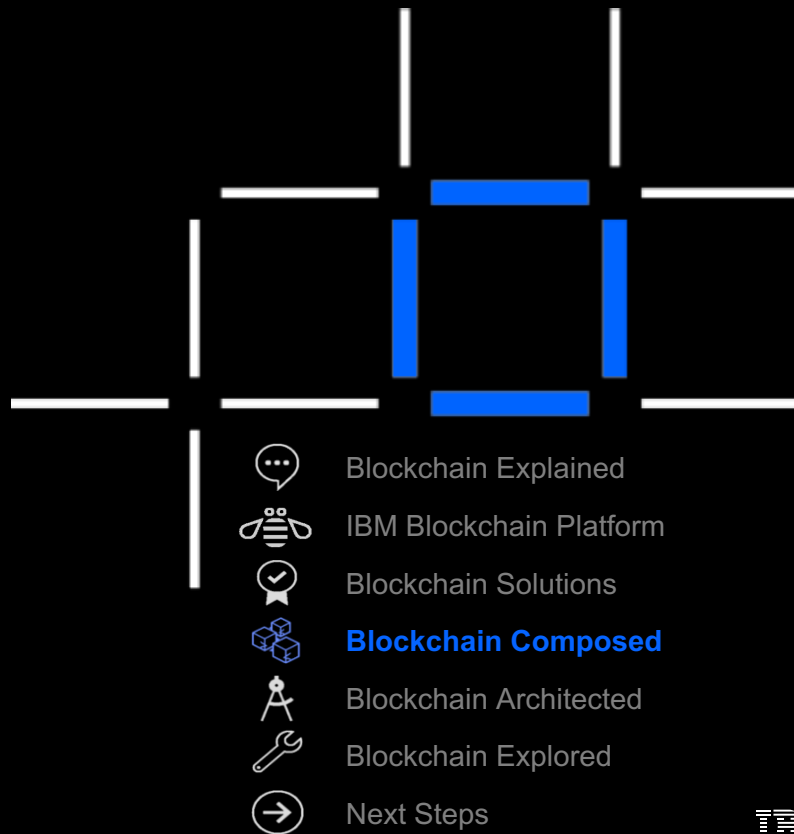


# Blockchain Composed

# A Technical Introduction to Hyperledger Composer

*Dave Wakeman*





What is Hyperledger  
Composer?



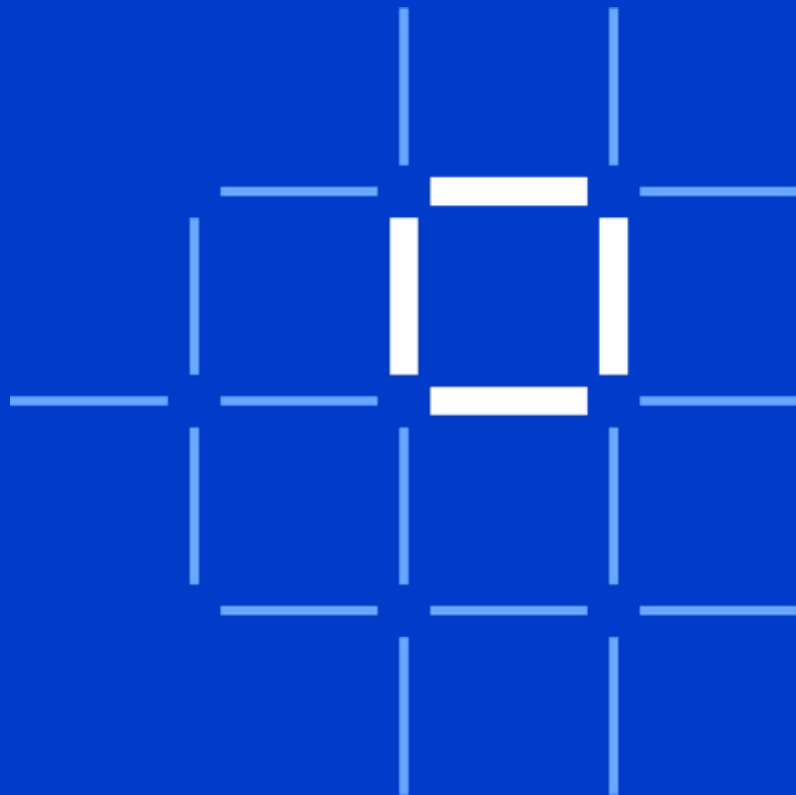
## Application Development

*Writing the application*  
*Modeling the business network*

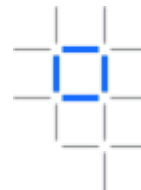


## Effective Administration

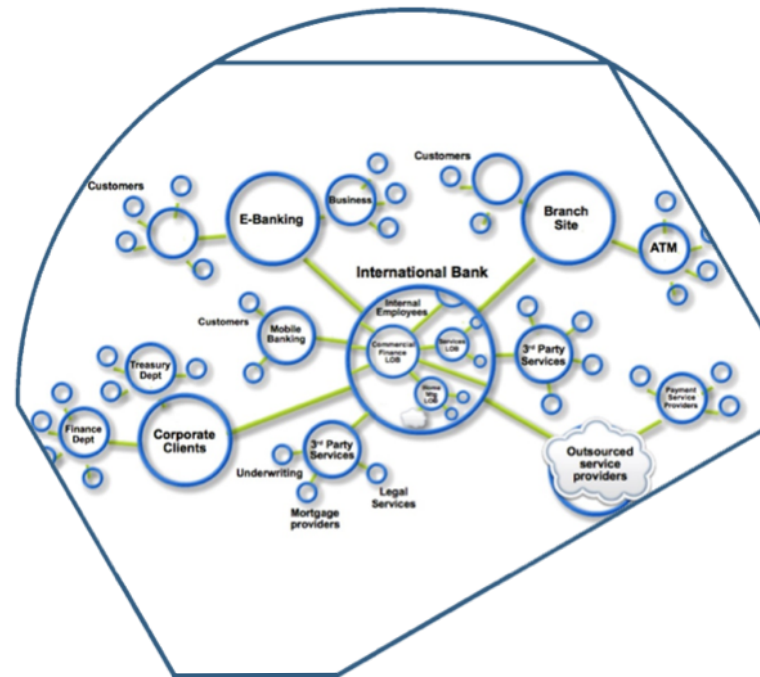
*Deploying to a blockchain*  
*Interacting with systems of record*



