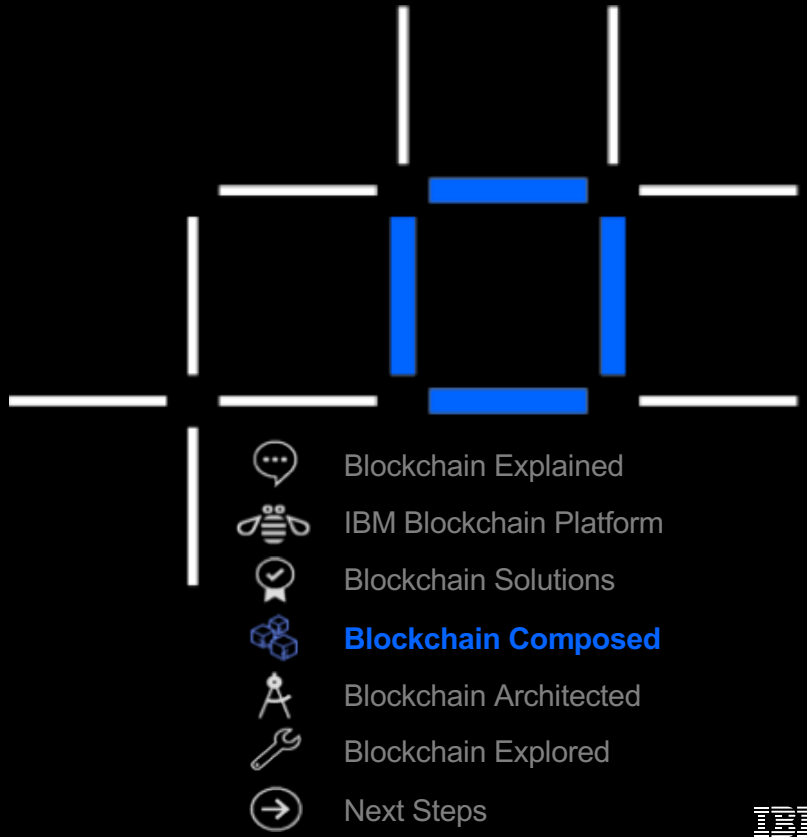
Blockchain Composed

A Technical Introduction to Hyperledger Composer



V2.07, 23 January 2018

IBM **Blockchain**

What is Hyperledger Composer?

Application Development

Writing the application
Modeling the business network

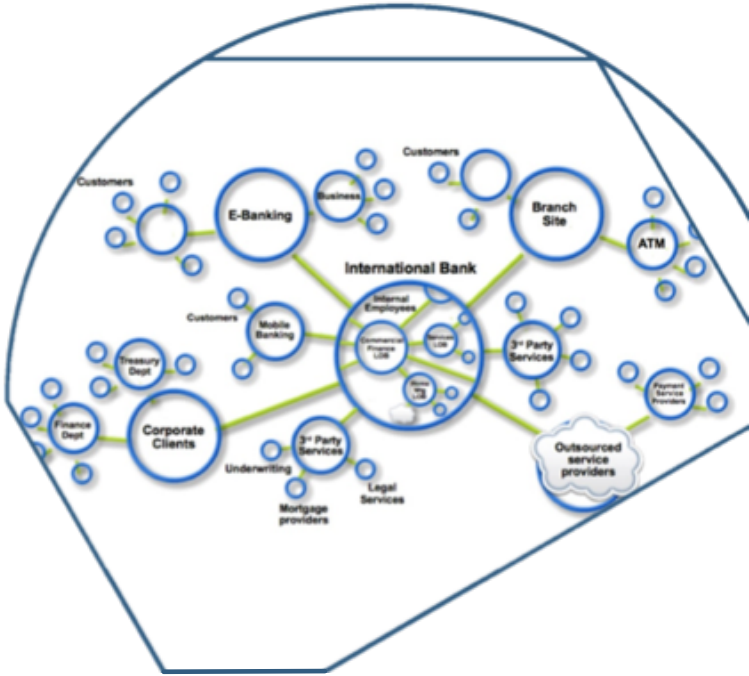
Effective Administration

Deploying to a blockchain
Interacting with systems of record

Blockchain Recap

- Blockchain builds on basic business concepts
  - **Business Networks** connect businesses
  - **Participants** with Identity
  - **Assets** flow over business networks
  - **Transactions** describe asset exchange
  - **Contracts** underpin transactions
  - The **ledger** is a log of transactions

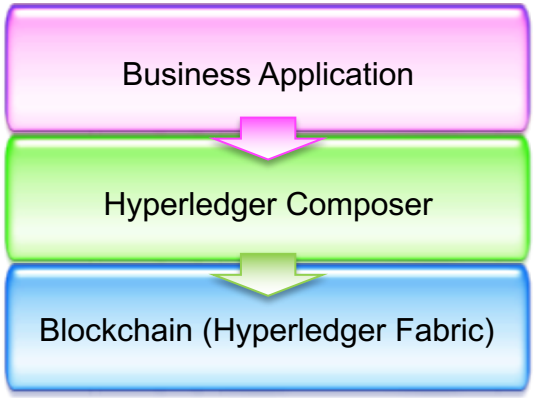
- Blockchain is a shared, replicated ledger
  - Consensus, immutability, finality, provenance

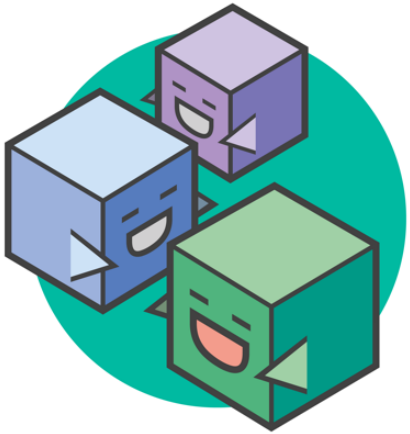


Hyperledger Composer: Accelerating time to value

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

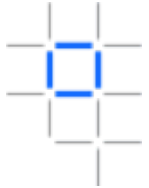
Reduces risk

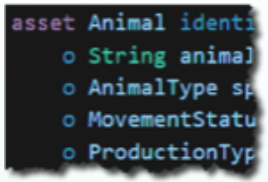
Well tested, efficient design conforms to best practice

