Module 10

Plugins and APIs

Learning outcomes

- Understand how nodes are customized using plugins
- Learn how to register an API
- Learn how to write your own node API

Node plugins

- Plugins extend the node to offer APIs and static web content
- The nodes registers any plugins it wishes to use in its **WebServerPluginRegistry**
- These plugins contain two things:
  - Web APIs hosted by the node
  - Any associated static web content

WebServerPluginRegistry

- Corda web plugins subclass **CordaPluginRegistry**:

```
interface WebServerPluginRegistry {

    val webApis get() = emptyList()

    val staticServeDirs get() = emptyMap()

}
```

Registering APIs

- The syntax to register an API in the plugin is as follows:

```
override val webApis: List<Function<CordaRPCOps, out Any>>
   = listOf(
                          Function(::ExampleApi1),
                          Function(::ExampleApi2)
             )
```

- The API itself is defined using Java's **JAX-RS**:

```
@Path("example")
class ExampleApi(val services: CordaRPCOps)

…
```

Registering static web content

- The syntax to register static web content in the plugin is as follows:

```
override val staticServeDirs: Map<String, String>
            = mapOf(
            "example" to javaClass
                                        .classLoader
                                        .getResource("exampleWeb")
                                        .toExternalForm()
                        )
```

- The static web content is placed in the resources directory, in a folder with the same name as the string passed to **getResource** above

Using plugins on a node

- Each CorDapp contains a *src/main/resources/META-INF/services* folder containing a file called **net.corda.webserver.services.WebServerPluginRegistry**
- The node will only load plugins if their fully-qualified class name is listed in this file:

```
# Register a ServiceLoader service extending from
net.corda.webserver.services.WebServerPluginRegistry

com.example.plugin.ExamplePlugin
```

Plugins in summary

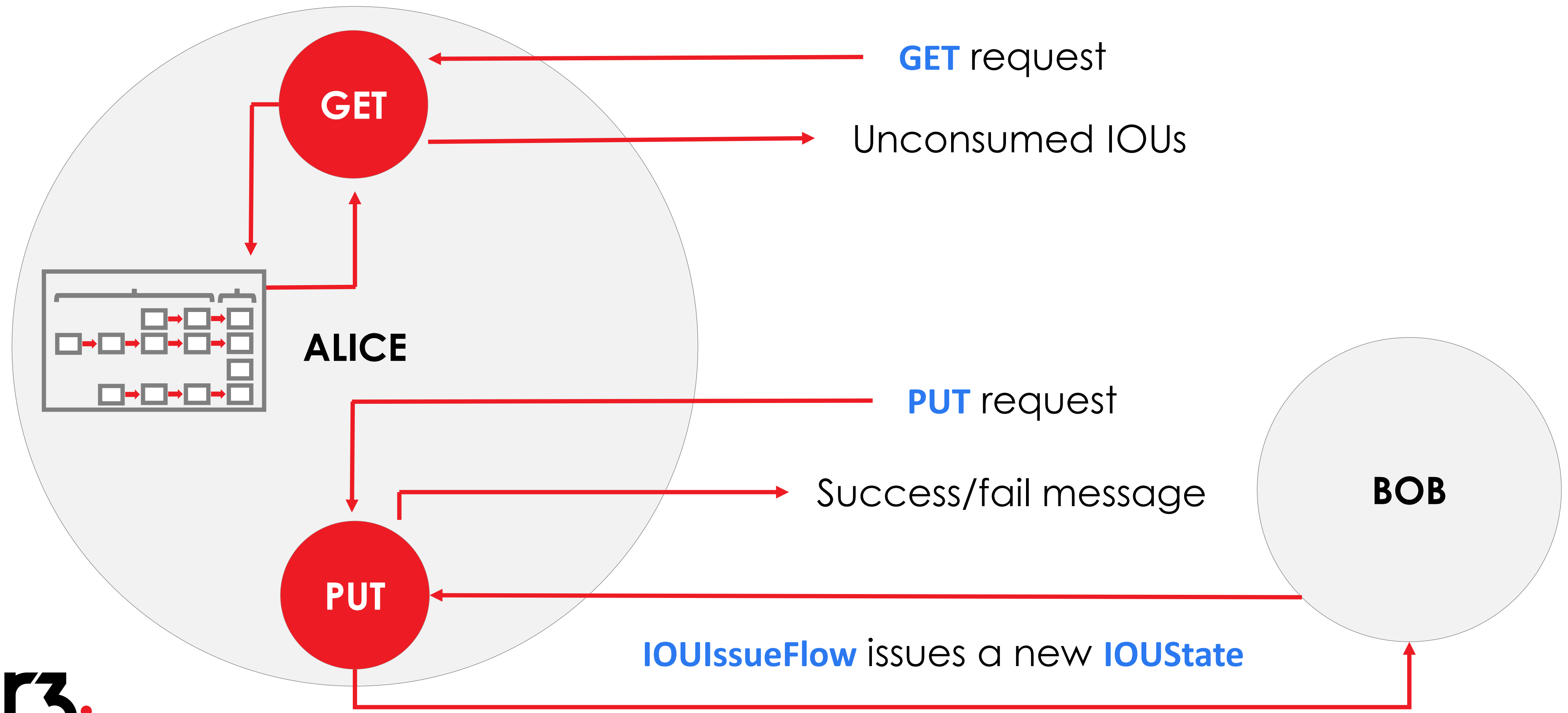
- Plugins extend the node to offer:
  - Web APIs
  - Static web content
- New plugins must be registered in the node’s **WebServerPluginRegistry**