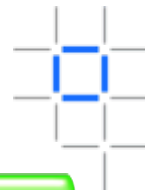
# Blockchain Recap



- 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

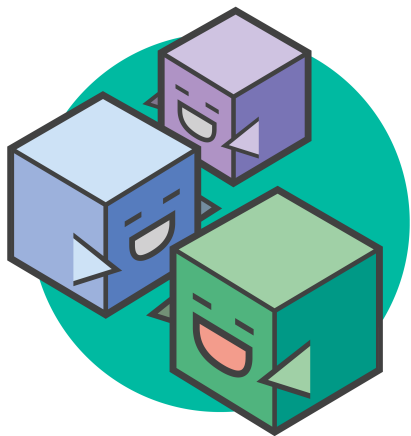


# Hyperledger Composer: Accelerating time to value

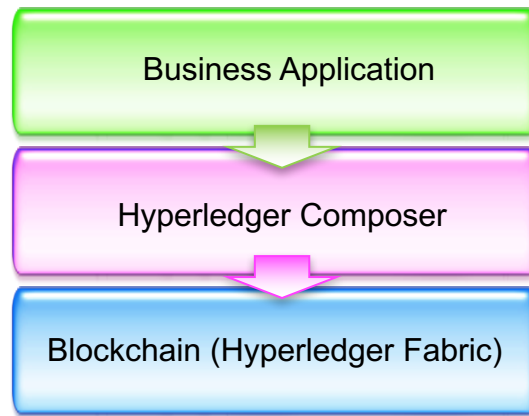


<https://hyperledger.github.io/composer/>

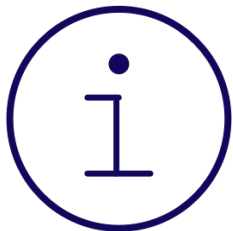
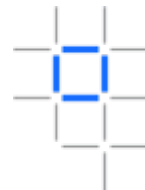
- A suite of high level application **abstractions** for business networks
- Emphasis on business-centric vocabulary for quick solution creation
- Reduce risk, and increase understanding and flexibility



- 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



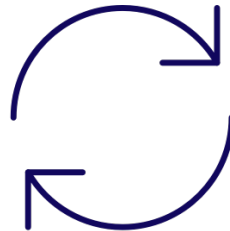
**Saves  
time**

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



Code  
generation



Web Playground

composer-client  
composer-admin



Clint Libraries

```
asset Animal identi
  o String animal
  o AnimalType sp
  o MovementStatu
  o ProductionTyp
```

Data modelling



JavaScript  
business logic



Editor Support

\$ composer

CLI Utilities

Powered by



LoopBack  
Node.js Framework



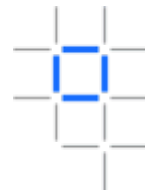
Swagger

Existing Systems  
and Data

IBM **Blockchain**



# Extensive, Familiar, Open Development Toolset

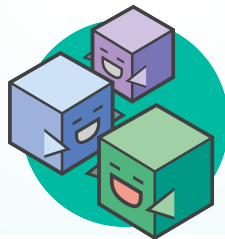


```
asset Animal identi
  o String animal
  o AnimalType sp
  o MovementStatu
  o ProductionTyp
```

Data modelling



JavaScript  
business logic



Web playground

```
composer-client
composer-admin
```



Client libraries



Editor support

```
$ composer
```

CLI utilities



Code generation

Powered by



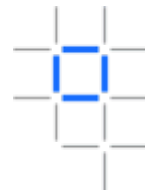
LoopBack  
Node.js Framework



Swagger

Existing systems and  
data

# User Roles in a Blockchain Project



## **Application Developer**

- Developing the application that interacts with the ledger
- Modelling the business network
- Implementing the script files that define transaction behaviour



## **Solution Administrator**

- Provisioning the target environment
- Deploying the business application
- Managing the blockchain



## **Business Network Participant**

- Running an end-user application that invokes transactions
- Aware of business concepts: assets, participants and transactions
- May not be aware of blockchain underpinnings





What is Hyperledger  
Composer?



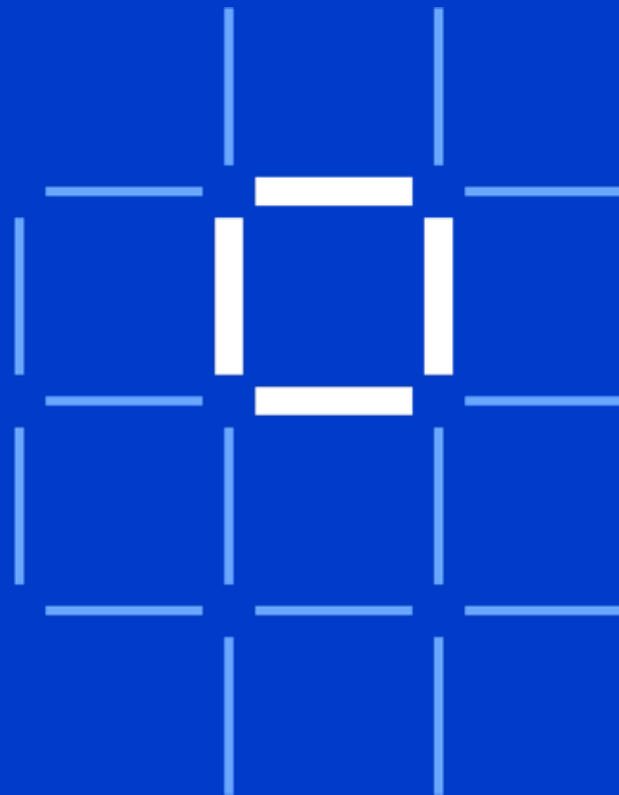
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*Writing the application*  
*Modeling the business network*

