Exploring The Demo

Canton Network Quickstart Guide | 2025

Version: 1.0.7-2025-04-21

Contents

Exploring the Demo

The CN-QS and its guides are a work-in-progress (WIP). As a result, the CN-QS guides may not accurately reflect the state of the application. If you find errors or other inconsistencies, please contact your representative at Digital Asset.

This section works through a complete business operation within the CN-QS.

Prerequisites

You should have successfully installed the CN-QS before beginning this demonstration.

Access to the CN-Quickstart Github repository and CN Docker repository is needed to successfully pull the Digital Asset artifacts from JFrog Artifactory.

Access to the *Daml-VPN* connection or a SV Node that is whitelisted on the CN is required to connect to `DevNet`. The GSF publishes a list of SV nodes who have the ability to sponsor a Validator node. To access `DevNet`, contact your sponsoring SV agent for VPN connection information.

If you need access, email support@digitalasset.com.

The CN-QS is a Dockerized application and requires Docker Desktop. Running CN-QS on `LocalNet` is resource intensive. It is recommended to allocate 18 GB of memory and 3 GB of Swap memory to properly run the required Docker containers. If you witness unhealthy containers, please consider allocating additional resources, if possible.

`DevNet` is not as intensive because the SVs and other `LocalNet` containers are hosted outside of your local machine.

Walkthrough

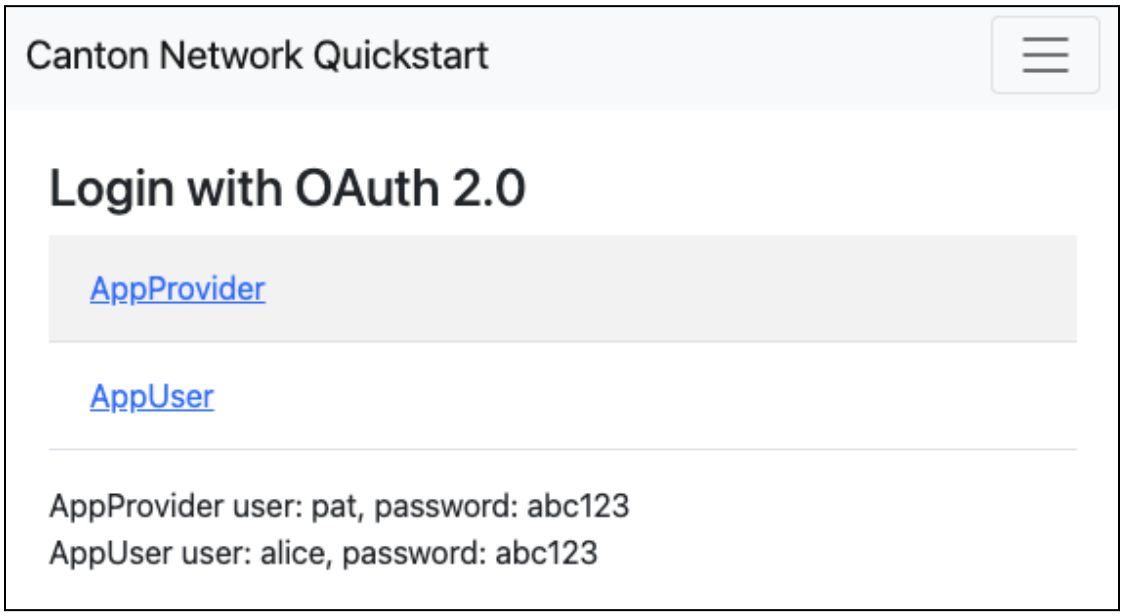
After the QS is installed and running, confirm that you are in the `quickstart` subdirectory of the CN-QS.
Open an incognito browser.
Navigate to:

```
localhost:3000/login
```

> 💡 Currently, `localhost` URLs do not work in Safari. We are working on a solution and apologize for the inconvenience.

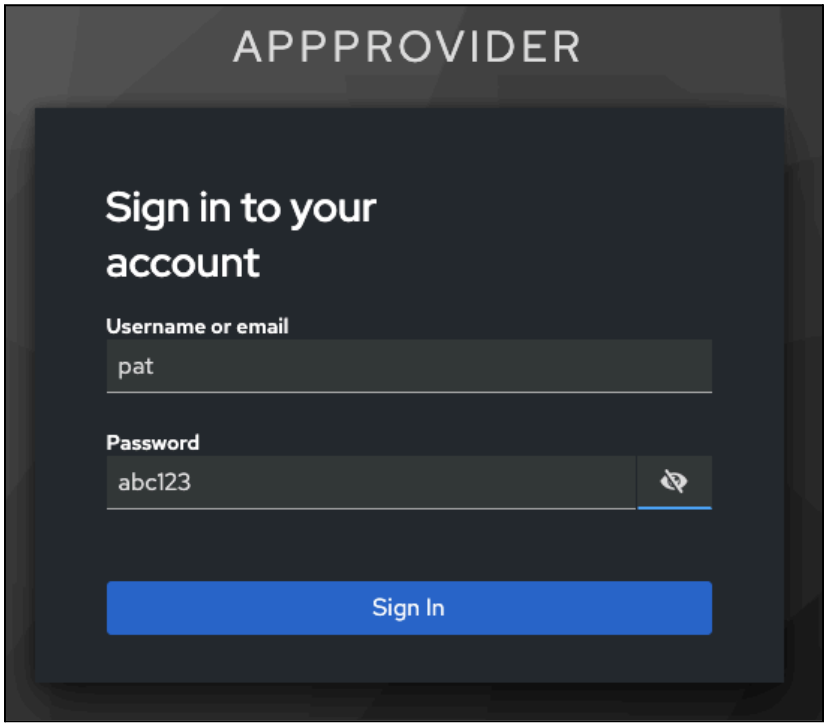
Alternatively, in the terminal, from `quickstart/` run:

```
make open-app-ui
```

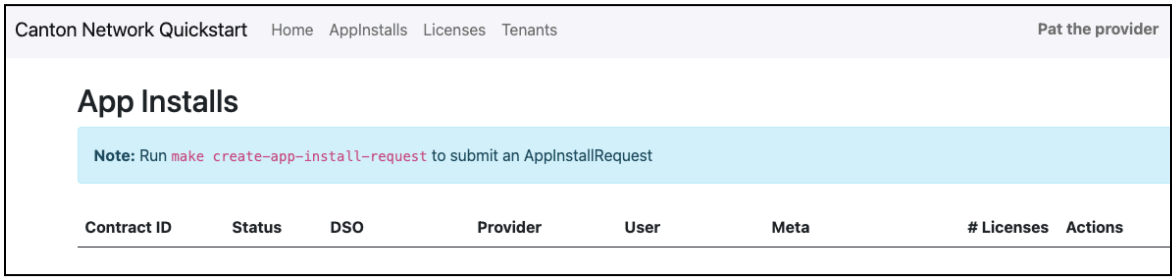


Make note that the AppProvider's username is "pat" and the password is "abc123" (all lowercase).

Login as the AppProvider.
Fill in the login credentials: username: pat, password: abc123



Select “AppInstalls” in the menu.



Open a terminal.
From `/quickstart/` run:

```
make create-app-install-request
```

This command creates an App Installation Request on behalf of the Participant.

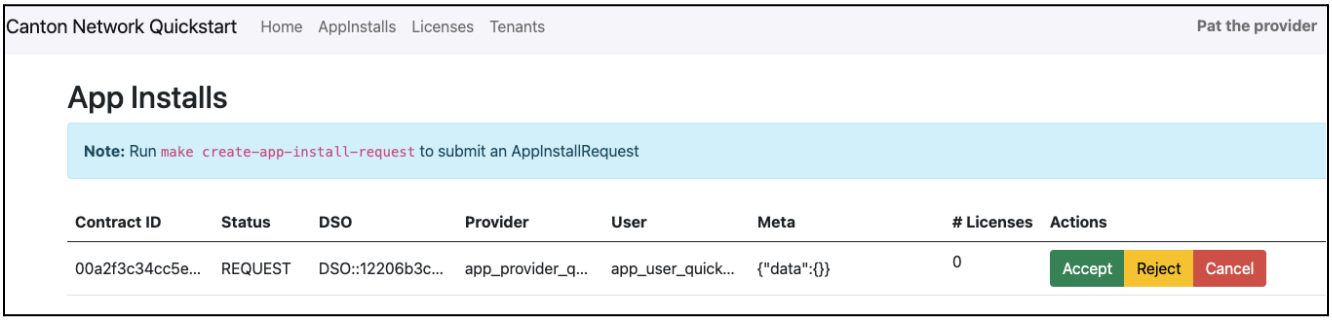
```
(base) quickstart ~ % make create-app-install-request
docker compose -f docker/app-user-shell/compose.yaml --env-file .env run --rm create-app-install-request ||
 true
get_token ledger-api-user AppProvider
get_user_party AppProvider participant-app-provider
http://participant-app-provider:7575/v2/users/AppProvider
get_token ledger-api-user Org1
get_user_party Org1 participant-app-user
http://participant-app-user:7575/v2/users/Org1
get_token administrator Org1
http://validator-app-user:5003/api/validator/v0/scan-proxy/dso-party-id
http://participant-app-user:7575/v2/commands/submit-and-wait
--data-raw {
        "commands" : [
           { "CreateCommand" : {
                "template_id": "#quickstart-licensing:Licensing.AppInstall:AppInstallRequest",
                "create_arguments": {
                    "dso": "DSO::12209a3af80af3fa93853be8a8b9f5887055edc3b0a94f4b198f486d08d197784c09",
                    "provider": "AppProvider::1220b3de80de523473aa2ca56745ef1fb29a2203dfd13029e0448336bbcf3
82aaf86",
                    "user": "Org1::1220e69bc6115cd8ed360aa6caafce122c2a24561262c2f6ce6a6070e170e9e8244d",
                    "meta": {"values": []}
                }
            }
           }

        ],
        "workflow_id" : "create-app-install-request",
        "application_id": "ledger-api-user",
        "command_id": "create-app-install-request",
        "deduplication_period": { "Empty": {} },
        "act_as": ["Org1::1220e69bc6115cd8ed360aa6caafce122c2a24561262c2f6ce6a6070e170e9e8244d"],
        "read_as": ["Org1::1220e69bc6115cd8ed360aa6caafce122c2a24561262c2f6ce6a6070e170e9e8244d"],
        "submission_id": "create-app-install-request",
        "disclosed_contracts": [],
        "domain_id": "",
        "package_id_selection_preference": []
    }
{"update_id":"1220aebcd64fc960c2aeec834d415967899994f21a69ef9cab5639b8521169a0ca67","completion_offset":81}
```

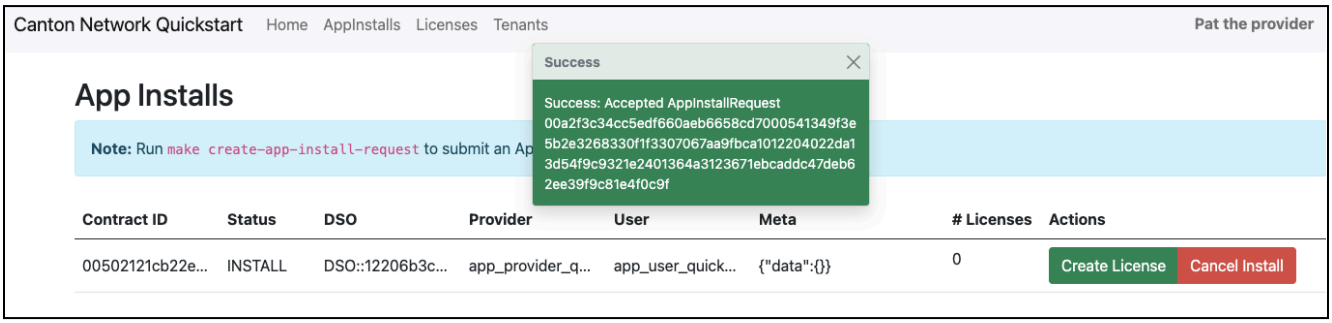
If your machine is not powerful enough to host `LocalNet` or if the docker containers are not responsive then the response may show a failure with status code `404` or `000`. Increasing Docker memory limit to at least 18 GB should allow the `LocalNet` containers to operate properly.

```
(base) quickstart ~ % make create-app-install-request
docker compose -f docker/app-user-shell/compose.yaml --env-file .env run --rm create-app-install-request || true
[+] Building 0.0s (0/0)                                                                 docker:desktop-linux
[+] Building 0.0s (0/0)                                                                 docker:desktop-linux
get_token ledger-api-user AppProvider
get_user_party AppProvider participant-app-provider
http://participant-app-provider:7575/v2/users/AppProvider
get_token ledger-api-user Org1
get_user_party Org1 participant-app-user
http://participant-app-user:7575/v2/users/Org1
get_token administrator Org1
http://validator-app-user:5003/api/validator/v0/scan-proxy/dso-party-id
Request failed with HTTP status code 404
Response body: The requested resource could not be found.
```

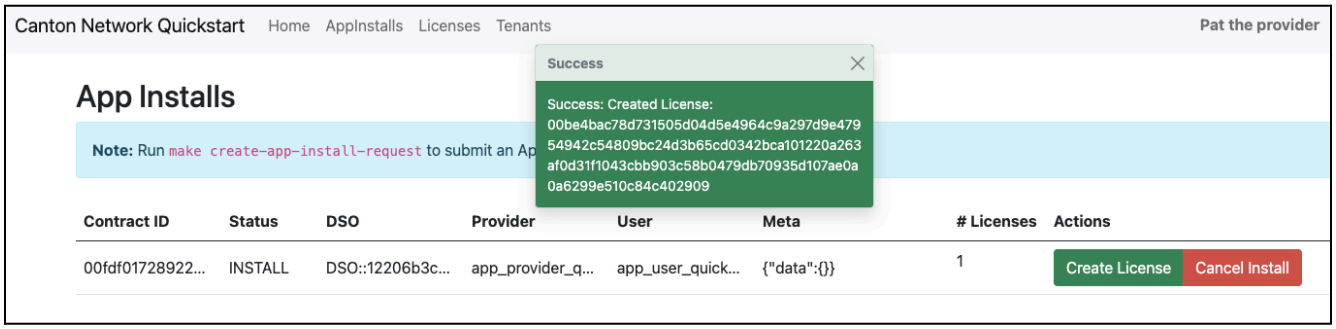
Return to the browser.
The install request appears in the list.
Click “Accept”.