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

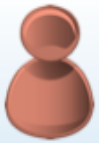
Existing systems and data

User Roles in a Blockchain Project

- Network Service Provider
  - **Governs** the network: channels, membership etc.
  - A consortium of network members or designated authority

- Network Service Consumer
  - **Operates** a set of peers and certificate authorities on the network
  - Represents an organization on the business network

- Business Service Provider
  - **Develops** blockchain business applications
  - Includes transaction, app server, integration and presentation logic



- Business Service Consumer
  - Hosts application and integration logic which invokes blockchain transactions

- End-user
  - Runs presentation logic e.g. on mobile device or dashboard

A single organization may play multiple roles!

The Developer Role in a Blockchain Project

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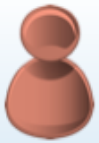

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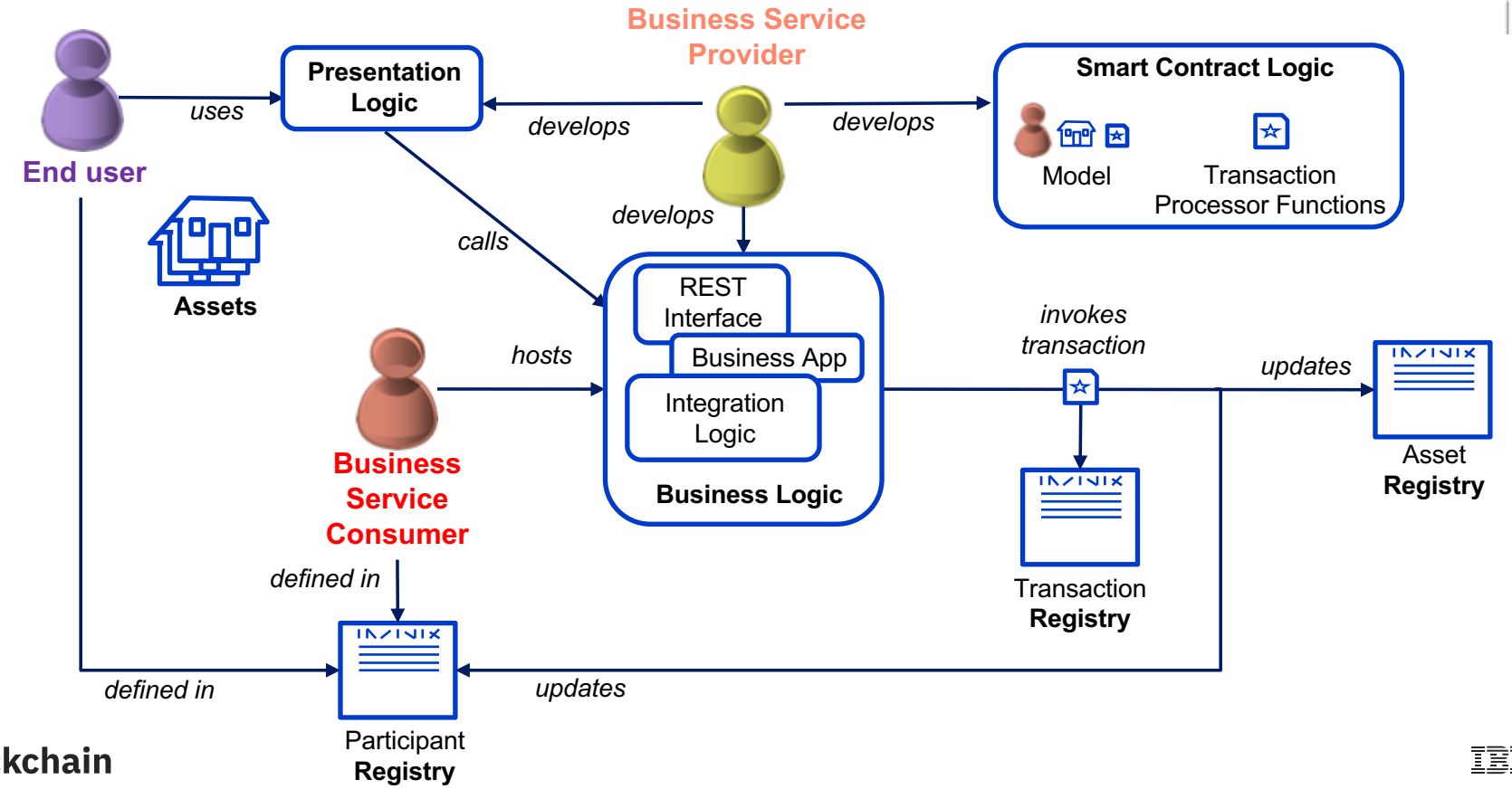
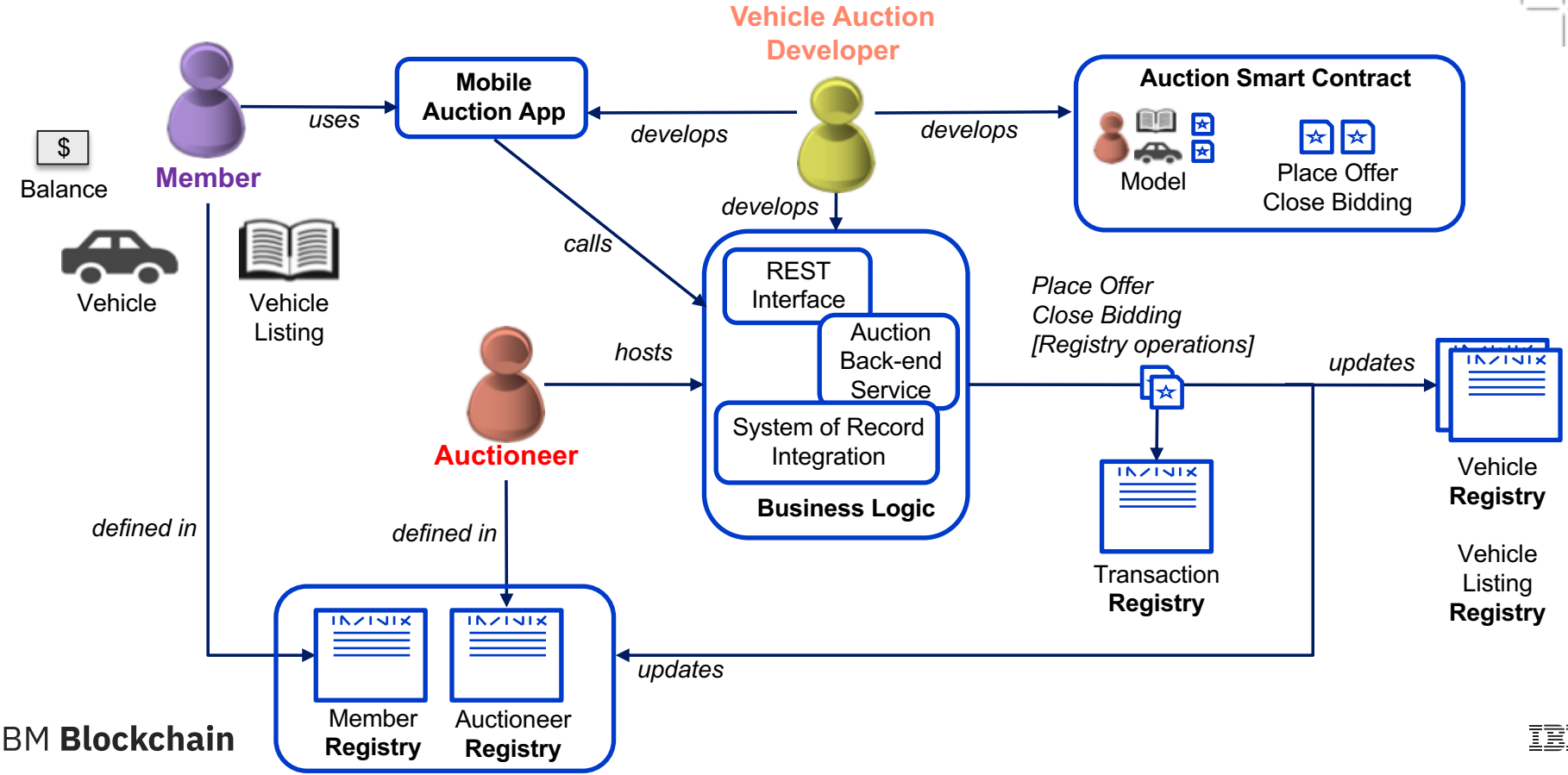
Key Concepts for the Business Service Provider