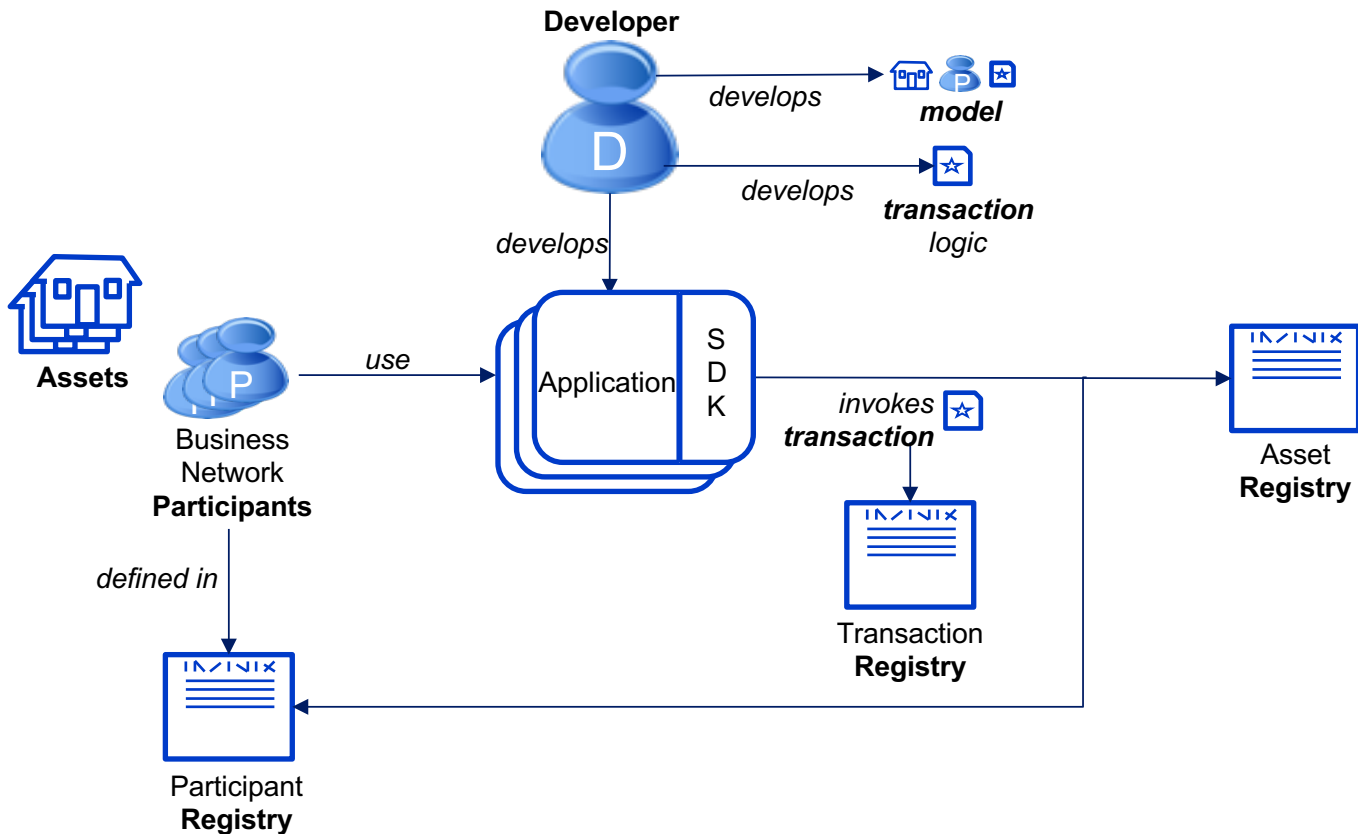
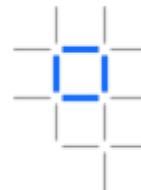


## Effective Administration

*Deploying to a blockchain*  
*Interacting with systems of record*

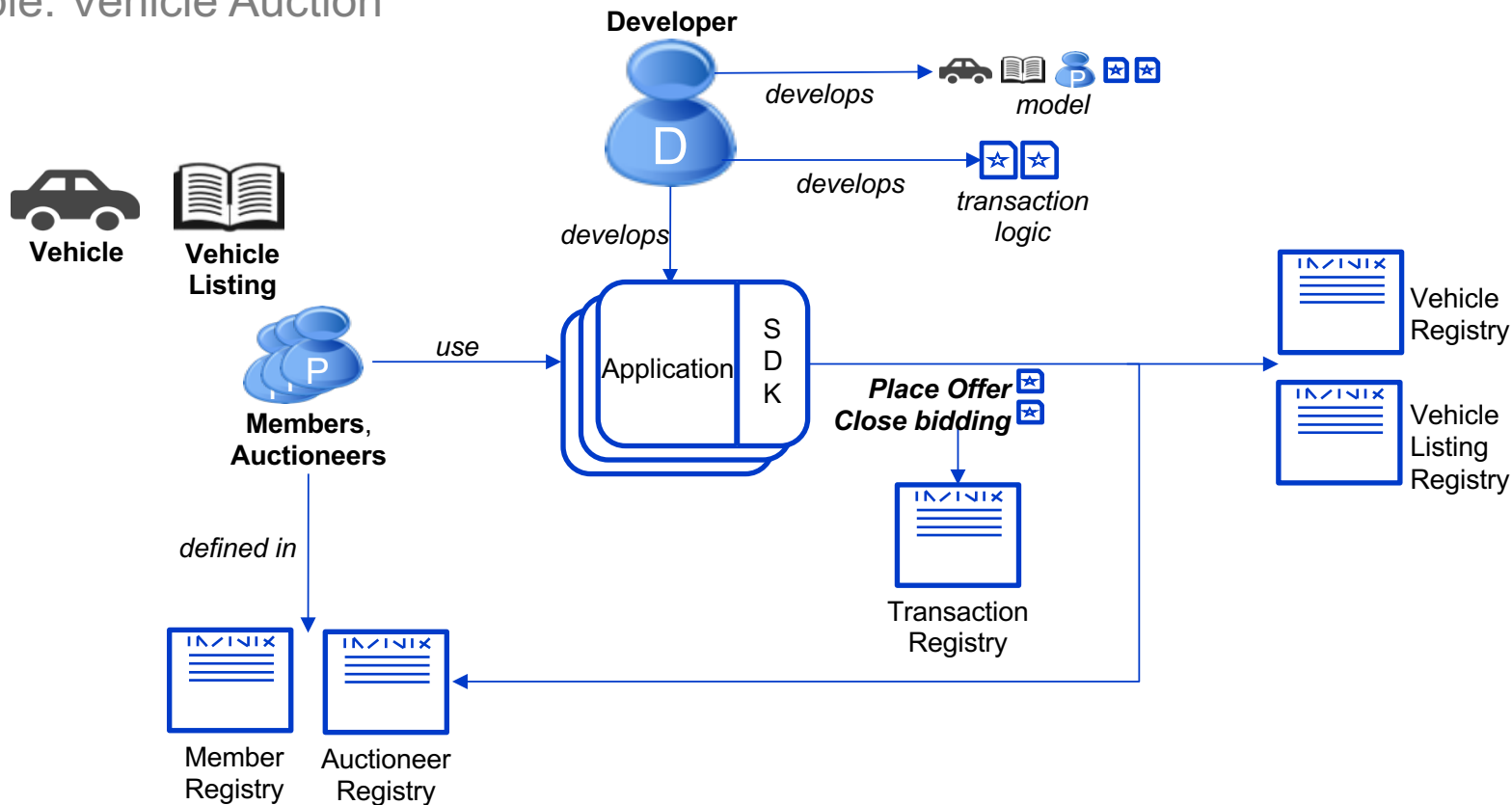
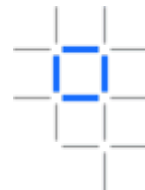