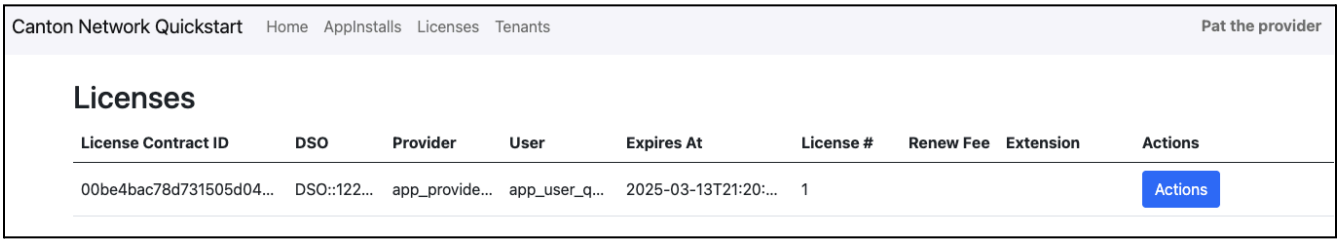
The `AppInstallRequest` is Accepted. The actions update to create or cancel the license.



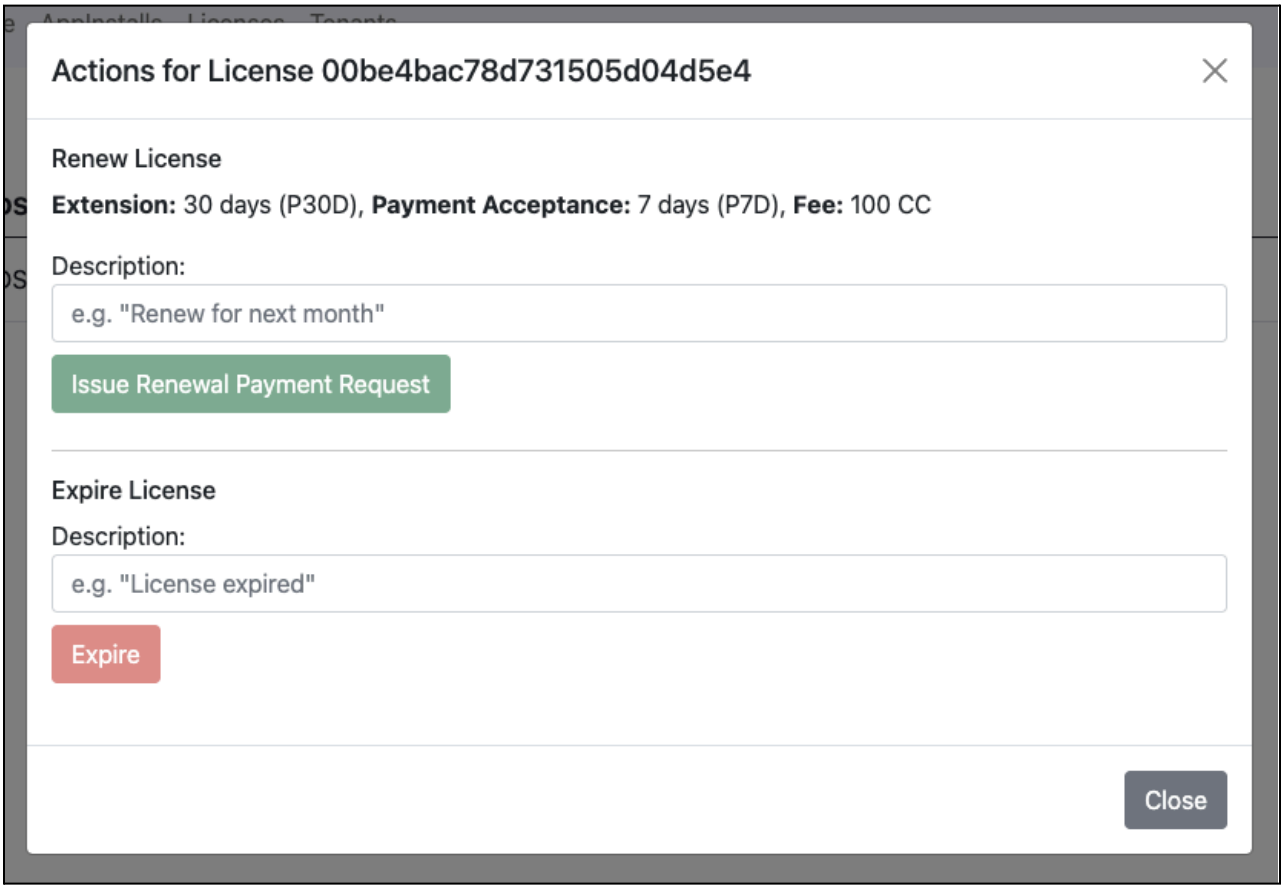
Click “Create License”.
The license is created and the “# Licenses” field is updated.



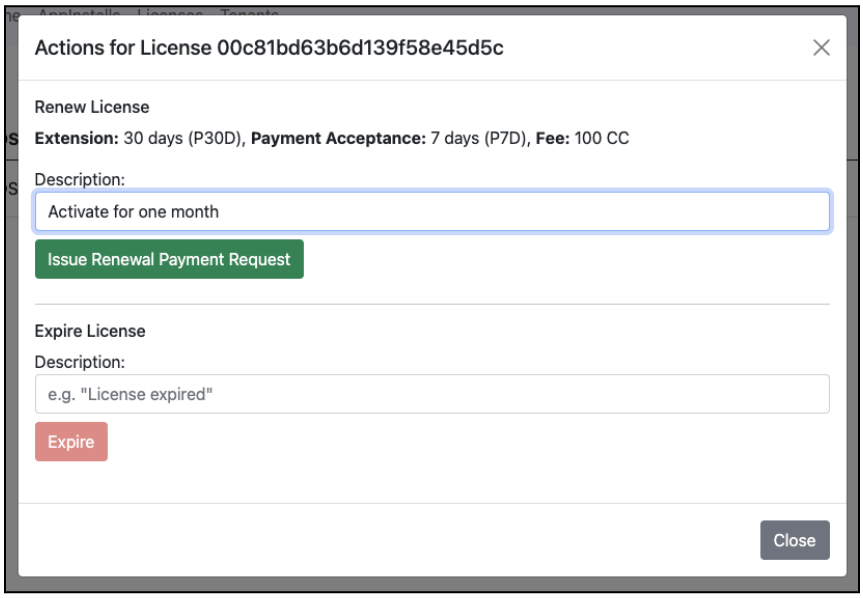
In the AppProvider, “Pat the provider’s,” account, navigate to the **Licenses** menu and select “Actions.”



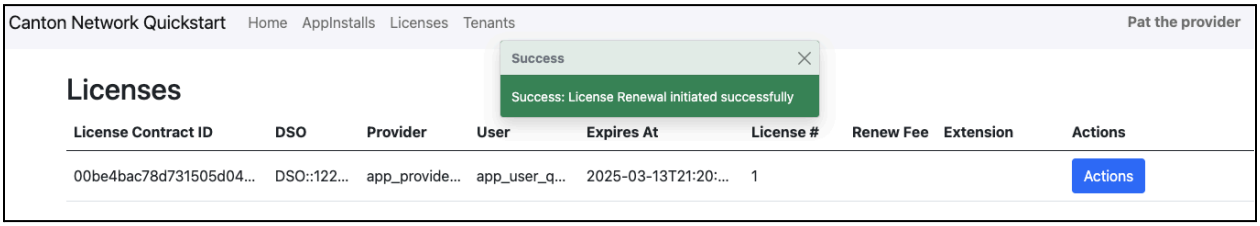
An “Actions for License” modal opens with an option to renew or expire the license. Per the Daml contract, licenses are created in an expired state. To activate the license, it must be renewed.



To renew the license, enter a description then click the green “Issue Renewal Payment Request” button.



The license renewal process is initiated and ultimately successful.



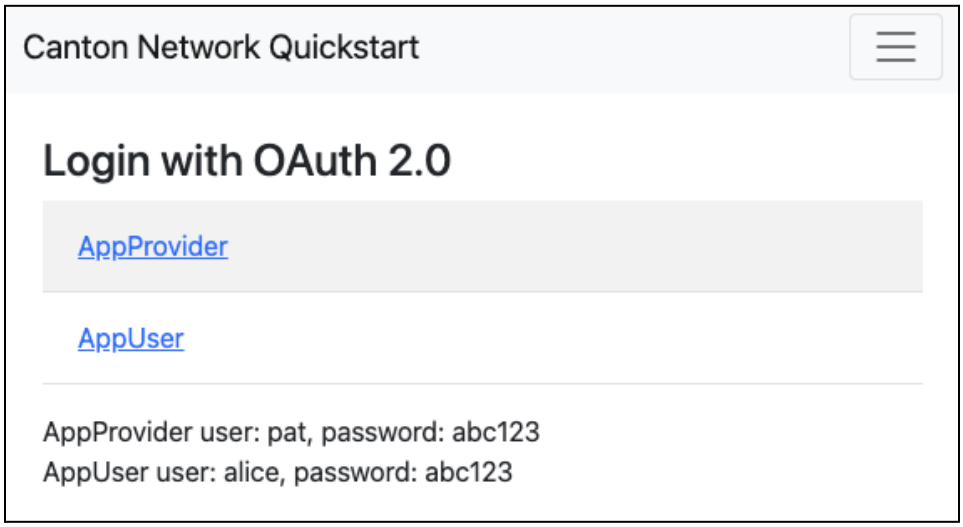
The license is now available for a 30-day extension for a flat fee of $100 CC.

.

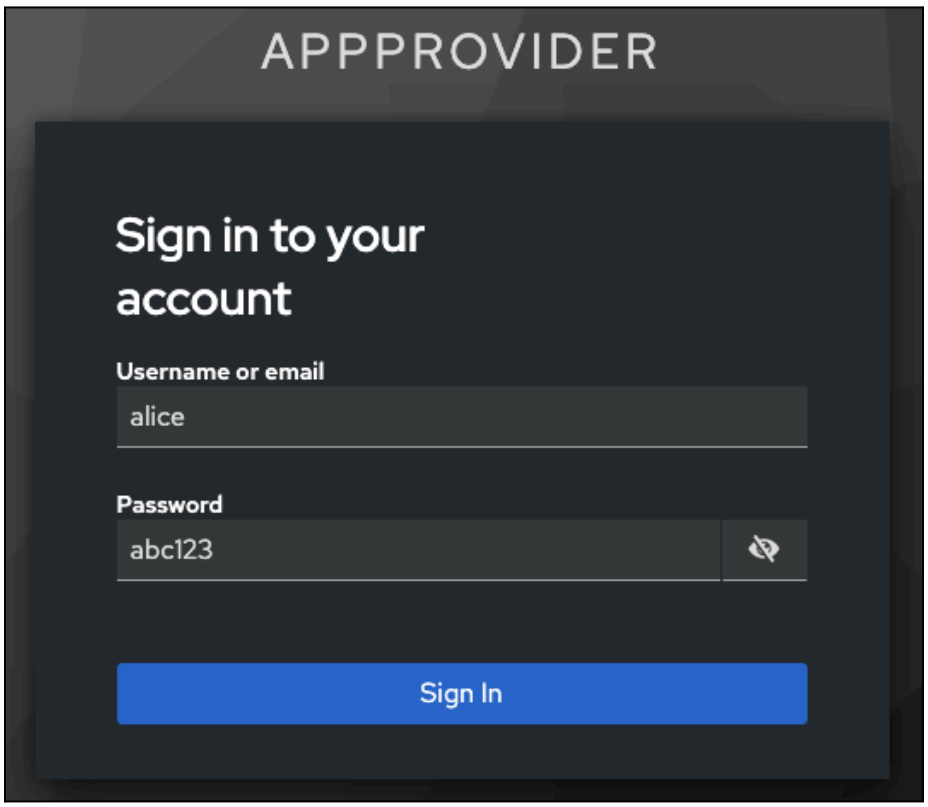
Pat the provider has done as much as they are able until Alice pays the renewal fee.