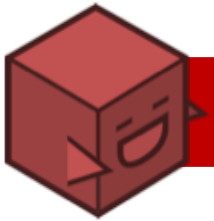
Key Concepts for a Vehicle Auction Developer



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

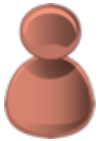
- Provides the **front-end** for the end-user
  - May be several of these applications
- Interacts with business logic via standard interfaces (e.g. REST)
- Composer can generate the REST interface from model and a sample application

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);
```

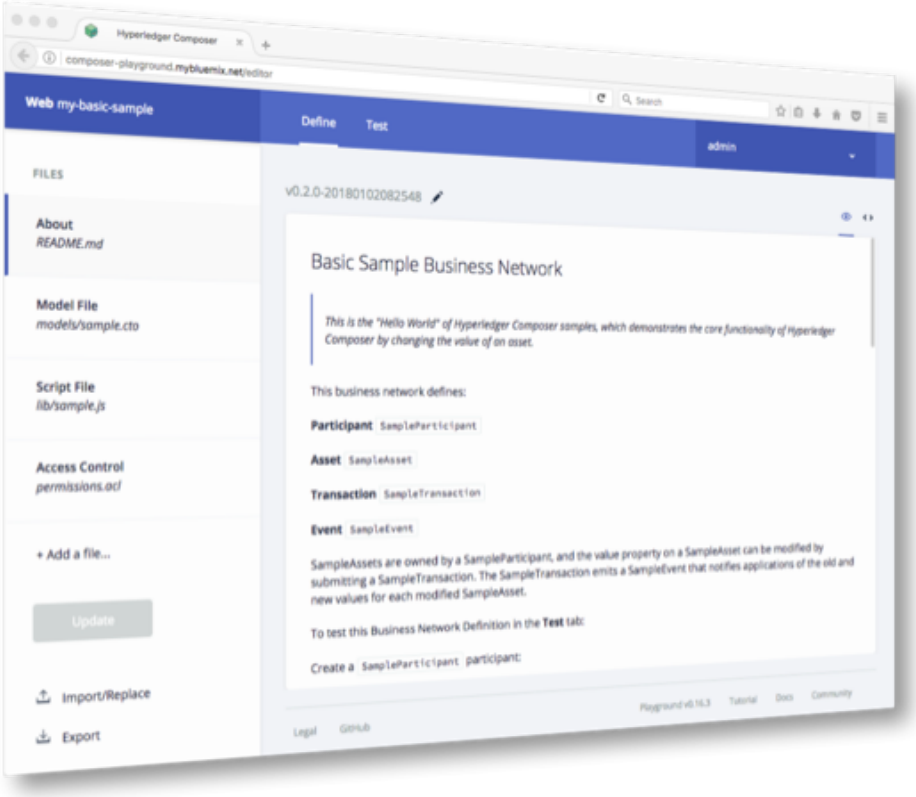
```
businessNetworkConnection.on('SampleEvent', (event) => {
    console.log(event);
}
```

- 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

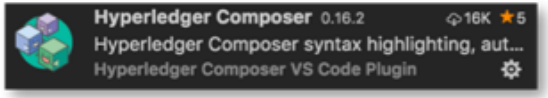