# Key Concepts for the Application Developer

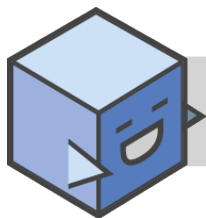
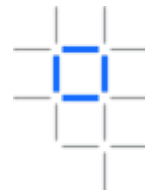


# Key Concepts for the Application Developer

Example: Vehicle Auction

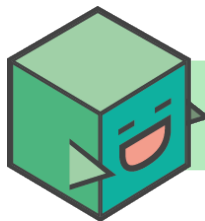


# Develop Concepts



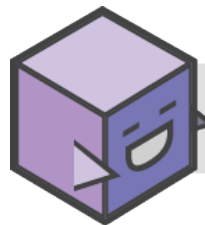
## Applications

- Provides front-end for the user
  - May require different applications per participant
- Interacts with the registries
  - Add, delete, update, query
  - Registries persisted on blockchain
- Connects to blockchain via JavaScript client libraries (SDK) or REST



## Models

- A domain specific language (.CTO) that defines the type structure of
  - Assets
  - Participants
  - Transactions
- Aims to match how we talk about business networks in the real world



## Scripts

- Scripts provide the implementation of transaction processor logic
- Specified in Javascript
- Designed for any reasonable Javascript developer to pick up easily

# Vehicle Auction



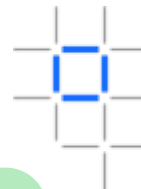
Applications



Models



Scripts



## Vehicle

VIN

(References a) Member

## Vehicle Listing

listingId, reservePrice,  
description, state, offers[]  
(References a) Vehicle



Vehicle



Vehicle  
Listing

## User

email, firstName, lastName

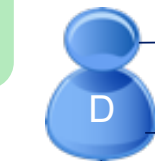
Member (extends User)  
balance

Auctioneer (extends User)



Members,  
Auctioneers

use



develops

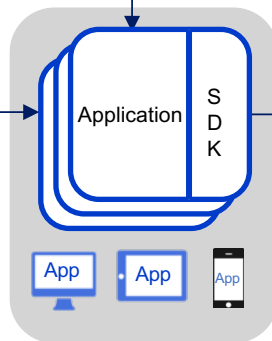


model



transaction  
logic

develops



Application  
S  
D  
K

Place Offer  
Close bidding



Transaction  
Registry



Member  
Registry



Auctioneer  
Registry

defined in

## Place Offer

bidPrice

(References a) listing, member

## Close Bidding

(References a) listing



Vehicle  
Registry



Vehicle  
Listing  
Registry

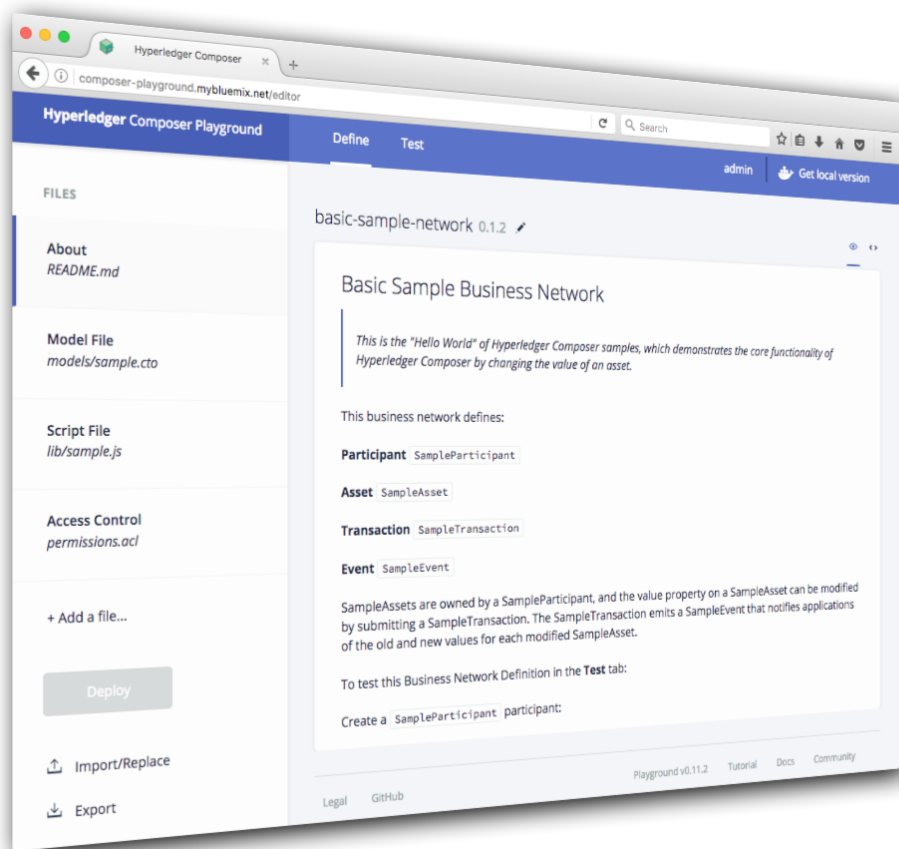
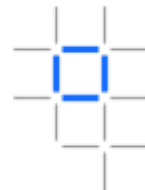
## Place Offer

If listing is for sale, add offer to  
this vehicle listing's offers[]

## Close Bidding

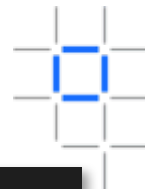
If reserve price met  
Increment seller's balance  
Decrement buyer's balance  
Change owner to buyer