> 💡For the next step we recommend opening a separate browser in incognito mode. Each user, `AppProvider`, and `Org1`, should be logged into separate browsers for most consistent results. For example, if you logged into `AppProvider` using Chrome, you would use Firefox when logging into `Org1`.

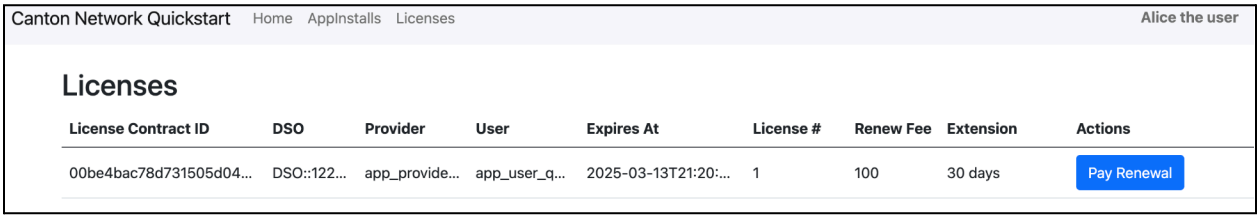
Navigate to `http://localhost:3000/login` using a separate browser in incognito or private mode.



Login as `AppUser` alice.
Note that AppUser's username is "alice" and the password is "abc123".

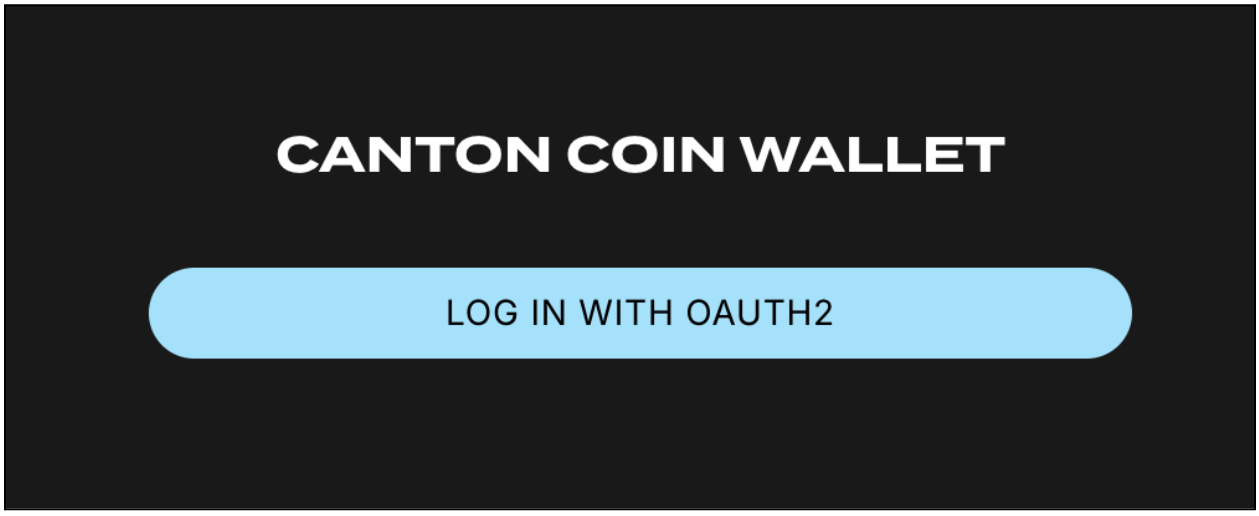


Go to the **Licenses** View and click the "Pay renewal" button.

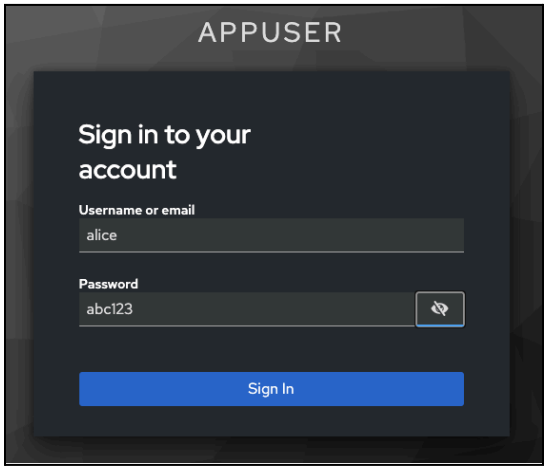


Click on the Pay Renewal button. This navigates to the Canton Coin Wallet log in. Click “LOG IN WITH OAUTH2”.

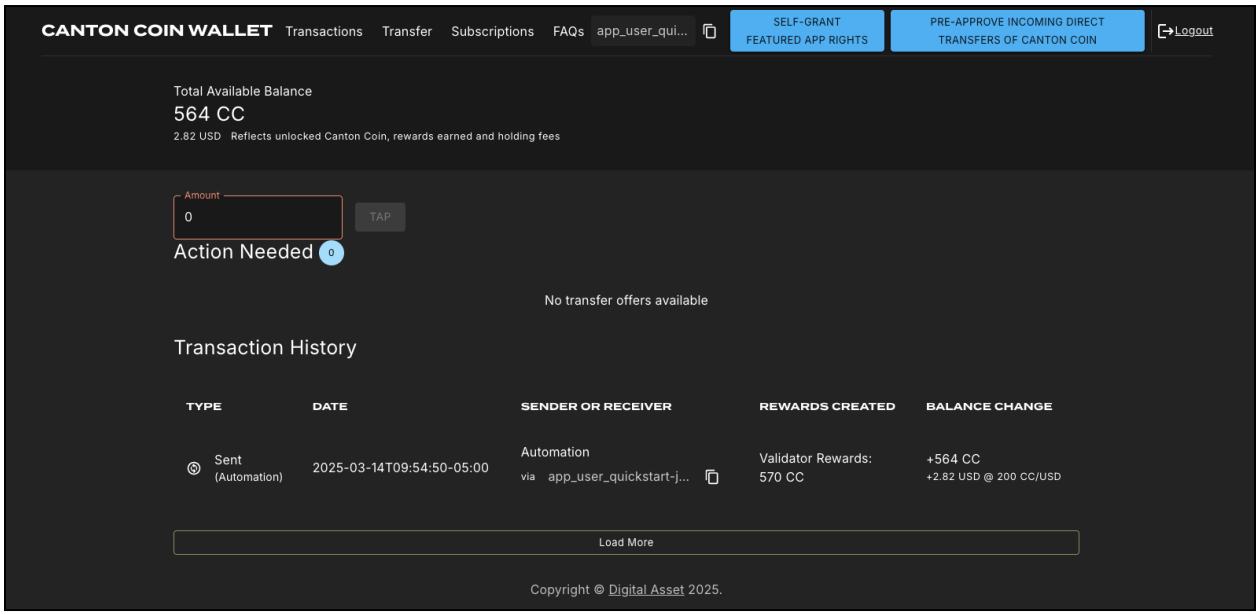
💡 If you have any issues with log in, navigate directly to http://wallet.localhost:2000/.



This navigates to a keycloak login.
Enter the same username and password as before.

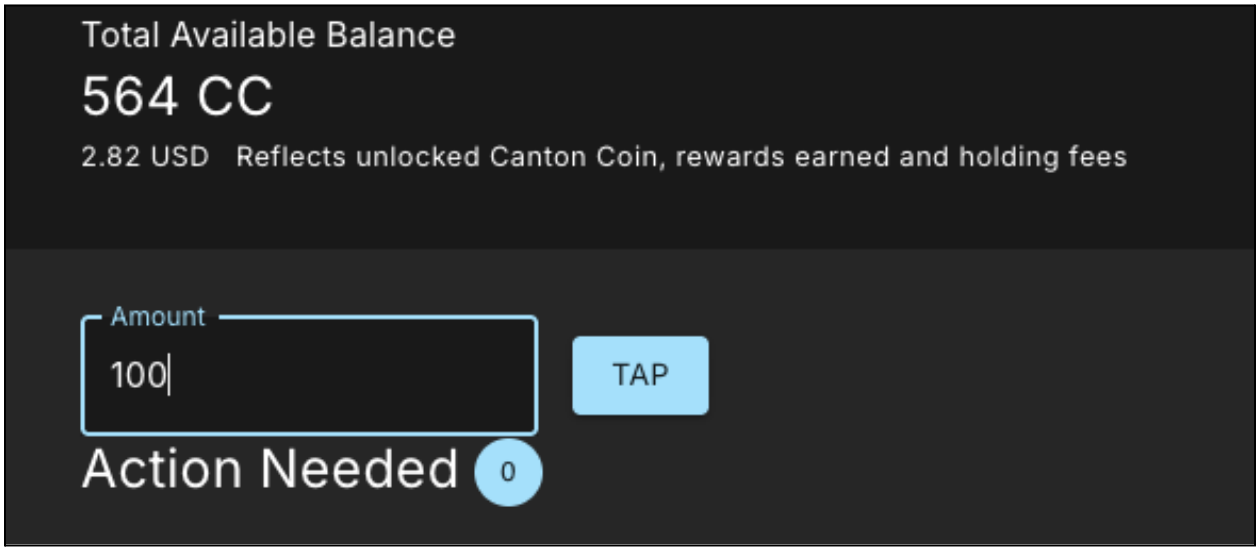


Signing in directs to the Canton Coin Wallet.

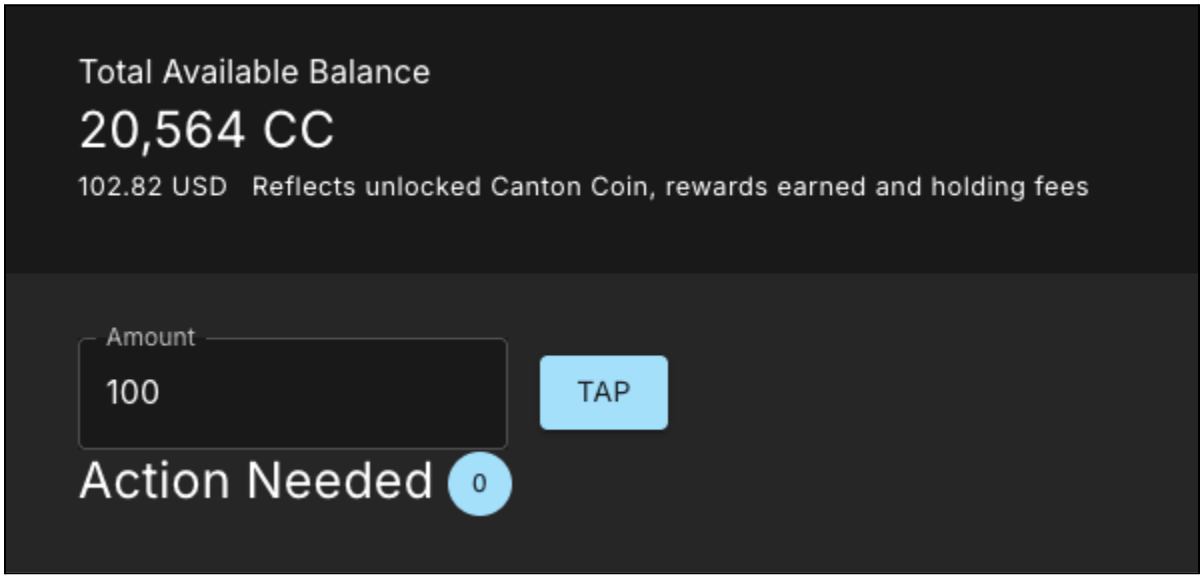


The wallet must be populated with CC in order to fulfill the transaction.

In CC Wallet, populate the wallet with $100 USD, or the equivalent of 20,000 CC.