- Install directly from Code Marketplace

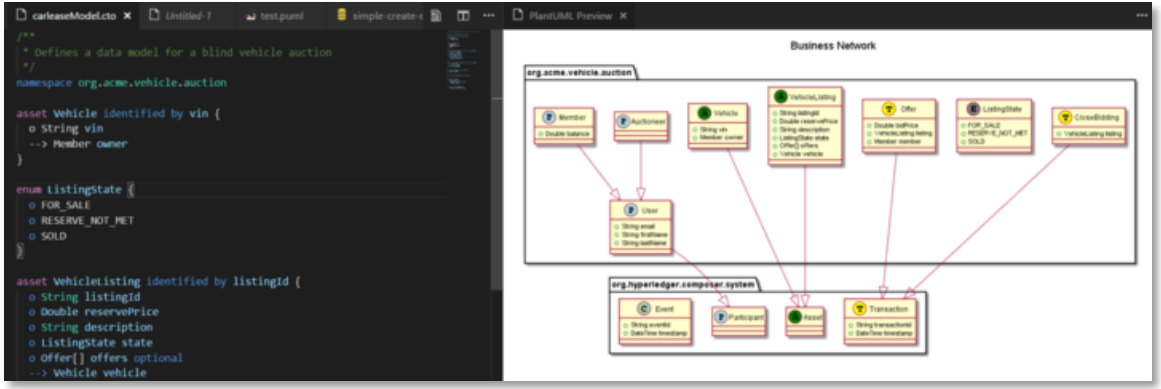
```
namespace org.acme.vehicle.lifecycle

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
}
```





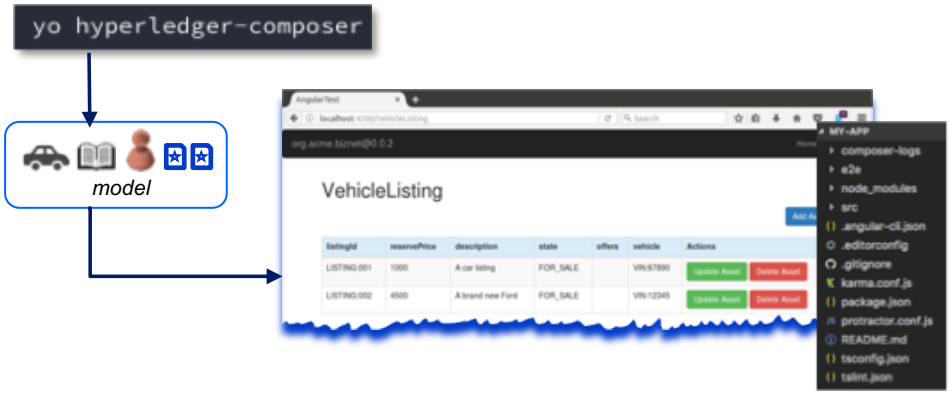
Creating the Business and End-User Applications

- 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

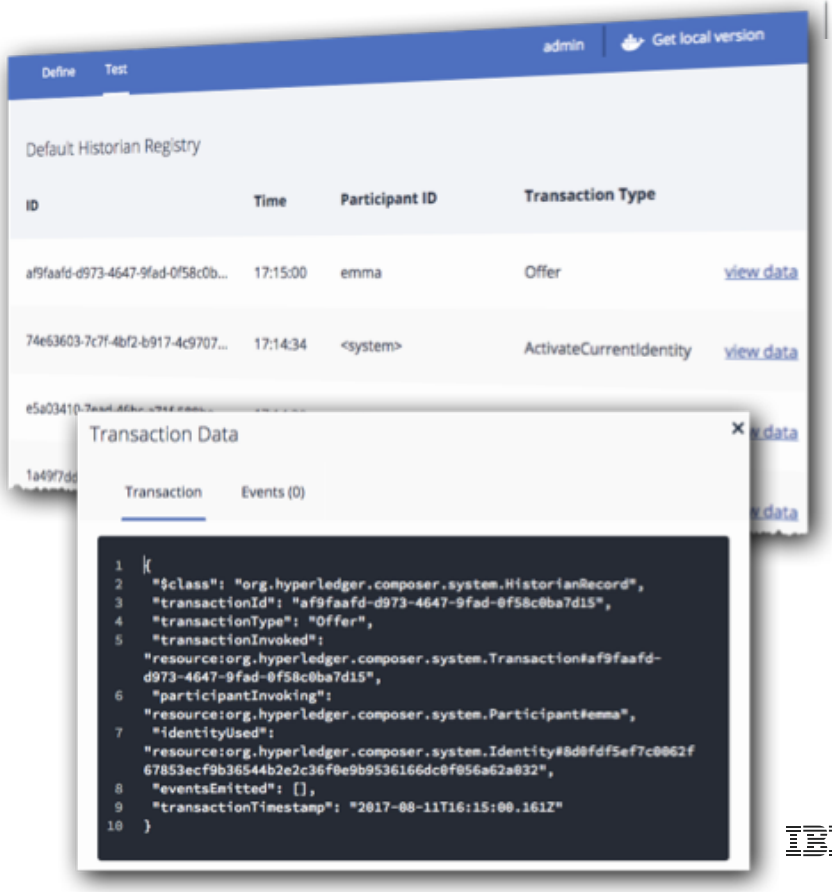
```
const BusinessNetworkConnection = require('composer-client')
                                  .BusinessNetworkConnection;
this.bizNetworkConnection = new BusinessNetworkConnection();
this.titlesRegistry = this.bizNetworkConnection.getAssetRegistry
                      ('net.biz.digitalPropertyNetwork.LandTitle')