# Tools: 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>

# Visual Studio Code Support



- 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

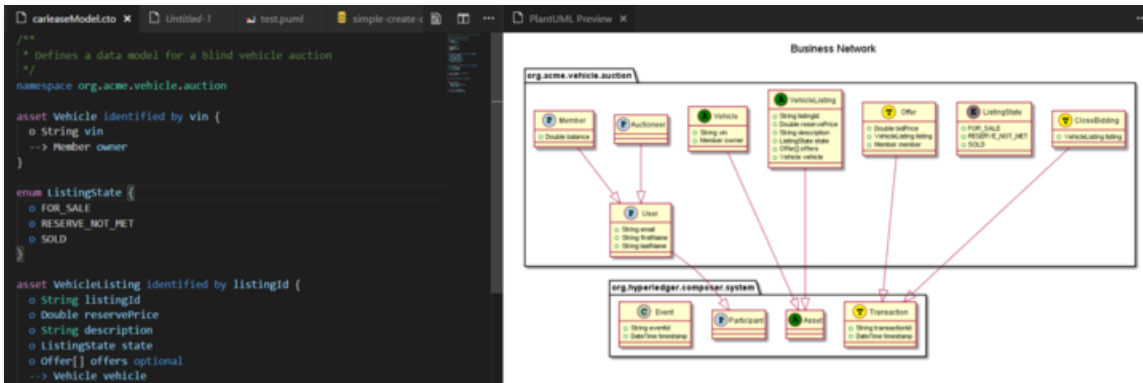
```
namespace org.acme.vehicle.lifecycle

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

**Hyperledger Composer 0.11.3**  
Hyperledger Composer syntax highlighti...  
Hyperledger Composer VS Code Plugin



# Creating the Application

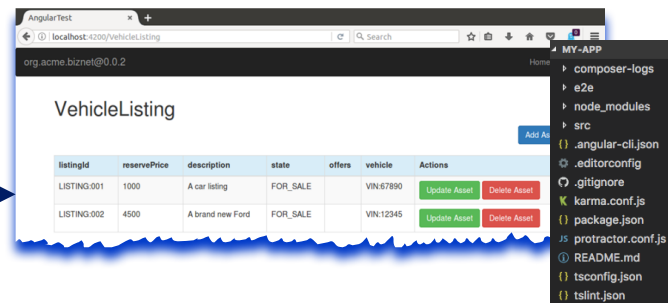
- JavaScript applications *require()* the NPM “composer-client” module
  - This provides the API to access assets, participants and transactions
- RESTful API (via Loopback) also available... see later
- Command-line tool available to generate skeleton command-line or Angular2 application from model
- 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')

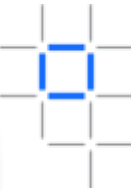
let landTitle1 = factory.newResource
    ('net.biz.digitalPropertyNetwork', 'LandTitle', 'LID:1148');
landTitle1.owner = ownerRelation;
landTitle1.information = 'A nice house in the country';
this.titlesRegistry.add(landTitle1);
```

yo hyperledger-composer





# Events and Queries



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

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

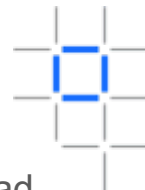
```
// Emit an event for the modified asset.  
var event = getFactory().newEvent('org.acme.sample', 'SampleEvent');  
event.asset = tx.asset;  
event.oldValue = oldValue;  
event.newValue = tx.newValue;  
emit(event);
```

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

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

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

# 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
}
```

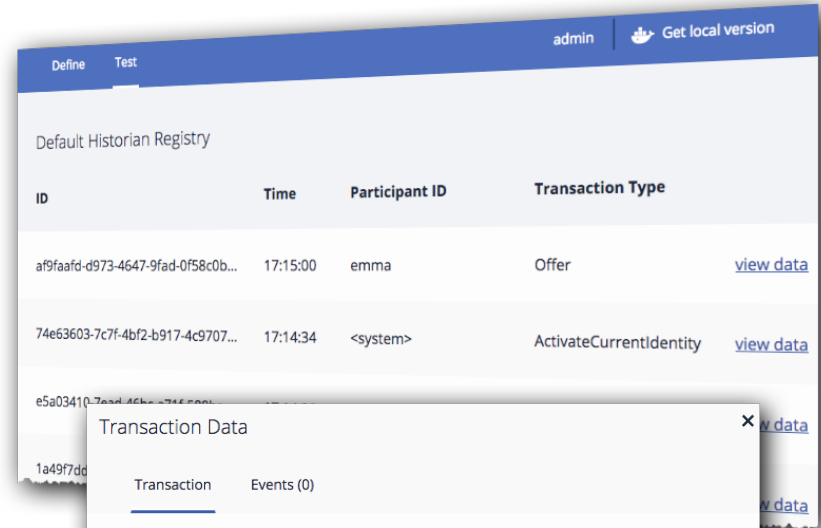
```
rule OwnerHasFullAccessToTheirAssets {
  description: "Allow all participants full access to their assets"
  participant(p): "org.acme.sample.SampleParticipant"
  operation: ALL
  resource(r): "org.acme.sample.SampleAsset"
  condition: (r.owner.getIdentifier() == p.getIdentifier())
  action: ALLOW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

```
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

# 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>



ID	Time	Participant ID	Transaction Type
af9faafd-d973-4647-9fad-0f58c0b...	17:15:00	emma	Offer
74e63603-7c7f-4bf2-b917-4c9707...	17:14:34	<system>	ActivateCurrentIdentity