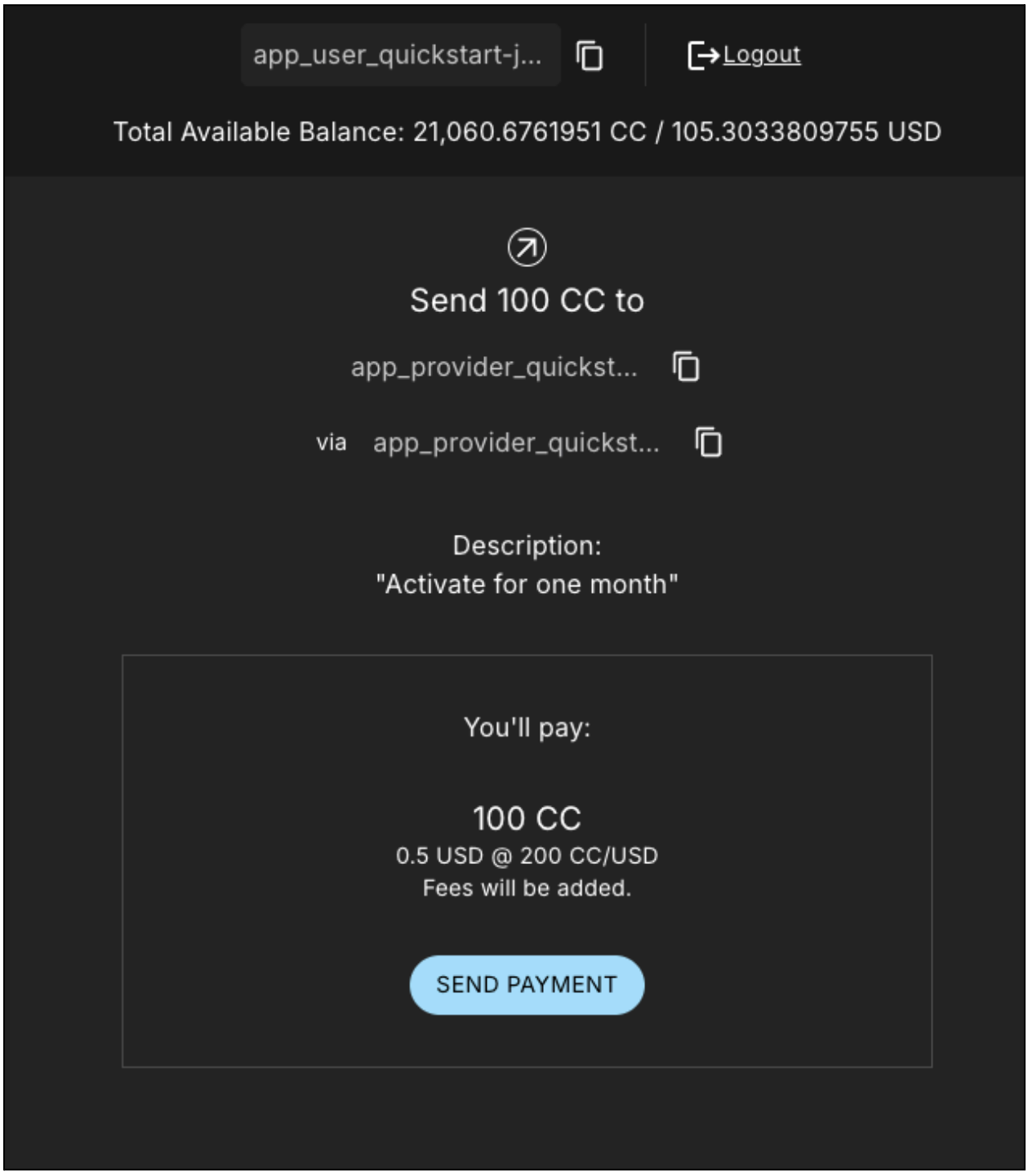


The wallet was prepopulated with 564 CC so it now contains 20,564 CC.

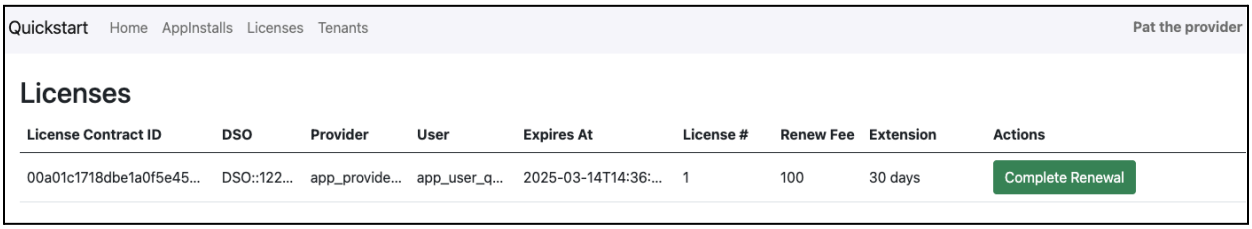


Return to the License Renewal Request as Org1. Click “Pay Renewal”.

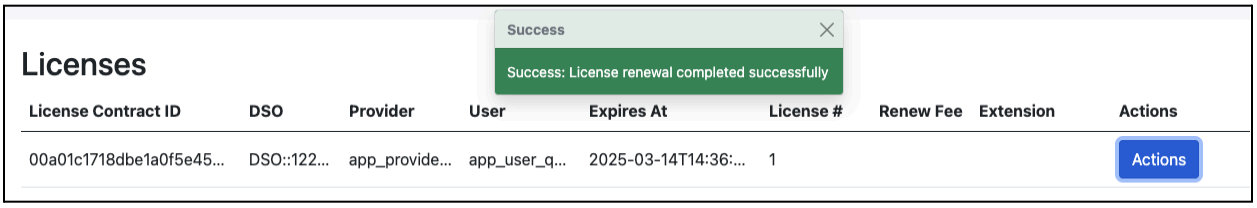
The CC Wallet balance is sufficient to send payment to the Provider.



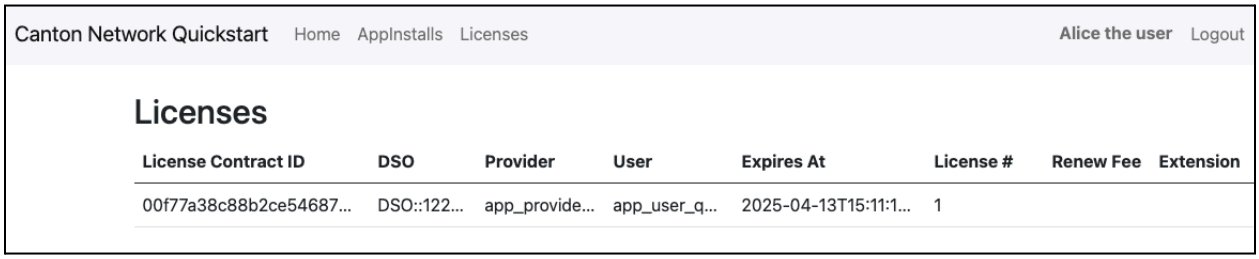
Return to the AppProvider's License Renewal Requests View.
The AppProvider may now Complete the Renewal.



Clicking "Complete Renewal" results in a Success.



Alice's License view shows the activated license.



Congratulations. You've successfully created and activated a license with a payment transfer!

Canton Console

The Canton Console connects to the running application ledger. The console allows a developer to bypass the UI to interact with the CN in a more direct manner. For example, in Canton Console you can connect to the Participant to see the location of the Participant and their domain.

The app provider and the app user each have their own console. To activate the app provider's Canton Console in a terminal from the `quickstart/` directory. Run:

```
make console-app-provider
```

Open the participant's Canton Console with

```
make console-app-user
```

After the console initiates, run the `participant` and `participant.domains` commands, respectively.

`participant`
Returns their location in the ledger.

```
[@ participant
res0: com.digitalasset.canton.console.RemoteParticipantReference = Participant 'participant'
```

`participant.domains`
Shows the Participant's synchronizer.

```
[@ participant.domains
res1: participant.domains.type = com.digitalasset.canton.console.commands.ParticipantAdministration$domains$@4f4c3934
```

`participant.health.ping(participant)`
Runs a health ping. The ping makes a round trip through the CN blockchain. Pinging yourself validates communication throughout the entire network.

```
[@ participant.health.ping(participant)
res0: Duration = 4979 milliseconds
```

Daml Shell

The Daml Shell connects to the running PQS database of the application provider's Participant. In the Shell, the assets and their details are available in real time.

Run the shell from `quickstart/` in the terminal with:

```
make shell
```

Run the following commands to see the data:

`active`
Shows unique identifiers and the asset count

```
postgres-splice-app-provider:5432/scribe> active
```

Identifier	Type	Count
quickstart-licensing:Licensing.AppInstall:AppInstall	Template	1
quickstart-licensing:Licensing.License:License	Template	1
splice-amulet:Splice.Amulet:Amulet	Template	1
splice-amulet:Splice.Amulet:ValidatorRight	Template	1
splice-wallet:Splice.Wallet.Install:WalletAppInstall	Template	1

`active quickstart-licensing:Licensing.License:License`

List the license details.

```
postgres-splice-app-provider:5432/scribe 6d → f7> active quickstart-licensing:Licensing.License:License
```

Created at	Contract ID	Contract Key	Payload
a9	000cd68ca7d2cf95454b…		dso: DSO::12203a329668884fac6377f41c924df6a11c59f3be909737d27799252930e537c42b user: Org1::12209d2965deec586b4a6d12b80e535bb52407fad54dc2dd88575291780ed5fd9ff4 params: meta: values: provider: AppProvider::12206e5249b12cd9fd05e9b25894c0663b73a18c90baccd7f2d48e7958157b510358 expiresAt: 2025-03-16T21:59:38.403435Z licenseNum: 1

`active quickstart-licensing:Licensing.License:LicenseRenewalRequest`

Displays license renewal request details.

`archives quickstart-licensing:Licensing.AppInstall:AppInstallRequest`

Shows any archived license(s).

```
postgres-splice-app-provider:5432/scribe 6d → f7> archives quickstart-licensing:Licensing.AppInstall:AppInstallRequest
```

Created at	Archived at	Contract ID	Contract Key	Payload
6f	75	00e906b2720a9b7965a3…		dso: DSO::12203a329668884fac6377f41c924df6a11c59f3be909737d27799252930e537c42b meta: values: user: Org1::12209d2965deec586b4a6d12b80e535bb52407fad54dc2dd88575291780ed5fd9ff4 provider: AppProvider::12206e5249b12cd9fd05e9b25894c0663b73a18c90baccd7f2d48e7958157b510358

Connect to DevNet

Stop the `LocalNet` containers to change the connection from `LocalNet` to `DevNet`.

In the terminal, run:

```
make stop && make clean-all
```

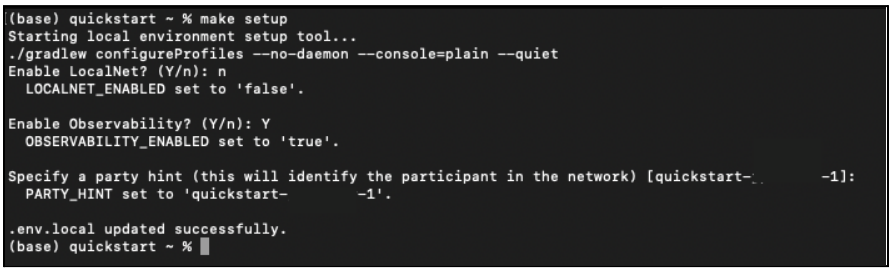
To edit the connection and observability parameters run:

```
make setup
```

When prompted to enable `LocalNet`, enter "`n`". This enables `DevNet`

Optionally, enter "`Y`" to enable observability. This starts additional containers which may require more memory for Docker.

You may leave the party hint as the default value by tapping 'return' on the keyboard.



💡Running `make setup` regenerates `.env.local` but preserves the contents of the `.env` file settings.

The application is now connected to `DevNet`.

Important: Migration ID for DevNet Connections

When connecting to `DevNet`, verify that the `MIGRATION_ID` value in `.env` matches the current network migration ID for your DevNet Super Validator (SV).

Check the current migration ID at https://sync.global/sv-network/ under the GSF DevNet information section.

For example, if the SV Node Information shows the `migration_id` value as "`0`" then update `MIGRATION_ID` to "`0`" in your `.env`.

GSF DevNet Super Validator Node Information


```
{
  "network": "devnet",
  "sv": {
    "migration_id": 0,
    "version": "0.3.15"
  },
  "synchronizer": {
    "active": {
      "chain_id_suffix": "5",
      "migration_id": 0,
      "version": "0.3.15"
    },
    "legacy": null,
    "staging": null
  }
}
```


In `.env`:

```
ONBOARDING_SECRET_URL=https://sv.sv-1.dev.global.canton.network.digitalasset.com/api/sv/v0/devnet/onboard/validator/prepare
MIGRATION_ID=0
APP_PROVIDER_VALIDATOR_PARTICIPANT_ADDRESS=participant-app-provider
APP_USER_VALIDATOR_PARTICIPANT_ADDRESS=participant-app-user
```

Configuring Non-Default DevNet Sponsors

In `DevNet` mode, you can configure a non-default `SPONSOR_SV_ADDRESS`, `SCAN_ADDRESS` and `ONBOARDING_SECRET_URL` or `ONBOARDING_SECRET` in the `quickstart/.env` file.

