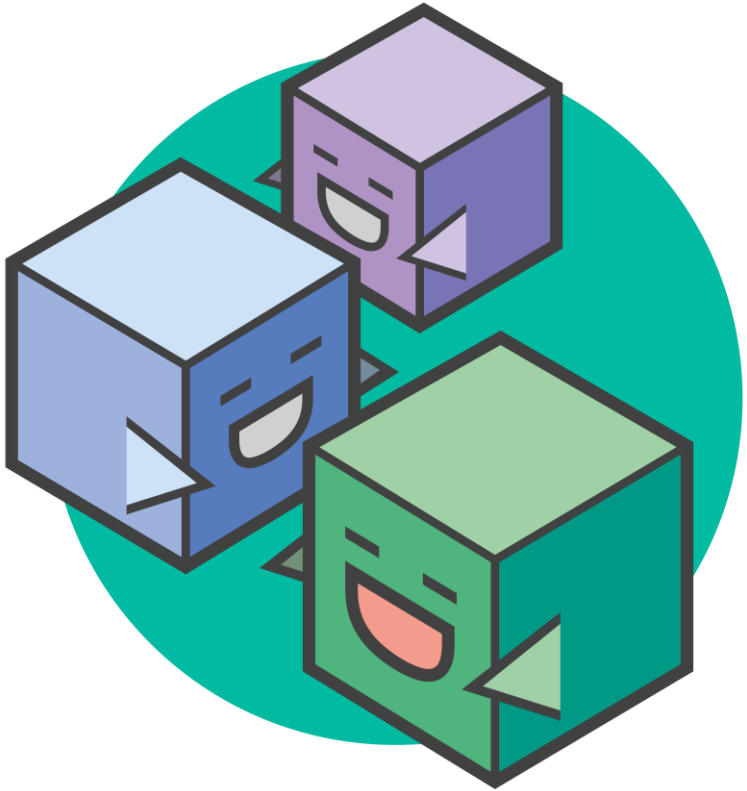
- **Node.RED**
  - Pre-built nodes available for Composer
  - Connect to hardware devices, APIs and online services
  - Install direct from Node.RED UI
    - Manage Palette -> Install -> node-red-contrib-composer

How Composer Maps to Fabric Chaincode



- Each Business Network is deployed to its own chaincode container
  - Container contains a static piece of Go chaincode that starts a Javascript virtual machine running transaction processors
- Browse these containers to view diagnostic information (docker logs)
- Embedded chaincode is not a Composer external interface

Get started with Hyperledger Composer



– Define, Test and Deploy Business Networks

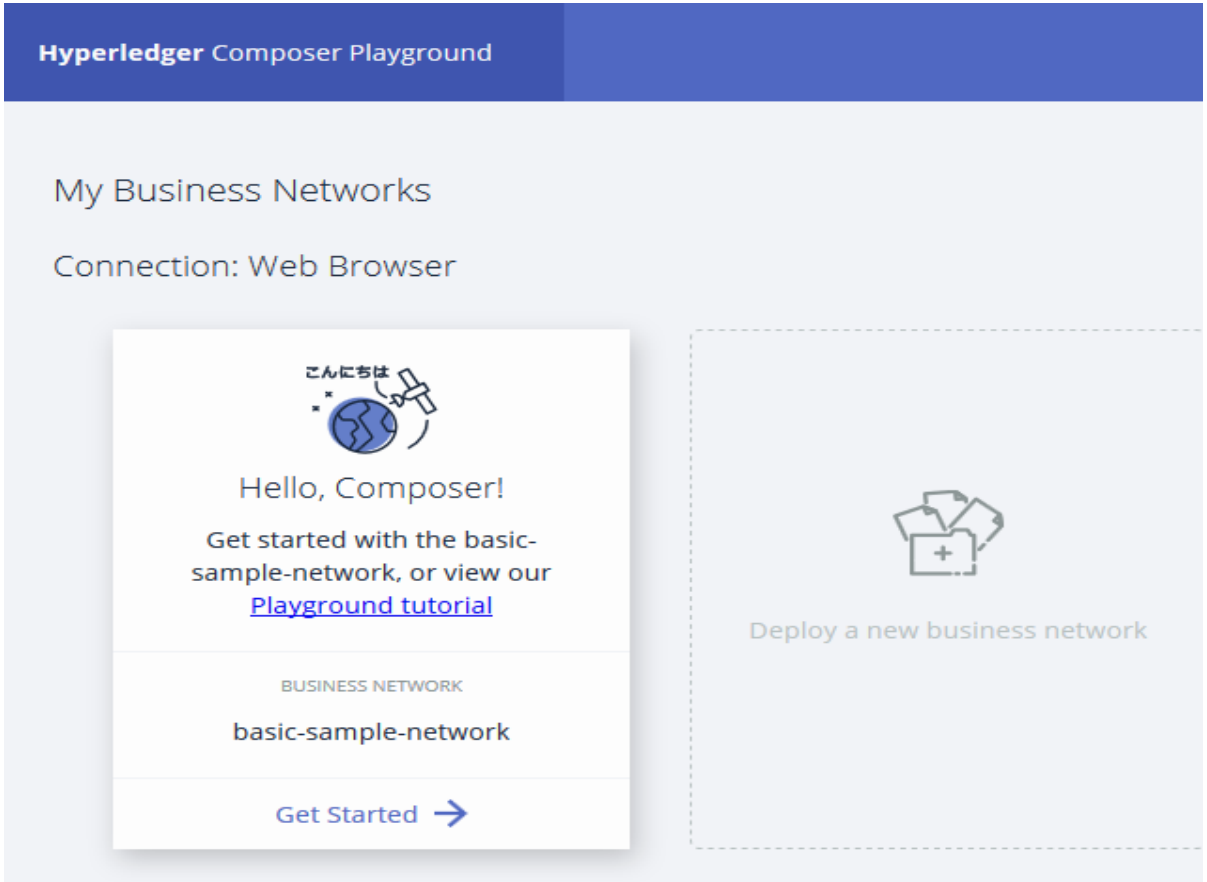
– Create domain APIs and sample applications

– Integrate existing systems and data

https://hyperledger.github.io/composer/

http://composer-playground.mybluemix.net/

https://hyperledger.github.io/composer/latest/tutorials/playground-tutorial


Hyperledger Composer Playground
My Business Networks
Connection: Web Browser
こんにちは
Hello, Composer!
Get started with the basic-sample-network, or view our Playground tutorial
BUSINESS NETWORK
basic-sample-network
Get Started
Deploy a new business network

Choose a Business Network Definition to start with:

Choose a sample to play with, start a new project, or import your previous work

- 
  basic-sample-network
- 
  empty-business-network
- 
  Drop here to upload or browse

Samples on npm


animaltracking-network


bond-network


carauction-network


digitalproperty-network


marbles-network


perishable-network


pii-network


trade-network


vehicle-lifecycle-network


vehicle-manufacture-network