```
1 {
2   "$class": "org.hyperledger.composer.system.HistorianRecord",
3   "transactionId": "af9faafd-d973-4647-9fad-0f58c0ba7d15",
4   "transactionType": "Offer",
5   "transactionInvoked":
6     "resource:org.hyperledger.composer.system.Transaction#af9faafd-
7       d973-4647-9fad-0f58c0ba7d15",
8   "participantInvoking":
9     "resource:org.hyperledger.composer.system.Participant#emma",
10    "identityUsed":
11      "resource:org.hyperledger.composer.system.Identity#8d0fdf5ef7c0062f
12        67853ecf9b36544b2e2c36f0e9b9536166dc0f056a62a032",
13    "eventsEmitted": [],
14    "transactionTimestamp": "2017-08-11T16:15:00.161Z"
15 }
```

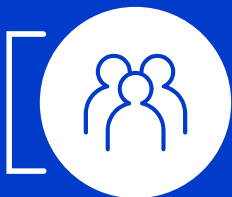


What is Hyperledger  
Composer?



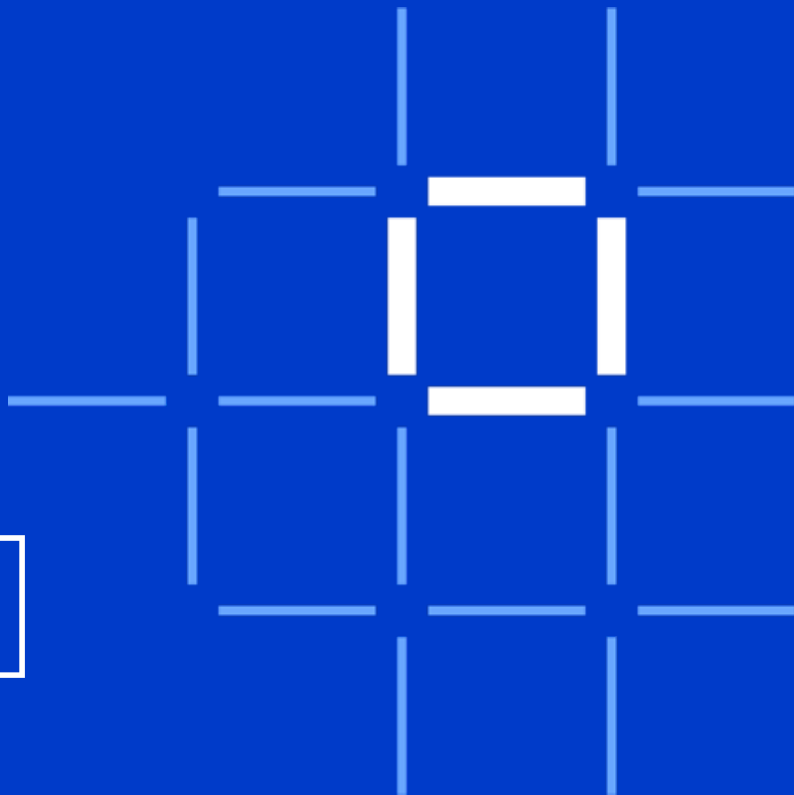
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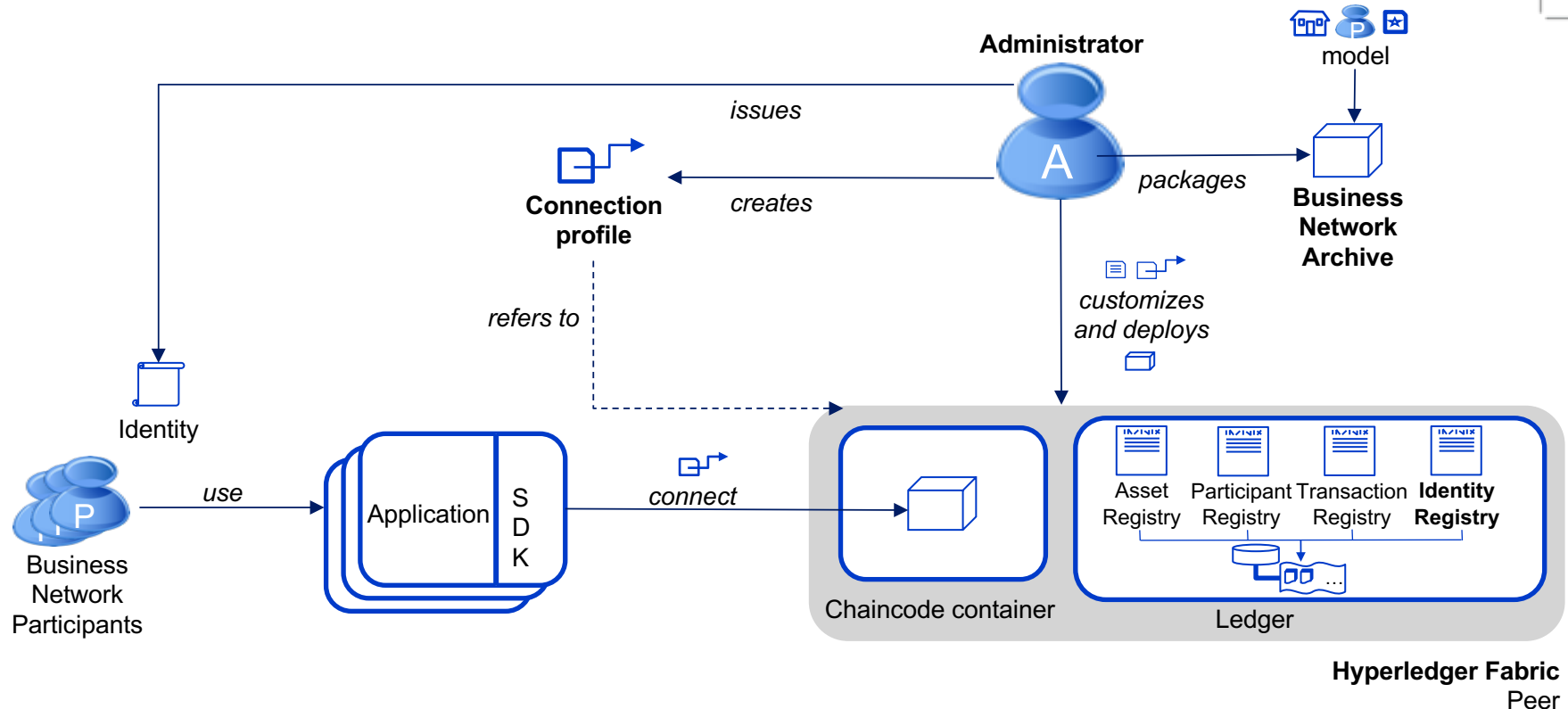
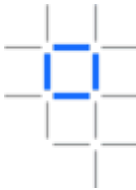


Effective Administration

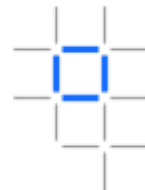
*Deploying to a blockchain*  
*Interacting with systems of record*



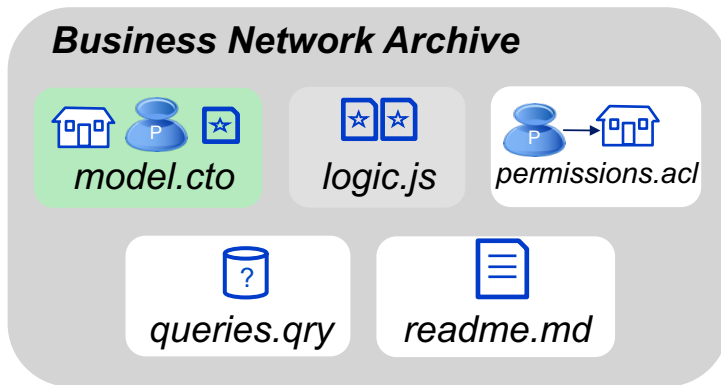
# Key Concepts for the Administrator



# Resources are packaged into BNA files

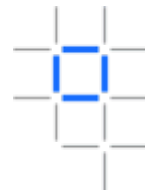


- Business Network Archive (.BNA) is a package of the resources used by Fabric:
  - Model files (.CTO)
  - Transaction processors (.JS)
  - Access Control Lists (.ACL)
  - Static queries (.QRY)
  - Documentation and versioning (.MD)
  - It does *not* contain the client application
- The BNA simplifies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

# Deployment to Hyperledger Fabric



The screenshot shows the 'Basic Configuration' tab of the Hyperledger Composer interface. It contains the following fields:

- Connection Profile Name:** hlfabric
- Orderer(s):**
  - Orderer URL:** grpc://orderer.example.com:7050
- Channel:** composerchannel
- MSP ID:** Org1MSP
- Certificate Authority (CA):**
  - URL:** http://ca.org1.example.com:7054
  - Name:** ca.org1.example.com
- Peer(s):**
  - Peer Request URL:** grpc://peer0.org1.example.com:7051
  - Peer Event URL:** grpc://peer0.org1.example.com:7053
- Key Value Store Directory:** /home/composer/.composer-credentials

At the bottom, there are two buttons: 'Use this profile' (blue) and 'Export Connection Profile' (white with a download icon).

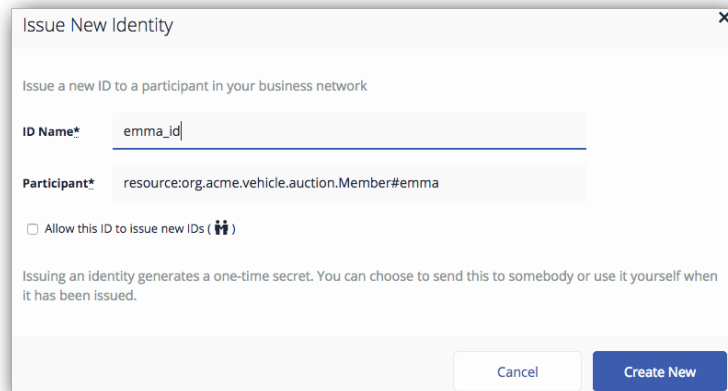
- Command line tool to script deployment