> 💡 Connecting to `DevNet` requires a connection to an approved SV. If your organization provides access to the DAML-VPN, then connect to it to access the Digital Asset-sponsored SV.
>
> Your organization may sponsor another CN-approved SV. If this is the case, speak with your administrator for privileged access.
>
> Review the DevNet Global Synchronizer (GS) documentation to learn more about the SV onboarding process.

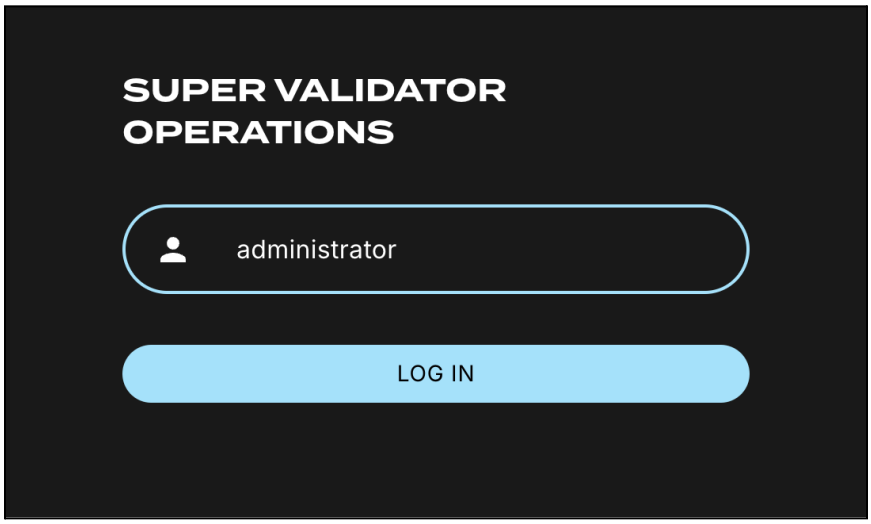
> ⏱️ If you run into errors when making `DevNet` operations, double check that the `DevNet` VPN is active. `DevNet` VPNs may timeout, especially if left unattended for extended periods of time.

In an incognito browser navigate to `localhost:3000/login`. Login as the `Org1` user and create and archive assets, as before. Logout and do the same as the `AppProvider`.

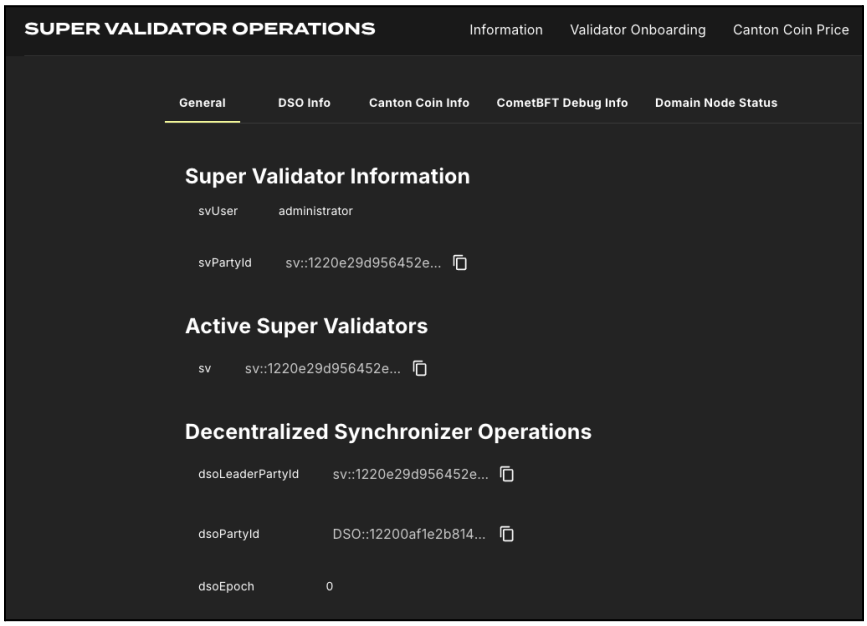
SV UIs

Navigate to `http://sv.localhost:4000/` for the SV Web UI. The SV view displays data directly from the validator in a GUI that is straightforward to navigate.

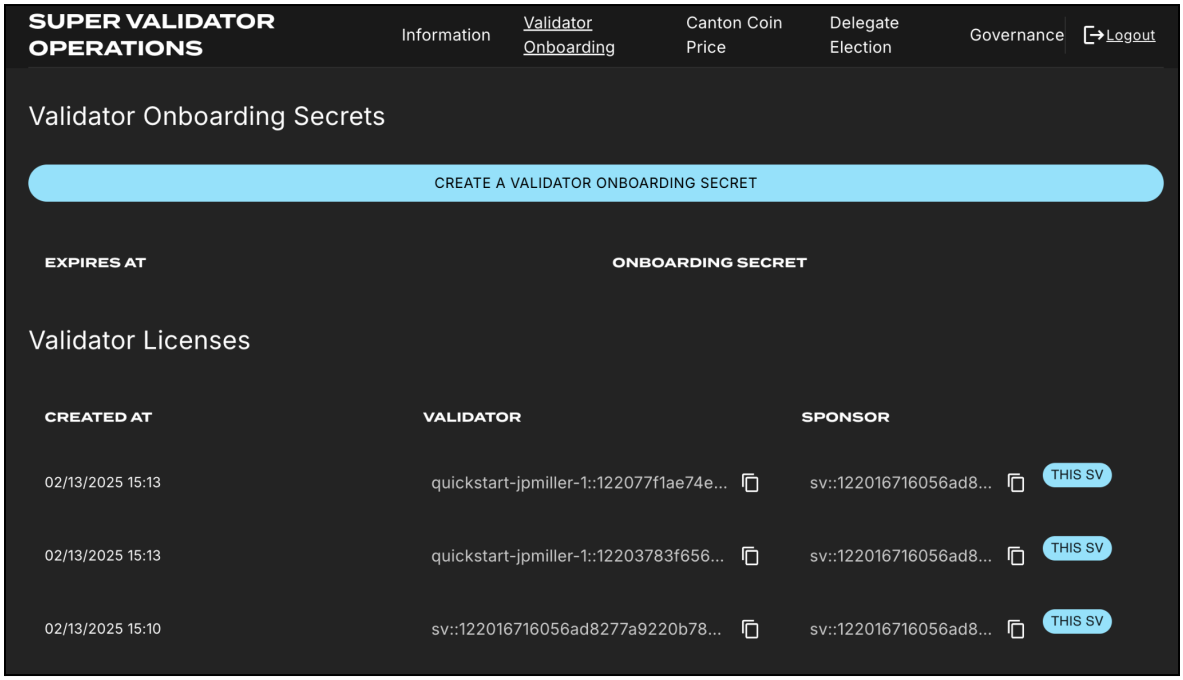
Login as ‘administrator’.



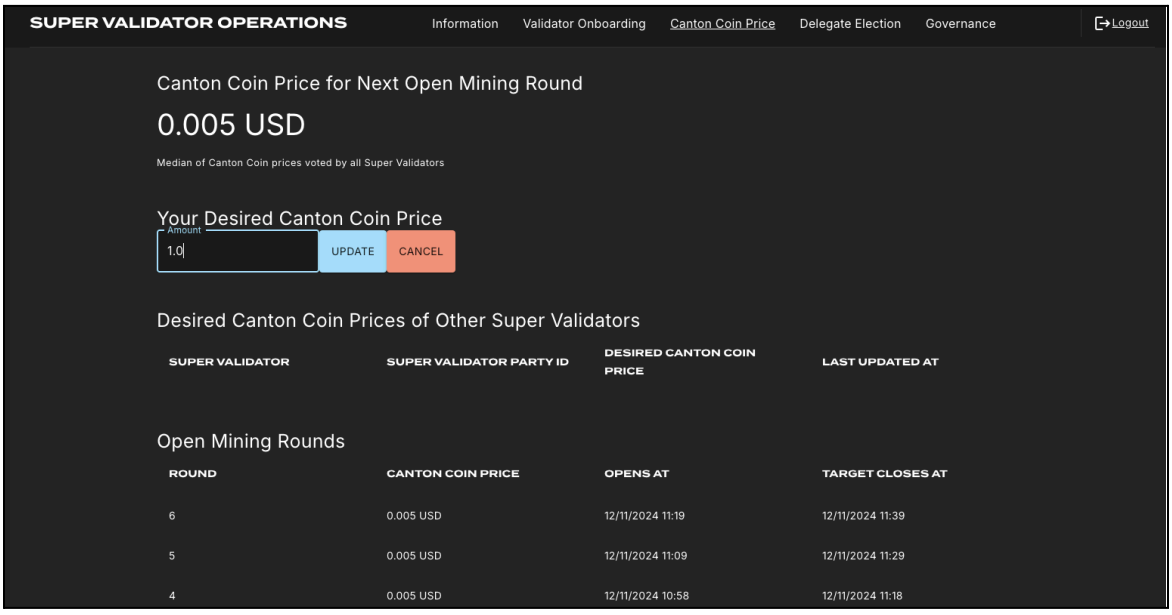
The UI shows information about the SV and lists the active SVs.



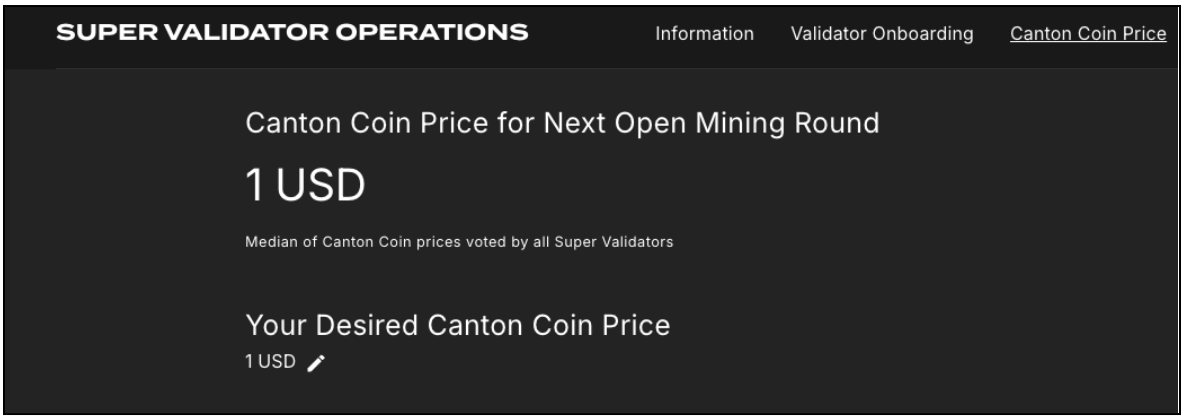
The Validator Onboarding menu allows for the creation of validator onboarding secrets.



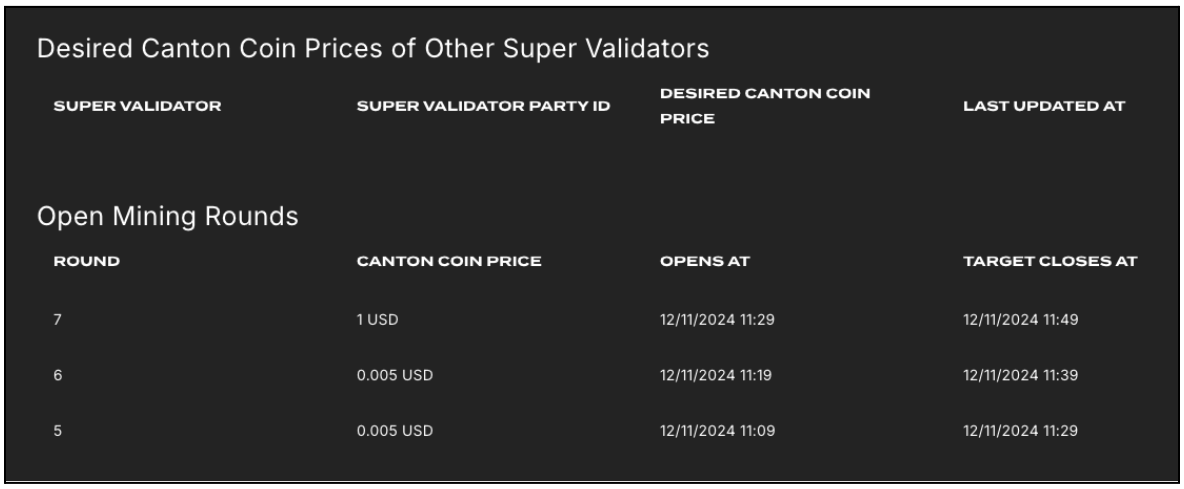
The CC Price menu option has an option to set the price for open mining rounds.



Update the price of the CC.