Practical

Building the API

- Our API will have two endpoints to start with:
  - A **GET** endpoint listing the states in the node's vault
  - A **PUT** endpoint enabling us to issue IOUs

IOU API Diagram



Step 1 – Testing Endpoints

Testing GET Endpoints with Postman

- We will be implementing a **GET** endpoint on the path "ious" to retrieve the node's vault states
- We'll use Postman to hit the endpoints
  - Download instructions: https://www.getpostman.com/
  - Installation instructions: https://www.getpostman.com/docs/install_native
- Making **GET** requests with Postman:
  - Change the verb to "GET" in the top-left dropdown
  - Enter the URL for the first node's endpoint, http://localhost:10005/api/iou/ious
  - Press "Send"

Testing Get-IOUs Endpoint - Instructions

Goal	Test the **GET** endpoint
Where?	The command line
Steps	1. Deploy the nodes: • Unix: **./gradlew deployNodes** • Windows: **gradlew deployNodes** 2. Run the nodes: • Unix: **sh build/nodes/runnodes** • Windows: **build\nodes\runnodes** 3. Use Postman to test the endpoint 4. The endpoint will return a 404 “Not Found” error
Key Docs	https://www.getpostman.com/docs/requests

Step 2 – The Get-IOUs Endpoint

GET Endpoint Syntax

- The node's API is defined in JAX-RS, the Java API for RESTful web services
- We define a **GET** endpoint as follows:

```
@GET
@Path("exampleGetEndpoint")
@Produces(MediaType.APPLICATION_JSON)
fun exampleGETEndpoint() {
    return Response.accepted()
        .entity("Example GET endpoint.")
        .build();
}
```

- Where:
  - **@GET** specifies the endpoint's type
  - **@Path** specifies the endpoint's relative path
  - **@Produces** specifies the endpoint's return type

The Get IOUs Endpoint

- Our **GET** endpoint will list the states in the node's vault
- The API holds a **CordaRPCOps** object that allows us to perform actions such as retrieve transactions or start flows
- **CordaRPCOps.vaultTrackBy** returns a **DataFeed** of:
  - The states currently in the node's vault
  - An observable to monitor for future vault updates
- We are only interested in the existing states, not the future updates

The Get-IOUs Endpoint - Implementation

Goal	Create a **GET** endpoint for retrieving a node's active states
Where?	IOUAPI.Kt
Steps	1. Implement a **GET** endpoint on the path "ious" to retrieve a list of the node's vault states
Key Docs	https://docs.oracle.com/javaee/7/tutorial/jaxrs002.htm