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



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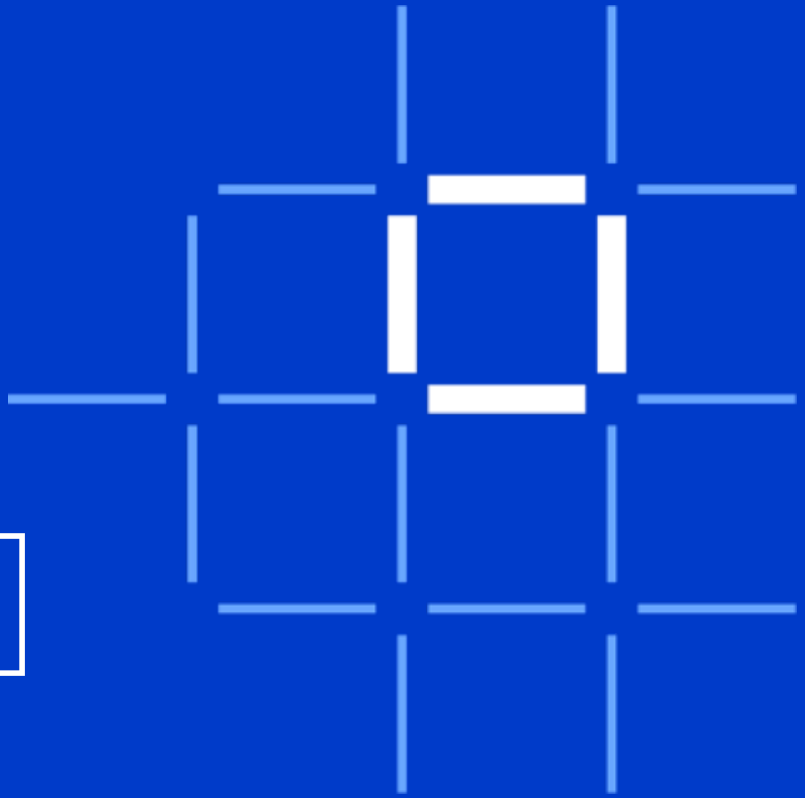

There are Two User Roles with “Administration” Responsibility

- Network Service Provider
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- Network Service Consumer
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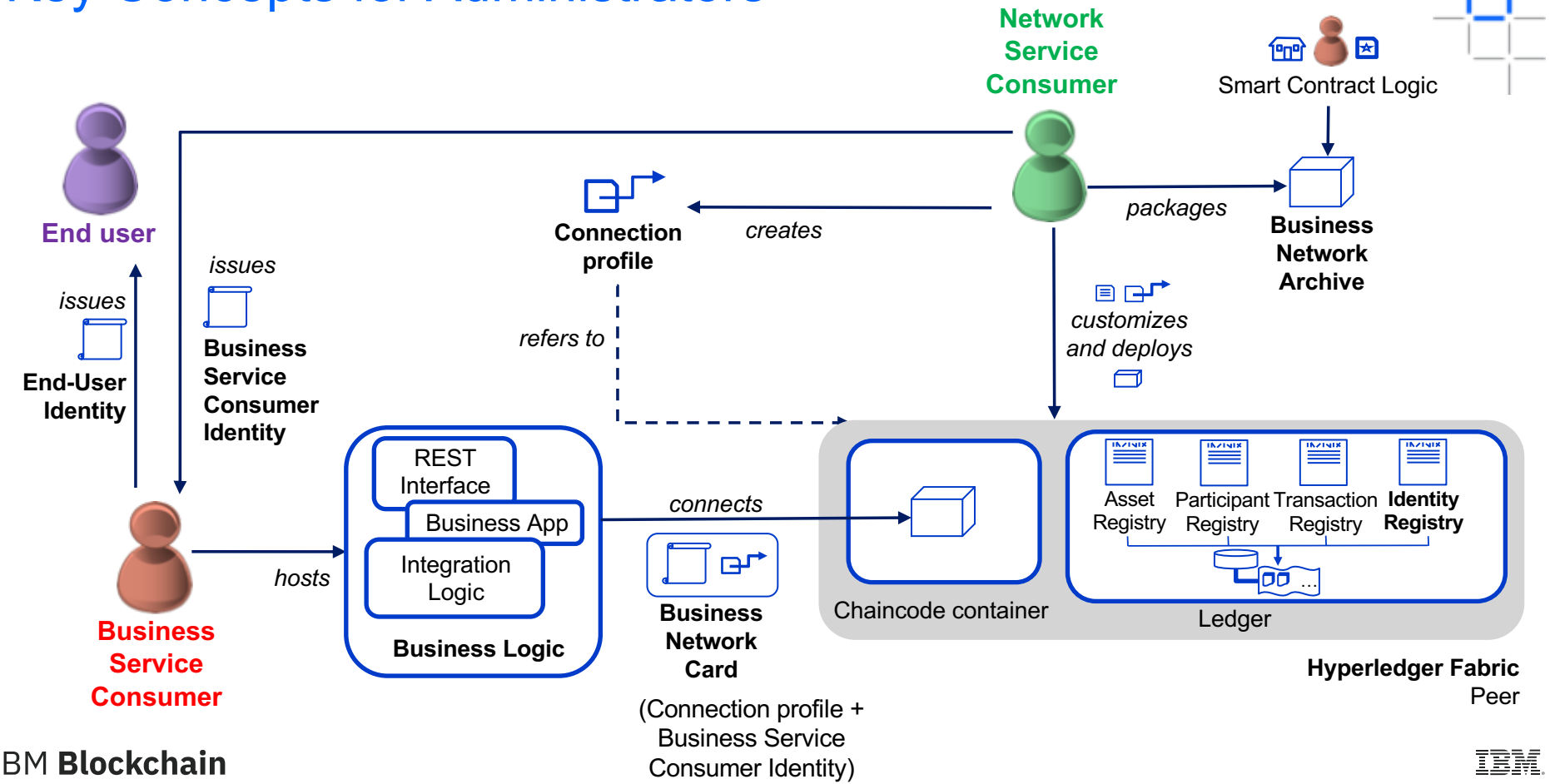
A single organization may play multiple roles!