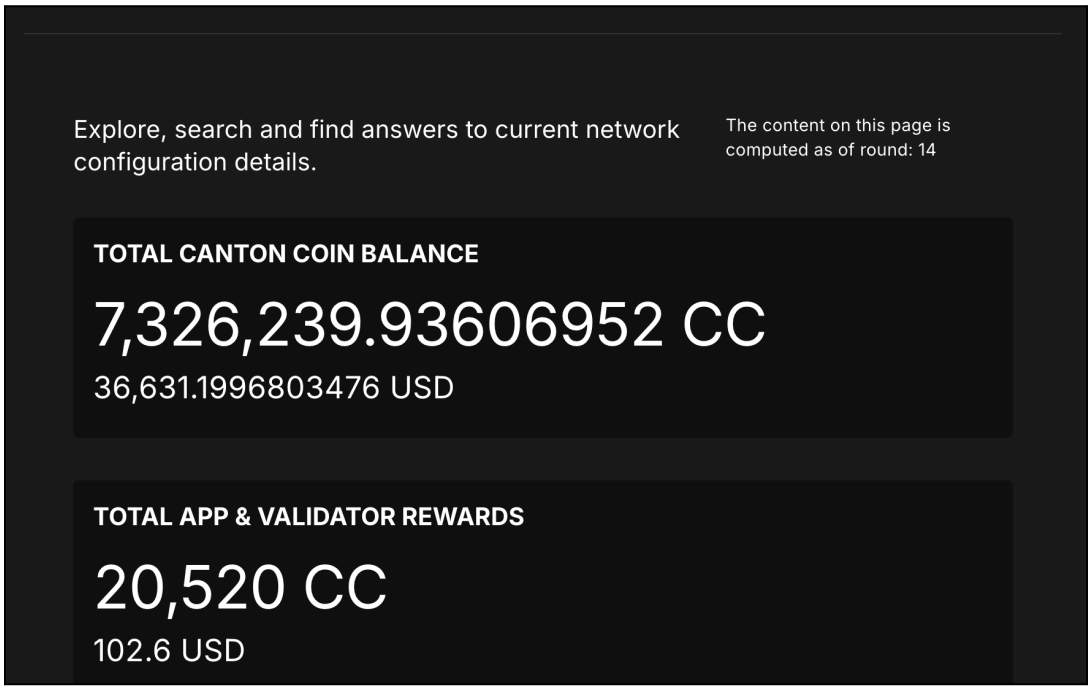
The updated coin price reflects the new open mining rounds.



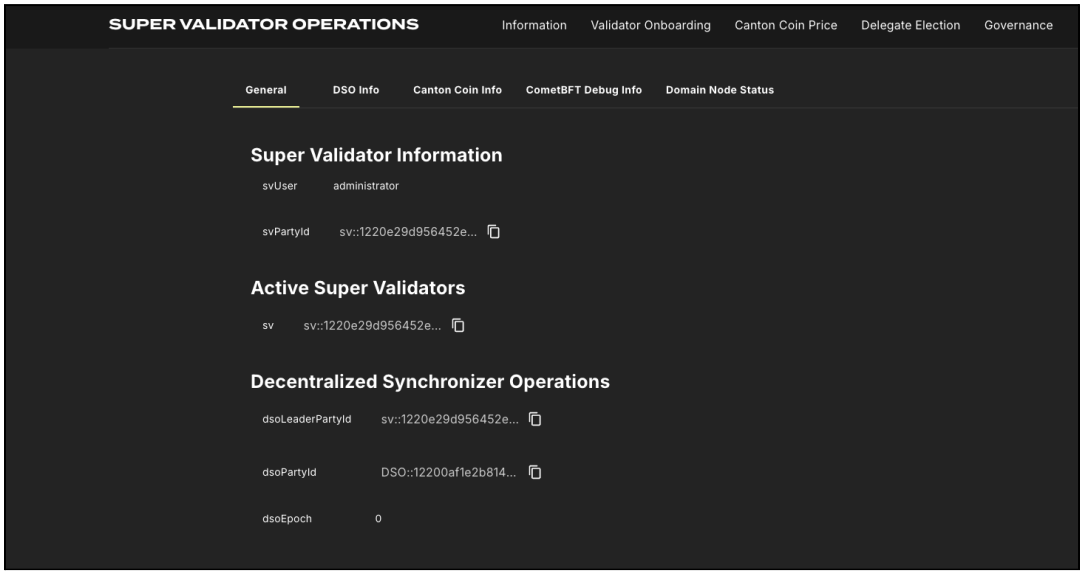
Canton Coin Scan

Navigate to the CC Scan Web UI at http://scan.localhost:4000/.

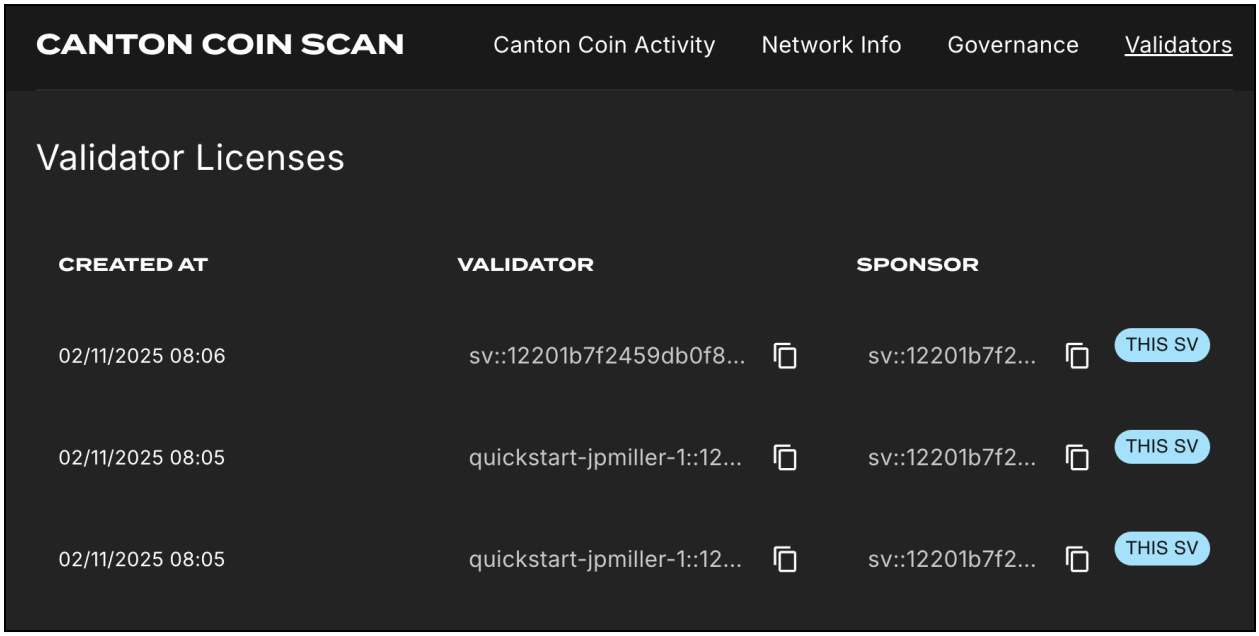
The default activity view shows the total CC balance and the Validator rewards.



Select the Network Info menu to view SV identification.

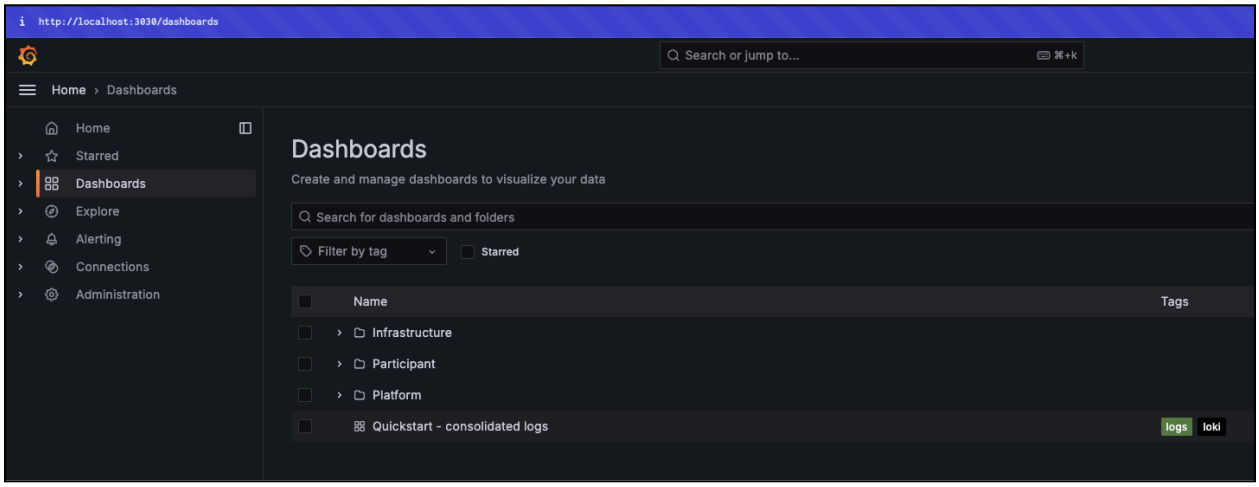


The Validators menu shows that the local validator has been registered with the SV.

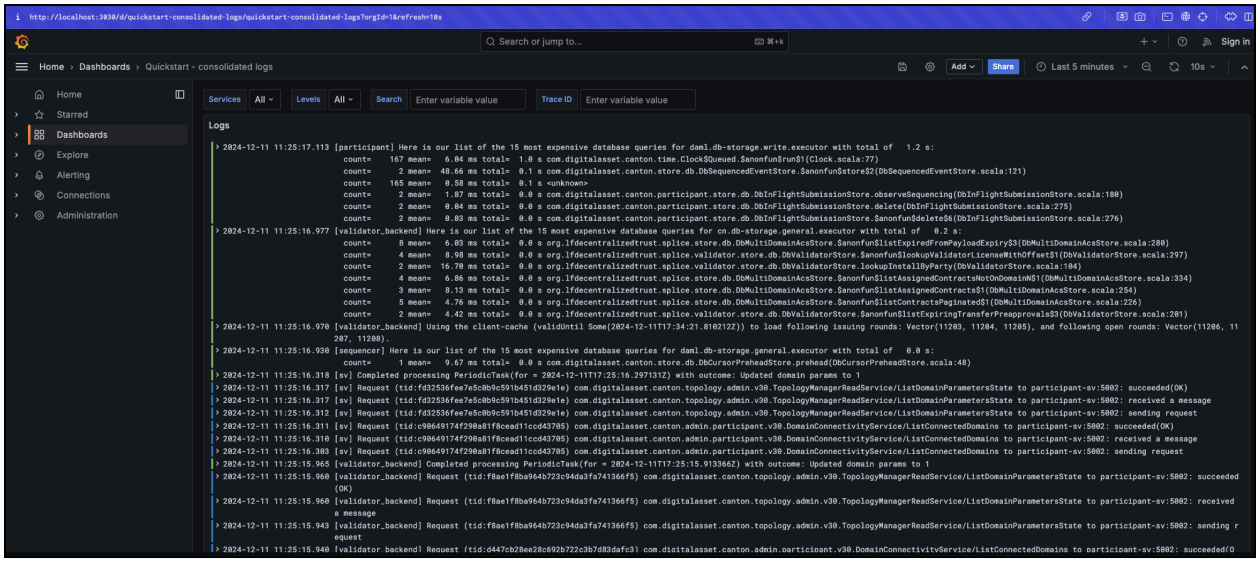


Observability Dashboard

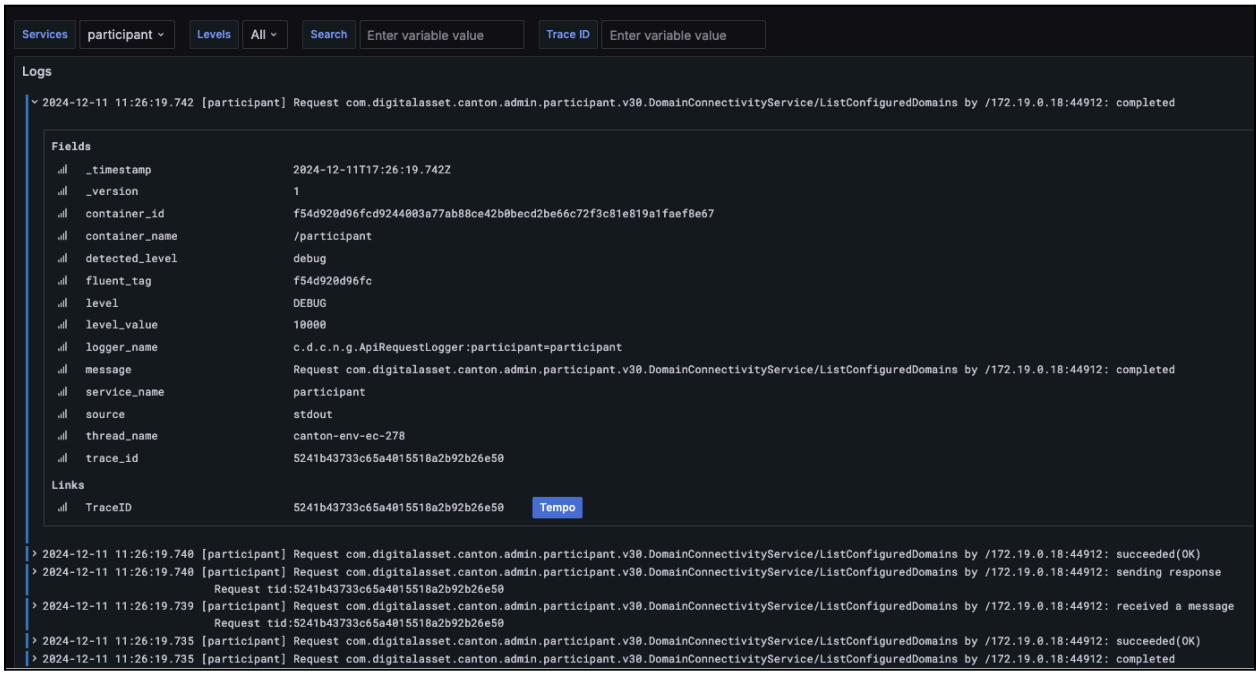
In a web browser, navigate to http://localhost:3030/dashboards to view the observability dashboards. Select “Quickstart - consolidated logs”.