```
composer network deploy -p myProfile -a my.bna -i user -s secret
```

- Use Connection profiles to describe Fabric connection parameters
  - Export from Playground, generate from script or create by hand
- Enrollment in Hyperledger Fabric network required
  - Issue Fabric identity from Composer participants
- Additional command line options for management of business network
  - For example: download, list, start, undeploy, upgrade...

# Participant Identity

- Participants require an *identity* in order to connect to Hyperledger Fabric
  - Issued by the administrator as a Hyperledger Fabric userid/secret
  - Supplied by the participant when the client application connects
- Composer Participant to Fabric Identity mapping is stored on the blockchain in an *identity registry*
- Perform identity management from Playground, Javascript, REST or command line
  - For example: Test connection, issue identity, bind an identity to a participant, revoke an identity, list identities



Issue New Identity

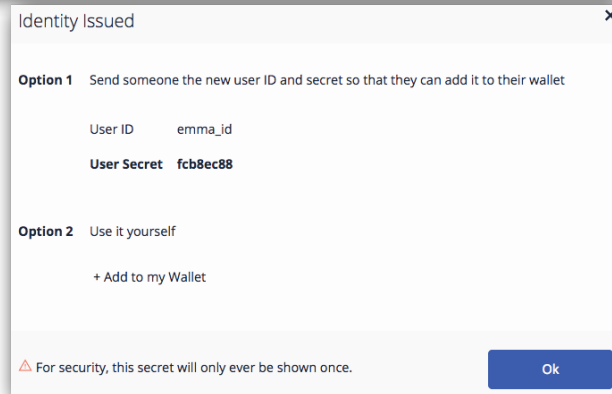
Issue a new ID to a participant in your business network

ID Name\*

Participant\*

☐ Allow this ID to issue new IDs (👤)

Issuing an Identity generates a one-time secret. You can choose to send this to somebody or use it yourself when it has been issued.



Identity Issued

**Option 1** Send someone the new user ID and secret so that they can add it to their wallet

User ID

User Secret

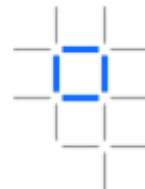
**Option 2** Use it yourself

⚠ For security, this secret will only ever be shown once.



# 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)



## angular-app

Auctioneer : A participant named Auctioneer		Show/Hide	List Operations
CloseBidding : A transaction named CloseBidding		Show/Hide	List Operations
Member : A participant named Member		Show/Hide	List Operations
Offer : A transaction named Offer		Show/Hide	List Operations
Vehicle : An asset named Vehicle		Show/Hide	List Operations
GET	/Vehicle	Find all instances of the model matched by filter fro	
POST	/Vehicle	Create a new instance of the model and persist it in	
GET	/Vehicle/{id}	Find a model instance by {{id}} fro	

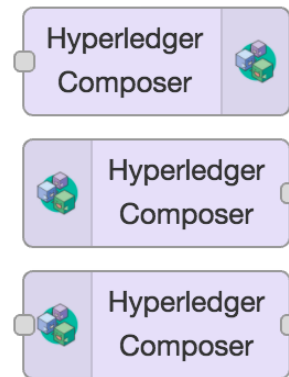
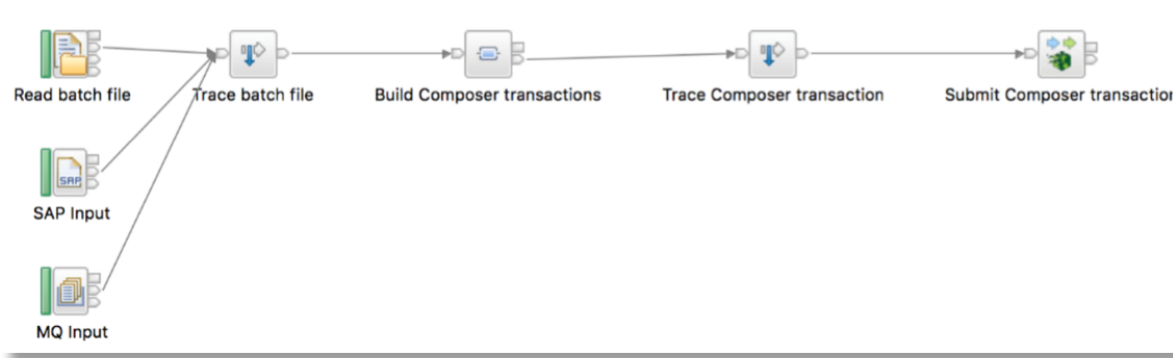
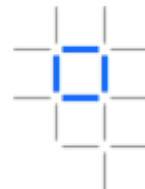
### Request URL

http://0.0.0.0:3000/api/Vehicle

### Response Body