Key Concepts for Administrators

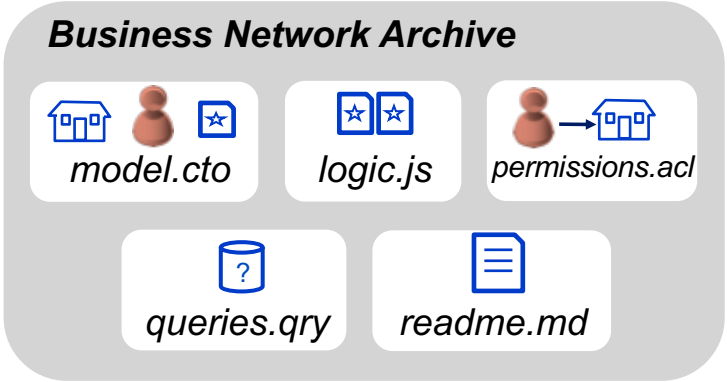


The Network Service Consumer packages resources into a BNA file

- Business Network Archive (.BNA) is a package of the resources used by Fabric:
  - Model files (.CTO)
  - Transaction processors (.JS)
  - Access Control Lists (.ACL)
  - Static queries (.QRY)
  - Documentation and versioning (.MD)
  - It does *not* contain the client application

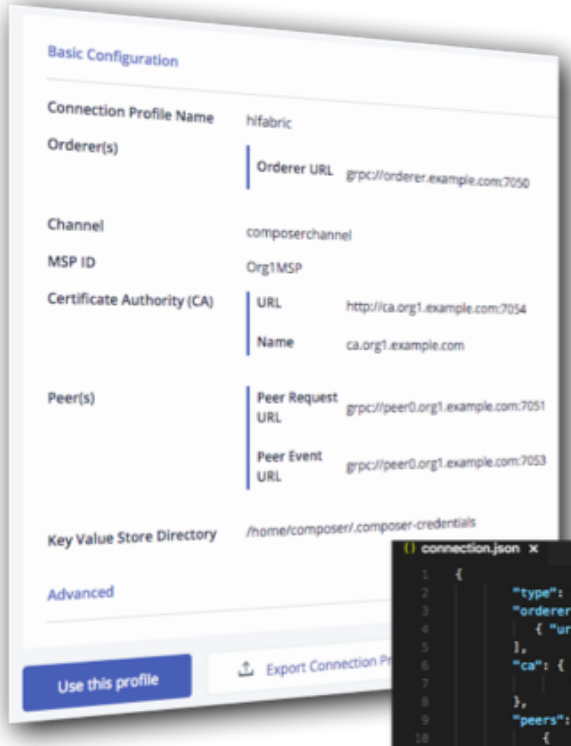
- The BNA simplifies deployment of blockchain and promotion between environments
  - c.f. TAR, WAR, EAR, JAR, BAR…

- Create BNA files from Playground or command line
  - Build from filesystem or NPM module




```
composer archive create –archiveFile my.bna
      --sourceType module --sourceName myNetwork
```

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

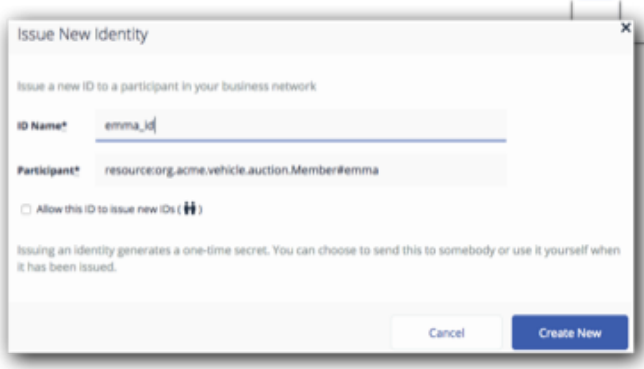
Participant Identity

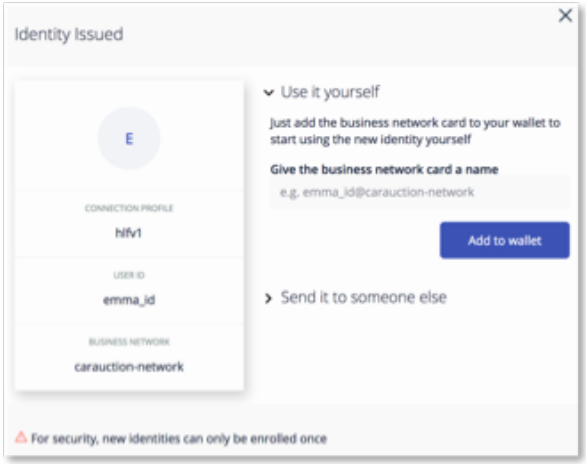
- The Network Service Consumer issues network participants with an **identity** in order to connect to Hyperledger Fabric
  - Issued as a Hyperledger Fabric userid/secret
  - Automatically swapped for a certificate on first use
  - Packaged in a Business Network Card and supplied when the client application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