The default view shows a running stream of all services.



Change the services filter from “All” to “participant” to view participant logs. Select any log entry to view its details.



Development Journey in the CN QS Lifecycle

The CN QS provides a foundation for developing applications on the GS.

CN QS Components

The CN QS consists of three components that the developer may find of interest. These include the CN QS development tools, LocalNet, and the sample application. Each component holds significance based on where the developer is in the lifecycle of the application.

Development Tools

The development tools in CN-QS provide critical infrastructure that outlasts the sample application code. Understanding these tools informs decisions about which components to keep, modify, or replace as your application evolves.

Build System

The build system integrates Daml smart contract with the Java and TypeScript applications. Running `./gradlew` build generates code from the Daml model, packages contracts into DAR files, and prepares deployment.

To understand the project structure, dependencies, and root project configuration, examine `quickstart/build.gradle.kts`. For Daml-specific build configurations, review `quickstart/daml/build.gradle.kts`.

To extend the build system for your application, create parallel project structures in `quickstart/settings.gradle.kts`. These settings allow you to maintain your code alongside the original CN QS components while leveraging the same build infrastructure. Customize code generation by modifying the Gradle tasks in `quickstart/buildSrc/src/main/kotlin/` to target specific languages or adjust output formats.

As your application evolves, you can fine-tune dependency management across language boundaries, configure artifact publishing for CI/CD pipelines, and integrate with the Canton ledger APIs. The build system serves as the foundation that connects your Daml models to client applications.

When troubleshooting build issues, check the generated code in `build/generated-daml-bindings/` to verify that your Daml models are correctly translated to your target languages.

Understanding the build system can save extensive time in development efforts compared to creating custom build processes from scratch.

Makefile Command Interface

The Makefile provides standardized commands for common operations:

make setup	Configure environment variables and dependencies
make build	Build all components (Daml, backend, frontend)
make start	Start the application stack
make console-app-provider	Access Canton console for the provider
make console-app-user	Access Canton console for the user
make shell	Start Daml Shell for interactive testing

The Makefile serves as the primary control panel for interacting with the CN QS environment.

Run `make setup` to configure environment variables in `.env` files.

`make start` applies the appropriate environment settings and orchestrates all services through Docker Compose.

When you need direct access to the Canton ledger, use `make console-app-provider` to open an interactive console session.

`Makefile` integrates with Gradle to trigger builds and code generation with a single command, rather than needing to map complex Gradle tasks directly. Examine makefile to understand all available commands to streamline common development workflows and extend with your own custom commands as your application evolves.

Configuration Files

Customize service behavior by modifying the configuration files to match your application's requirements. Start with the Canton console configuration in `quickstart/config/canton-console/app.conf` to adjust ledger access permissions and admin operations. When you need to change network routing or add SSL certificates, edit the NGINX configurations in `quickstart/config/nginx/` directory.

Fine-tune your observability stack by modifying the configurations in `quickstart/config/o11y/` to capture application-specific metrics and create custom dashboards for monitoring your services. These files use standard formats (`HOCON` for Canton, `YAML` for Docker services, `JSON` for dashboards), making them easy to edit with standard tools.

Override configuration values by setting environment variables in your `.env` files rather than editing the configuration files directly. This approach makes it easier to incorporate upstream updates by keeping your customizations separate from the base configurations. For example, set `CANTON_ADMIN_PORT=5022` in your `.env` file to change the Canton admin API port without modifying the `app.conf` file.

When troubleshooting, examine these configuration files to understand how services are connected and what parameters control their behavior. As your application grows, create additional configuration files for your custom services following the same patterns established in the CN QS configurations.

Utility Tools

Leverage the CN QS utility tools during development and testing workflows. Use the build utilities in `quickstart/buildSrc/` to automate common development tasks. The `UnpackTarGzTask` helps extract archive files while preserving permissions and symbolic links. The Java convention scripts standardize your application's build configuration across modules.

Configure your deployment environment by selecting the appropriate Docker Compose files in `quickstart/docker/`. Use `compose-validator.yaml` for validator nodes and adjust resource allocations with the resource-constraints-*.yaml files. Start the observability stack with docker-compose -f quickstart/docker/o11y/compose.yaml up to monitor your application's performance. The o11y directory integrates with Grafana dashboards defined in quickstart/config/o11y/ to provide real-time metrics visualization.

Examine these utilities early in your development process to understand their capabilities. Extend them to match your specific requirements rather than building similar functionality from scratch. For example, add custom test cases to the existing test framework or create new deployment scripts based on the provided templates.

We recommend keeping these utilities when you replace the sample application code. They provide infrastructure that would require significant effort to recreate. Copy them to your application's directory structure during the separation phase to maintain their functionality while decoupling from the original CN QS code.

LocalNet

LocalNet provides a self-contained Canton Network environment for development and testing. It includes all necessary components to simulate a production network on a single laptop without external dependencies.

Network Components

The LocalNet environment consists of three core components that work together to simulate a production Canton Network. The Application Provider and User Validator nodes run Canton participant nodes to host your contracts and represent user participants. Each validator operates within its own preconfigured domain.

The Global Synchronizer (GS) acts as the network coordinator through its Super Validator (SV). It runs a Canton domain node that handles transaction ordering and conflict resolution using sequencer and mediator services. It verifies that all network participants maintain a consistent view of the distributed ledger.

A set of essential services supports these core components. PostgreSQL stores the ledger data, while Keycloak handles authentication and authorization. The Wallet Service manages digital assets and payments, and NGINX provides routing and SSL termination for secure communication between services.

Technical Implementation

The LocalNet environment is defined in Docker Compose files:

- `quickstart/compose.yaml`: Main application stack
- `quickstart/docker/compose-validator.yaml`: Validator configuration
- `quickstart/docker/compose-super-validator.yaml`: SV configuration

Key configuration files:

- `quickstart/.env`: Environment variables for the entire stack
- `quickstart/docker/localnet.env`: Network-specific configuration
- `quickstart/config/canton-console/app.conf`: Canton node configuration

LocalNet persists data through Docker volumes. Its network topology can be modified to meet specific business requirements. `Canton console` provides direct ledger access for debugging.

Access service logs in terminal using

```
make logs
```

Access git logs in terminal with

```
git log
```

Most teams maintain LocalNet throughout development, even after replacing the sample application. LocalNet provides a consistent testing platform that mirrors a production CN.

ScratchNet

ScratchNet is a term that refers to a persistent Canton Network environment that extends beyond the limitations of LocalNet, but is not as decentralized as DevNet. It's designed for scenarios requiring longer-running instances, more resources, and multi-developer collaboration.

We've found that our clients prefer to set up their own ScratchNet to create a more persistent LocalNet-like environment that can also be developed upon by a team.

Technical Implementation

A successful ScratchNet should include the following requirements:

- Server or VM (recommended minimum 64GB RAM, 16 CPU cores)
- Docker and Docker Compose
- External storage volumes for data persistence
- Network configuration that allows team access

Deployment Architecture

ScratchNet also requires persistent storage directories that are accessible across a team. Deploying ScratchNet architecture may use the following pattern:

```
# Clone CN-QS repository to server
git clone https://github.com/digital-asset/cn-quickstart.git
cd cn-quickstart

# Create persistent storage directories
mkdir -p /mnt/scratchnet/postgres-data
mkdir -p /mnt/scratchnet/canton-data
```

Configure external volume mounts in a custom compose override file:

```
# scratchnet.yaml
```

```
version: '3.8'

services:
  postgres-splice-app-provider:
    volumes:
      -
/mnt/scratchnet/postgres-data/app-provider:/var/lib/postgresql/data

  postgres-splice-app-user:
    volumes:
      -
/mnt/scratchnet/postgres-data/app-user:/var/lib/postgresql/data

  postgres-splice-sv:
    volumes:
      - /mnt/scratchnet/postgres-data/sv:/var/lib/postgresql/data

  participant-app-provider:
    volumes:
      - /mnt/scratchnet/canton-data/app-provider:/canton-data

  participant-app-user:
    volumes:
      - /mnt/scratchnet/canton-data/app-user:/canton-data
```

Create a basic environment configuration.

```
# .env.scratchnet
# Unique network name
DOCKER_NETWORK=scratchnet

# External hostname where ScratchNet is accessible
EXTERNAL_HOSTNAME=scratchnet.example.com
Launch with persistent volumes:
# Set up environment
export ENV_FILE=.env.scratchnet

# Launch with volume persistence
COMPOSE_FILE=quickstart/compose.yaml:scratchnet.yaml make start
```

If your team is interested in setting up a ScratchNet environment, be sure to implement a regular, and preferably automated, backup strategy. Verify that access control is properly in place. We also suggest establishing a reliable way to monitor resource consumption, especially

for extended runs. Your team may want to take advantage of resource management tools available through CN's Observability tools (Learn more in the Project Structure Guide), or you may choose to incorporate your own lightweight tools.

For example, a monitoring script in crontab can offer basic alerting.

```
#!/bin/bash
   # db-monitor.sh - Run daily to monitor database growth

   THRESHOLD=80
   DB_PATH="/mnt/scratchnet/postgres-data"

   USAGE=$(df -h $DB_PATH | grep -v Filesystem | awk '{ print $5 }' | sed
's/%//')
   SIZE=$(du -sh $DB_PATH | awk '{ print $1 }')

   echo "$(date): DB size is $SIZE, volume usage at $USAGE%" >>
/var/log/scratchnet-storage.log

   if [ $USAGE -gt $THRESHOLD ]; then
     echo "ScratchNet PostgreSQL volume has reached ${USAGE}% capacity
(${SIZE})"
   fi
```

Containers can also be configured to automatically prune older data to reduce latency and maintain system integrity.

```
participant-app-provider:
  environment:
    CANTON_PARAMETERS:
"--canton.participants.participant.storage.write.pruning-interval=7d"
```

Sample Application

The CN-QS includes a complete reference application that demonstrates Canton Network application patterns. While you'll likely replace this component entirely, understanding its architecture provides valuable insights for your own application design.

Application Components

Daml Models `quickstart/daml/licensing/`:

- Core business logic implemented as smart contracts
- License and AppInstall templates demonstrate multi-party workflows
- Integration with Splice

Backend Service `quickstart/backend/`

- Java Spring Boot application
- Ledger API integration for contract creation and exercise
- REST API exposing contract operations to frontend
- Automated code generation from Daml models

Frontend `quickstart/frontend/`

- React/TypeScript single-page application
- Component-based architecture with state management using React hooks
- REST API integration with backend service

Technical Implementation
The API Design is defined in `quickstart/common/openapi.yaml`. It contains the RESTful API definitions, establishes the JSON schema for request/response objects, provides error handling conventions, and creates authentication patterns.

Development Lifecycle

We've observed five distinct phases of the CN QS development journey. Each phase presents unique strategies for interacting with the CN QS.

Learning Phase

(½ - 2 weeks)
Often the first interaction with the CN QS is understanding how to get the environment running. The next goal is to explore the application and develop knowledge around the architecture and its workflow. It's also important to learn how to navigate the most common observability dashboards and move between LocalNet and DevNet.

The most direct update strategy in this phase is to regularly update your local copy of the CN QS by making a `git pull` from the main branch.

```
# Initial setup
git clone https://github.com/digital-asset/cn-quickstart.git
cd cn-quickstart

# Regular updates during learning
git pull origin main

# Environment customization (only if needed)
```

```
echo 'export PARTY_HINT="company-name"' > .envrc.private
direnv allow
```

Experimentation Phase

(1-2 weeks)
In this phase, you'll reinforce your understanding of the CN QS by experimenting with the configurations, exploring the Ledger and CN app APIs, and modify the Daml code, Java client, and Makefile to test integration patterns.