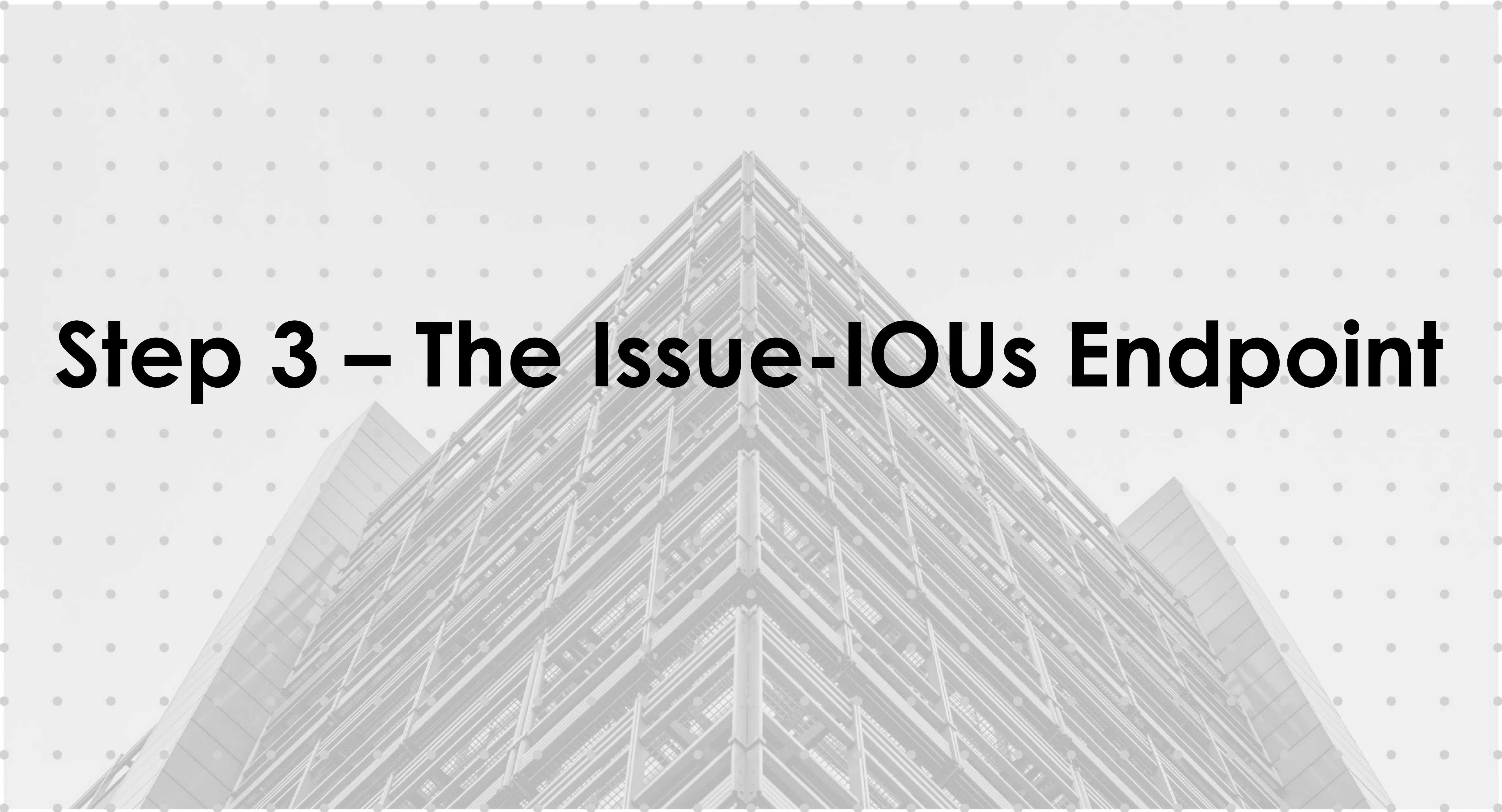
The Get-IOUs Endpoint - Solution

Goal	Set up a **GET** endpoint returning the node's active states
Steps	• Update the endpoint's path • Change the return type • Return only the first element of **vaultAndUpdates**