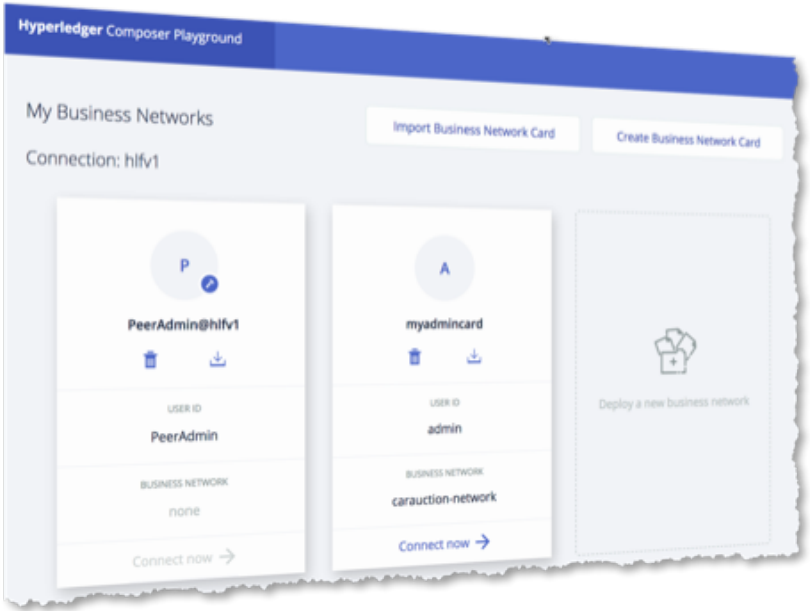
- Manage identity from Playground, Javascript, REST or command line
  - For example: Test connection, issue identity, bind an identity to a participant, revoke an identity, list identities





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



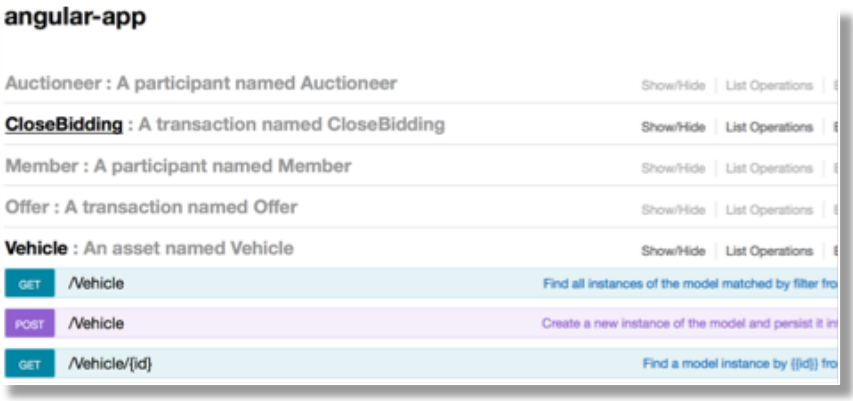
- Manage cards from both Playground and command-line
  - Create, delete, export, import, list
  - Create requires userid/secret or certificate/private key
- Use cards to connect to Fabric from Playground, command-line or from within your application

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

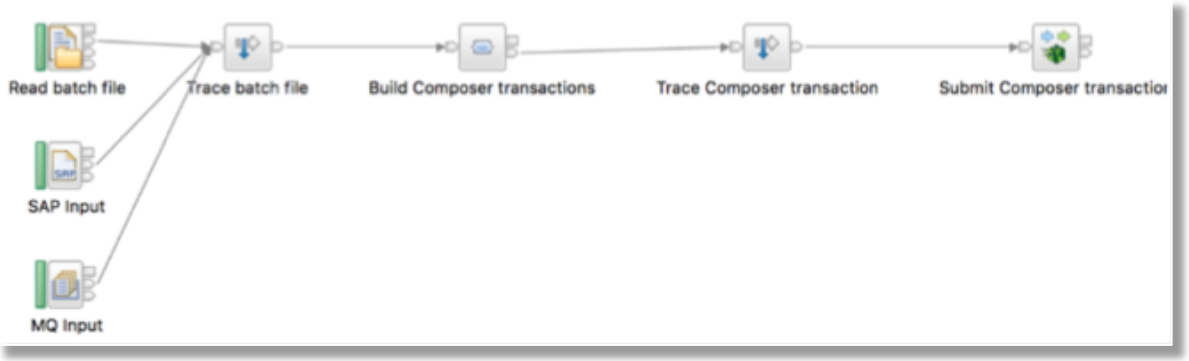
```
// Connect and log in to HLF
var businessNetwork = new BusinessNetworkConnection();
return businessNetwork.connect('cardName')
.then(function(businessNetworkDefinition){
    // Connected
});
```