```
{
  {
    "$class": "org.acme.vehicle.auction.Vehicle",
    "vin": "VEH:1234",
    "owner": "odowda@uk.ibm.com"
  }
}
```

# Exploiting Loopback: Examples



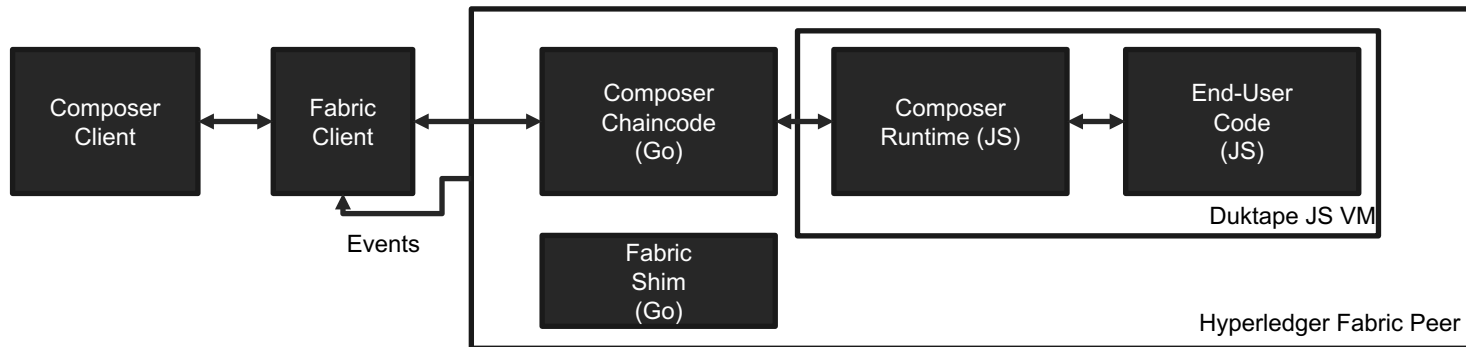
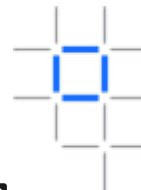
## – IBM Integration Bus

- 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!



## Hyperledger Rocket.Chat

You will need a [Linux Foundation ID](#) , or alternatively you can log in with Facebook, GitHub, Google, or OpenStack.

Let's chat

## Stack Overflow

Ask questions in Stack Overflow with the tag [#hyperledger-composer](#).

Ask now

## Contribute to the Project

### GitHub

Check out the code, feel free to get involved.

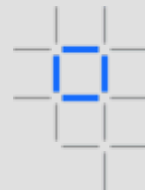
GitHub

## Community Call

Join our weekly open community calls.

Learn how

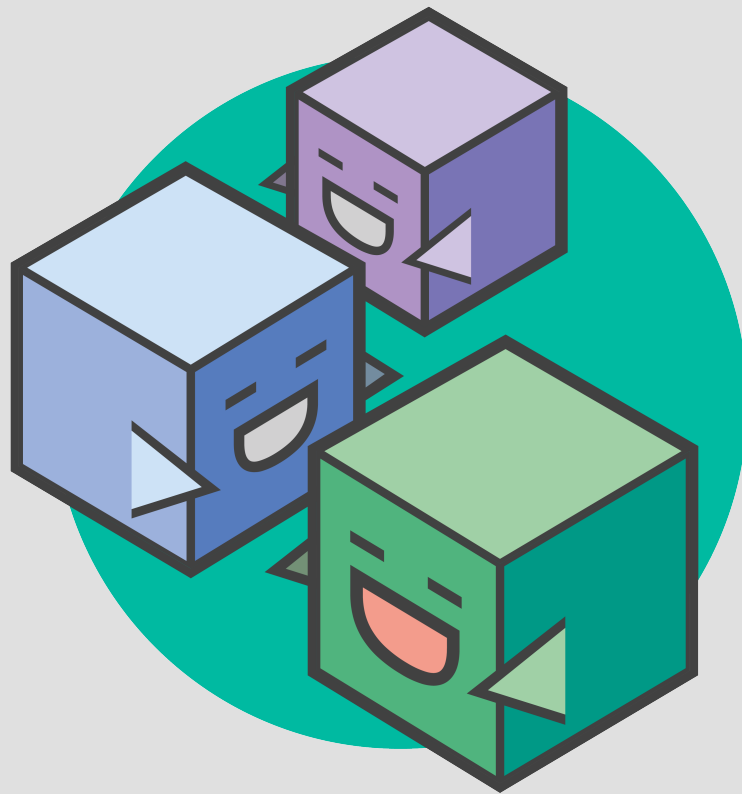
# Get started with Hyperledger Composer



- 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

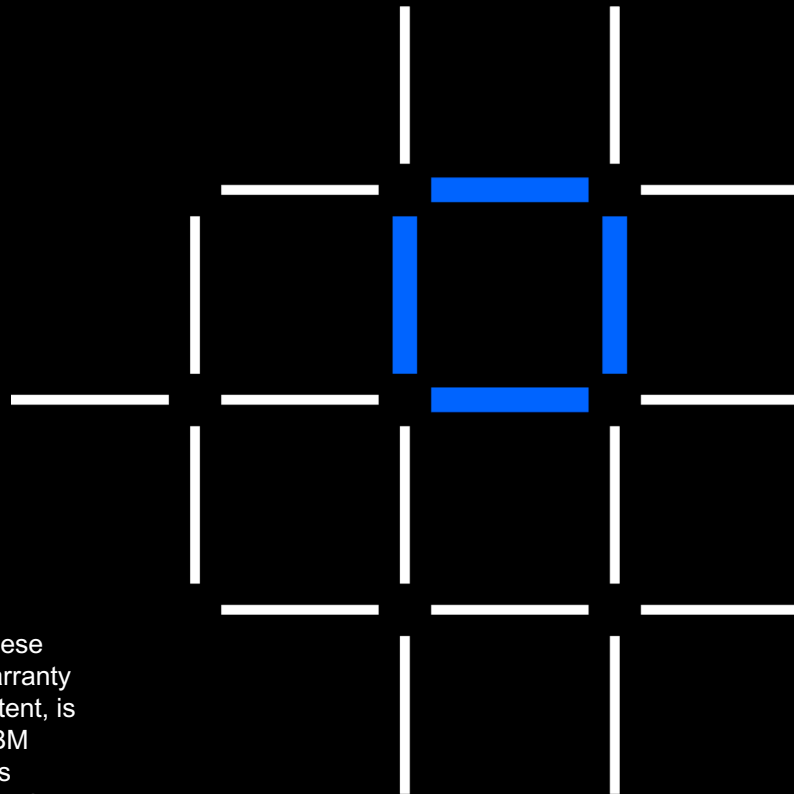
## IBM Blockchain

[www.ibm.com/blockchain](http://www.ibm.com/blockchain)

[developer.ibm.com/blockchain](http://developer.ibm.com/blockchain)

[www.hyperledger.org](http://www.hyperledger.org)

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