Code	`@GET`
	`@Path("ious")`
	`@Produces(MediaType.APPLICATION_JSON)`
	`fun getIOUs() = services.vaultQueryBy<IOUState>().states`

Testing the Get-IOUs Endpoint - Instructions

Goal	Test the **GET** endpoint
Where?	The command line
Steps	1. Make sure you've killed any nodes that are currently running 2. Deploy the nodes: • Unix: **./gradlew deployNodes** • Windows: **gradlew deployNodes** 2. Run the nodes: • Unix: **sh build/nodes/runnodes** • Windows: **build\nodes\runnodes** 3. Use Postman to test the endpoint 4. The endpoint will return an empty list – there's nothing in the vault yet!
Key Docs	N/A



Step 3 – The Issue-IOUs Endpoint

The Issue-IOUs Endpoint

- The ultimate goal of our new endpoint is to start the **IOUIssueFlow** and agree an IOU
- For now, the endpoint will just take the query-string params and return them as the body of an **Accepted Response** object
- The query-string params will be:
  - **amount (Int)**: the value of the IOU
  - **currency (String)**: the code of the IOU's currency
  - **party (String)**: the name of the party receiving the IOU

The Issue-IOUs Endpoint - Instructions

Goal	Start building the endpoint to issue IOUs
Where?	IOUAPI.kt
Steps	1. Implement a **PUT** endpoint on path "issue-iou" that: • Takes an "amount", "Currency" and a "party" as querystring params • Returns an **CREATED** response to the user with these values as the response's body
Key Docs	N/A

The Issue-IOUs Endpoint - Solution

Goal	Set up a dummy **PUT** endpoint for testing
Steps	• Create a **PUT** endpoint taking three querystring params • Return the querystring params in a HTTP response
Code	see below

```
@PUT
@Path(”issue-iou")
fun issue-iou(
   @QueryParam(value = ”amount") amount: Int,
   @QueryParam(value = ”currency") currency: String,
   @QueryParam(value = "party") party: String): Response {

   return Response
         .status(Response.Status.CREATED)
         .entity(“$amount $currency $party”)
         .build();
}
```

Testing the Issue-IOUs Endpoint - Instructions

Goal	Test the **PUT** endpoint
Where?	The command line
Steps	1. Make sure you've killed any nodes that are currently running 2. Re-deploy the nodes: • Unix: **./gradlew deployNodes** • Windows: **gradlew deployNodes** 3. Re-run the nodes: • Unix: **sh build/nodes/runnodes** • Windows: **build\nodes\runnodes** 4. Postman to test the endpoint 5. You should see your IOU value and counterparty • e.g. 99NodeC
Key Docs	N/A

Step 4 – Issuing IOUs via the API

Wiring up the Issue-IOUs Endpoint

- We need to extend our Issue-IOUs endpoint to actually issue an **IOUState** onto the ledger

- For this, our endpoint must:
  1. **Gather the flow's arguments:**
     - Retrieve the identities of the node and its counterparty
     - Create the Amount object for the amount to be issued
     - Construct the **IOUState** to be issued onto the ledger
  2. **Run the flow:**
     - Start the flow
     - Return the flow's result

- We'll start with the first step

Flow Set-Up

- We retrieve the node’s identity as follows:
  - CordaRPCOps.nodeInfo().legalIdentities.first()
- The counterparty’s identity is retrieved using:
  - CordaRPCOps.wellKnownPartyFromX500Name(CordaX500Name.parse(party))
- The Amount object is created using:
  - Amount(amount.toLong() * 100, Currency.getInstance(currency))
- Then to create an **IOUState** instance with the desired attributes and send the state to the Issue Flow

Flow Set-Up - Implementation

Goal	Continue building the Issue-IOUs endpoint
Where?	IOUAPI.java
Steps	1. Write the code to retrieve the party identities and create the desired **IOUState**
Key Docs	N/A

Flow Set-Up - Solution

Goal	Issue the **IOUState**
Steps	• Retrieve the **Party**s identities • Create the **Amount** object • Create the desired output **IOUState**

Code	`val me = services.nodeIdentity().legalIdentity`
	`val lender = services.wellKnownPartyFromX500Name(CordaX500Name.parse(party))`
	