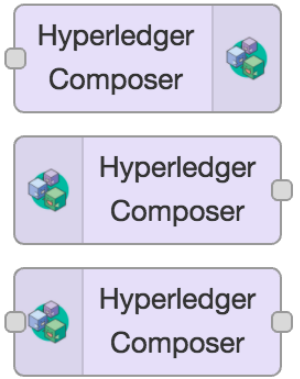
Systems of Record Integration

- 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

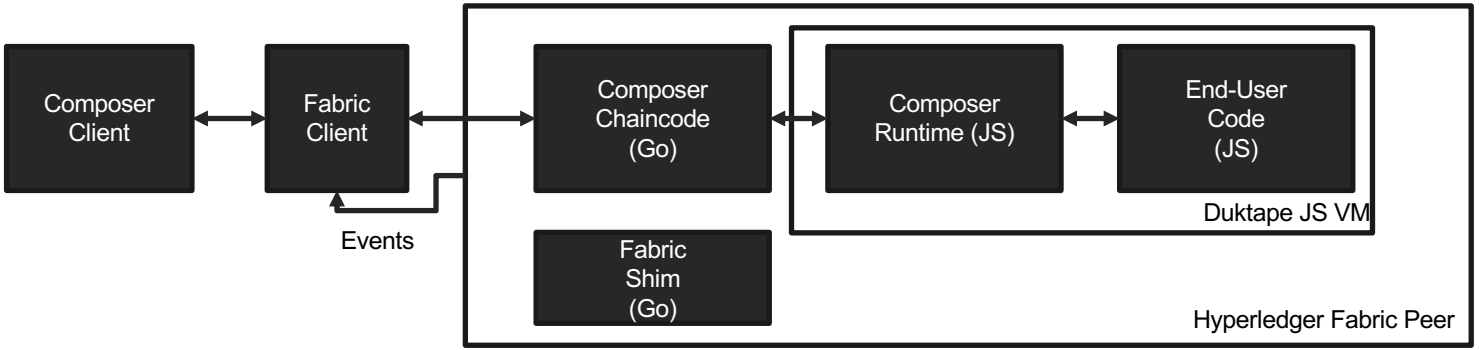




- **IBM Integration Bus**
  - IIB V10 contains Loopback connector
  - Example above takes input from file, SAP or MQ
  - Data mapping from CSV, BAPI/IDOC or binary form to JSON model definition

- **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

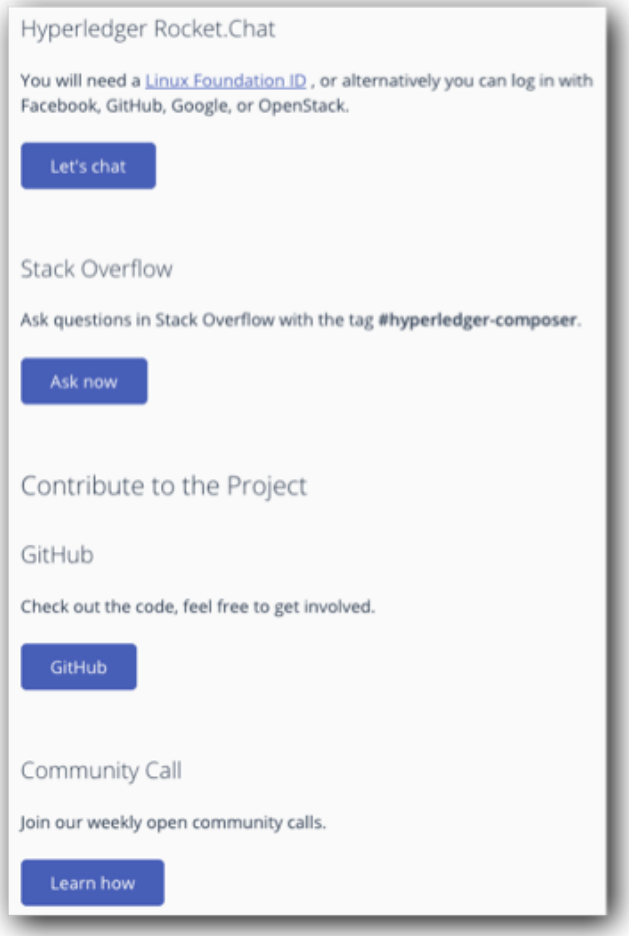
How Composer Maps to Fabric Chaincode



- 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

Hyperledger Composer Outlook

- Still early in product lifecycle
- Lots of improvements planned
  - See https://github.com/hyperledger/composer/issues
- An active development community
  - Open community calls every two weeks
  - Rocket Chat
  - Stack Overflow
- Get involved!



Get started with Hyperledger Composer

– Define, Test and Deploy Business Networks

– Create domain APIs and sample applications

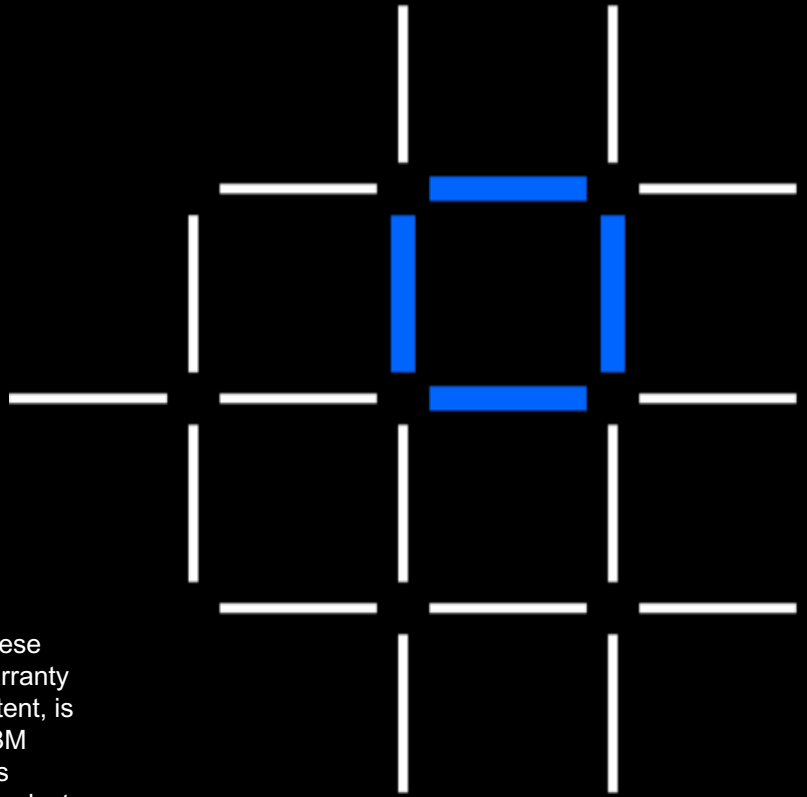
– Integrate existing systems and data

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

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

Thank you

IBM Blockchain



www.ibm.com/blockchain

developer.ibm.com/blockchain

www.hyperledger.org

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