	`val amountToIssue = Amount(`
	`    amount.toLong() * 100,`
	`    Currency.getInstance(currency))`
	
	`val state = IOUState(amountToIssue,lender,me);`

Kicking Off the Flow

- To actually start the flow, we call:

```
CordaRPCOps
    .startTrackedFlowDynamic(IOUIssueFlow::class.java, stateAndContract)
    .returnValue
    .get()
```

- This will:
  1. Return a **FlowHandle**
  2. Convert the **FlowHandle** into a **ListenableFuture**
  3. Convert the **ListenableFuture** into the on-ledger **SignedTransaction**

Returning a Response

- Finally, we return a **Created Response** object:

```
return Response
    .status(Response.Status.CREATED)
    .entity("Transaction id ${result.id} sent to counterparty.”)
    .build()
```

Kicking Off the Flow - Implementation

Goal	Finalize the Issue-IOUs endpoint
Where?	IOUAPI.java
Steps	1. Wire up the endpoint to kick off the **IOUIssueFlow** and return a response
Key Docs	Web logs accessible at tail -f build/nodes/ParticipantA/logs/web/node-<machine_name>.local.log

Kicking Off the Flow - Solution

<table>
<tr><td><b>Goal</b></td><td>Run the <b>IOUFlow</b> and return a HTTP response to the user</td></tr>
<tr><td><b>Steps</b></td><td>• Retrieve <b>IOUFlow</b>’s output
• Return a HTTP response with the transaction’s ID</td></tr>
<tr><td><b>Code</b></td><td><pre>val result = rpcOps.startTrackedFlow(::IOUIssueFlow, state)
                    .returnValue
                    .get()

return Response
   .status(Response.Status.CREATED)
   .entity("Transaction id ${result.id} sent to counterparty.”)
   .build()</pre></td></tr>
</table>

Step 5 – An End-to-End Test

An End-to-End Test - Instructions

Goal	Test the finalized Issue-IOUs endpoint
Where?	The command line
Steps	1. Make sure you've killed any nodes that are currently running 2. Deploy the nodes: • Unix: **./gradlew deployNodes** • Windows: **gradlew deployNodes** 3. Run the nodes: • Unix: **sh build/nodes/runnodes** • Windows: **build\nodes\runnodes** 4. Hit the **Issue-IOUs** endpoint 5. Use the **Get-IOUs** endpoint to check that the transaction has been recorded by the node
Key Docs	Postman collection with prebuilt endpoints is the template repository

An End-toEnd Test - Output

The endpoint should return the created IOU in JSON form!

```
[{"state":{
        "data":{
                "amount": "99.00 GBP",
                "lender": "C=US,L=New York,O=ParticipantB",
                "borrower": "C=GB,L=London,O=ParticipantA",
                "paid": "0.00 GBP",
                "linearId":{
                        "externalId": null,
                        "id": "2f1a3ec4-9e08-4dc3-a4b5-addd6f62bee3”
                },
                "participants":[
                        "C=US,L=New York,O=ParticipantB",
                        "C=GB,L=London,O=ParticipantA"]
                },
                "contract": "net.corda.training.contract.IOUContract",
                "notary": "C=GB,L=London,O=Network Map Service,CN=corda.notary.validating",
                "encumbrance": null,
                "constraint":{"attachmentId":48D97A620C18B4B2ED9FB7B89E05837FDF3BB5F6F1C5”}
        },
        "ref":{
                "txhash": "1877F31EF01EF342CC46118105B1C23ADDAE5DA07D74DE4F5260C242CBF8C8DE",
                "index": 0
        }
}]
```

Conclusion

Conclusion

- The IOU CorDapp is now complete
- We can apply the same process to build any CorDapp:

1. State	Write the states representing your shared facts
2. Contract Design	Design the constraints on the evolution of these facts
3. Contract Code	Use LedgerDSL to develop the corresponding contract
4. Flow Design	Define the process of agreeing the shared facts
5. Flow Code	Use the Flow Testbed to develop the corresponding flow
6. User Interface	Define how you'll interact with your node: • Via an API • Via RPC