At this phase, you may want to establish upstream tracking to selectively incorporate changes.

```
# Set up upstream tracking
git remote add upstream
https://github.com/digital-asset/cn-quickstart.git

# Create a branch for experiments
git checkout -b experiments

# Periodically incorporate upstream changes
git fetch upstream
git merge upstream/main
```

Development Phase

(2-3 weeks)
This is where you begin building your own application alongside the CN QS sample application. Many developers create their new app in parallel code directories to the CN QS application to learn from the CN QS while building their own application.

```
cn-quickstart/
├── quickstart/           # Original CN-QS code
│   ├── daml/             # CN-QS Daml code
│   ├── backend/          # CN-QS backend service
│   └── frontend/         # CN-QS frontend
│
└── myapp/                # Your application code
    ├── daml/             # Your Daml models
    ├── backend/          # Your backend services
    └── frontend/         # Your frontend code
```

Developers may generate new Daml packages, new client code in languages other than Java or TypeScript, UI elements, CI/CD integration, and unit tests.

Gradle Settings

When you develop parallel directories, remember to update your build configuration to include both structures.

```
// In settings.gradle.kts
include("quickstart:daml")
include("quickstart:backend")
include("quickstart:frontend")

include("myapp:daml")
include("myapp:backend")
include("myapp:frontend")
```

Maintain separate build files for application components.

```
// In myapp/backend/build.gradle.kts
dependencies {
    // Reference CN QS components if needed
    implementation(project(":quickstart:daml"))

    // Your specific dependencies
    implementation("your.dependency:library:1.0.0")
}
```

Environment Variables

Use `.envrc.private` for local overrides.

```
# Override CN QS defaults
export PARTY_HINT="your-company"
export DAML_SDK_VERSION="your-version"

# Add your application-specific variables
export MY_APP_CONFIG="/path/to/config"
```

Create separate environment files for your application.

```
# In myapp/.env
MY_APP_PORT=8080
```

```
MY_APP_DB_URL=jdbc:postgresql://localhost:5432/myapp
```

Docker Compose

Create custom compose files that extend the CN QS configuration.

```
# In myapp/compose.yaml
version: '3.8'

# Import the CN QS services
include:
  - ../quickstart/compose.yaml

# Add your services
services:
  myapp-backend:
    build: ./backend
    depends_on:
      - postgres
      - participant
    environment:
      - DB_URL=${MY_APP_DB_URL}
```

Use profiles to selectively enable groups of services.

```
# Start with CN QS and your services
docker-compose --profile quickstart --profile myapp up

# Start only your services (once they are able to run independently)
docker-compose --profile myapp up
```

Separation Phase

Over the course of a few weeks, CN developers have gained enough experience and their new application's complexity begins to exceed that of the CN QS. At this point, the CN QS is no longer helpful and the developer is advised to cut ties with the sample application.

To remove dependence on the CN QS, delete the example application directories, adjust gradle files, change the environment variable files, and remove the upstream connection in git.

The developer's source code repository is disconnected from the CN QS repository. It is advisable to write a bridge document that maps your application components to their CN QS

origins. This creates a historical development record and can make it more straightforward to incorporate future updates.

```
# Remove the CN-QS remote
git remote remove upstream

# Clean up unused directories (after backing up if needed)
rm -rf quickstart/

# Update build files to remove CN-QS references
# Edit settings.gradle.kts, build.gradle.kts, etc.
```

Ongoing Updates

By now, your application is likely to outgrow the capabilities of the CN QS. However, you may want the ability to update the development tooling or LocalNet support. The CN QS continuously adds more tooling features and updates existing tool versions.

This process includes periodically checking into CN QS, reviewing the ChangeLog to see what is new, and then selecting components you'd like to include in your application. You'll find the CN QS to be a source for improvements, rather than a direct dependency.

We recommend establishing a regular schedule (monthly or quarterly) to review CN QS updates.

Your update strategy may include creating a temporary clone of the CN QS to review changes, manually incorporate them into your project, and then remove the temporary clone.

```
# Temporary clone to review changes
git clone https://github.com/digital-asset/cn-quickstart.git
cn-quickstart-temp
cd cn-quickstart-temp
git log --since="3 months ago" --pretty=format:"%h - %an, %ar : %s"

# After identifying useful changes, manually incorporate them into
your project
# Then remove the temporary clone
cd ..
rm -rf cn-quickstart-temp
```

Every development team's journey is unique. Adapt these strategies to fit your specific needs, team structure, and application requirements. As a CN developer, your goal is to find an

approach that supports your development goals while also using the CN QS as a foundation to accelerate your development lifecycle.

Upgrades On The Global Synchronizer

The SVs periodically implement upgrades to the GS to improve functionality, resolve issues, and introduce new features. As a node operator or application provider you should be aware of the three types of upgrades that may occur.

Type 1: Backward-Compatible Changes

Type 1 upgrades involve backward-compatible changes to the Splice applications and/or modifications to the behavior of the Canton synchronization layer. These non-breaking changes occur on Mondays, weekly.

While validators can operate effectively when behind by a version or two, the SVs recommend keeping your node up to date with weekly upgrades. It's worth noting that "skip upgrades" (jumping multiple versions at once) are not officially tested by the SVs, so while they generally work, they come with increased risk.

Type 2: Daml Model Changes

Type 2 upgrades modify the Daml models that underlie the Splice applications. These changes introduce a fork in the application chains and occur every few months.

The process for Type 2 upgrades begins with distribution of the new Daml models through Type 1 upgrades, followed by an offline Canton Improvement Proposal (CIP) that must be approved by the SV node owners. Next, the SVs conduct an onchain vote to establish a specific date and time when the new models take effect. At this cutoff point, only validators running the most recent Splice version are able to participate in transactions using the new models. Validators that haven't adopted the latest version are unable to participate in transactions.

Type 3: Non-Compatible Protocol Changes

Type 3 upgrades involve fundamental changes to the Canton synchronization protocol. These major upgrades require downtime (sometimes called Hard Migrations) and occur every three to four months.

The implementation of Type 3 upgrades requires a Canton Improvement Proposal (CIP) approved through an offchain vote, followed by an onchain vote by the SVs to schedule the upgrade. These migrations impact all SVs and Validators, requiring a coordinated transition from

the prior protocol to the new one. Currently, Canton requires all nodes to migrate together during these upgrades.

Preparing for Upgrades

Application providers should maintain nodes on DevNet, TestNet, and MainNet to guarantee smooth operations during upgrades. By maintaining nodes across all three environments you substantially increase the likelihood that MainNet upgrades proceed without disrupting your services or customers.

Developing the CN QS with the Canton Network Token Standard

Introducing Canton Network's Token Standard

The Canton Network Token Standard (CIP-0056) provides a uniform API for tokens on the Canton Network. This guide walks through how to develop applications that use the token standard in the Canton Network Quick Start (CN QS), with specific focus on implementing payments using Canton Coin (CC).

We use the CN QS licensing application as a practical example to show how it uses the token standard to implement license payments.

Using the Token Standard in the QS

Why CN Developers Use the Token Standard

Developers choose to integrate with the token standard for several reasons:

Canton Network applications often require payment functionality, whether for licensing, subscriptions, or other transactional use cases. Rather than building custom payment solutions for each application, the token standard provides a standardized way to handle payments that works across the ecosystem. This approach offers several advantages:

Interoperability
The token standard provides true interoperability across the Canton Network ecosystem. Your application instantly works with any compliant token by interfacing with the standard API rather

than relying on specific token implementations. The CN token standard future-proofs your code. And it allows you to extend your app's payment options without maintenance headaches.

Abstraction
It handles the heavy lifting around token transfers, allocations, and settlements. This allows you to focus on building your application and cuts development time dramatically. The abstraction layer allows for sophisticated payment flows with fewer security vulnerabilities and edge cases to manage.

Consistency
The token standard provides a familiar payment experience across different applications. Users in the Canton Network ecosystem don't need to learn new workflows when moving between applications. It reduces friction and abandonment for the entire ecosystem of CN Applications.

The CN QS demonstrates the token standard's advantages by implementing a licensing system that bills users with Canton Coin using the standard interfaces. This approach allows the licensing application to focus on its core business logic in tandem with a proven payment infrastructure.

The Exploring the Demo and Project Structure Guides offer orientation to the CN QS. We recommend reviewing these guides if you have not read them, yet.

Payments using Canton Coin with the Token Standard

The licensing use case in the CN QS demonstrates a direct payment flow using Canton Coin through the token standard.

Using the Required DARs

The CN QS includes the Daml packages for token standard functionality. When you run `make build`, the build process generates the required components, including:

- `splice-amulet-0.1.6.dar` - The Canton Coin token implementation
- `splice-util-0.1.1.dar` - Utility functions used by the token standard
- `splice-wallet-payments-0.1.6.dar` - Payment functionality built on the token standard

These packages are referenced in `quickstart/daml/licensing/daml.yaml`:

```
data-dependencies: # TODO: fetch as artifacts when integrating
gradle-daml-plugin - ../dars/splice-amulet-0.1.6.dar -
```

```
../dars/splice-util-0.1.1.dar -
../dars/splice-wallet-payments-0.1.6.dar
```

Initializing the Token Standard

In the Daml code, access the token standard by importing its models:

```
import Splice.Wallet.Payment
import Splice.AmuletRules (AppTransferContext(..))
import Splice.Round
import Splice.Util
```

Payment Steps in the CN QS

The licensing application implements a direct payment flow for license renewals.

Create a Payment Request
When a license needs renewal, the application creates a payment request using the `License_Renew` choice.

```
nonconsuming choice License_Renew : (ContractId LicenseRenewalRequest,
ContractId AppPaymentRequest)
  with
    licenseFeeCc: Decimal
    licenseExtensionDuration : RelTime
    paymentAcceptanceDuration: RelTime
    description: Text
  controller provider
  do now <- getTime
    paymentRequest <- create AppPaymentRequest with
      provider, dso
      sender = user
      receiverAmounts = [ReceiverAmount provider (PaymentAmount licenseFeeCc
AmuletUnit)]
      description
      expiresAt = now `addRelTime` paymentAcceptanceDuration
    renewalOffer <- create LicenseRenewalRequest
      with
        provider, dso, user
        licenseFeeCc
        licenseExtensionDuration
        licenseNum
        reference = paymentRequest
    pure (renewalOffer, paymentRequest)
```

`License_Renew` creates a payment request named `AppPaymentRequest` contract that specifies who's making the payment, who's receiving it, the amount in CC, and when the payment request expires.

`sender = user` details who's making the payment
`provider` is the receiver
`licenseFeeCc` determines the amount in CC
`expiresAt` sets the expiration

User Pays the Request
The user may make a payment when their wallet receives the renewal request.

Complete the Payment and Renewal
When payment is completed, the application receives an `AcceptedAppPayment` contract. The `LicenseRenewalRequest_CompleteRenewal` choice processes the payment and renews the license.

```
postconsuming choice LicenseRenewalRequest_CompleteRenewal : ContractId License
  with
    acceptedPaymentCid : ContractId AcceptedAppPayment
    licenseCid: ContractId License
    transferContext : AppTransferContext
  controller provider
  do
    -- archival happens via the consuming AcceptedAppPayment_Collect choice
    acceptedPayment <- fetchUncheckedButArchiveLater acceptedPaymentCid
    exercise acceptedPaymentCid (AcceptedAppPayment_Collect transferContext)
    openMiningRound <- exercise @OpenMiningRound
transferContext.openMiningRound (OpenMiningRound_Fetch provider)
    let expectedAcceptedPayment = AcceptedAppPayment with
          sender = user
          provider
          amuletReceiverAmounts = [ReceiverAmuletAmount provider licenseFeeCc]
          dso
          lockedAmulet = acceptedPayment.lockedAmulet
          round = openMiningRound.round
          reference
    acceptedPayment === expectedAcceptedPayment
    license <- fetchAndArchive Group {user, provider, dso} licenseCid
    licenseNum === license.licenseNum
    now <- getTime
    create License with
                dso
                user
```

```
                provider
                licenseNum
                params = license.params
                expiresAt = (max now license.expiresAt) `addRelTime`
licenseExtensionDuration
```

The `LicenseRenewalRequest_CompleteRenewal` choice verifies that payment details match what was expected, collects payment using `AcceptedAppPayment_Collect`, extends the license duration, and creates a new license contract with the updated expiration date.

Integrate a Pre-Existing Token

As a CN developer, you can follow this pattern when implementing the token standard in your own derivatives of the CN QS:

1. **Access token standard modules**: Import the necessary modules from the splice DARs
2. **Create payment requests**: Use `AppPaymentRequest` for direct payments
3. **Process payments**: Handle `AcceptedAppPayment` contracts to complete transactions

The CN Token Standard simplifies payment handling while providing the flexibility to implement your specific business logic on top of the payment infrastructure.

Keycloak in the CN-QS

Keycloak is an open-source Identity and Access Management (IAM) solution that provides authentication, authorization, and user management for modern applications and services. It acts as a centralized authentication server that handles user logins, session management, and security token issuance.

The CN-QS uses Keycloak to provide secure authentication across its distributed architecture. Keycloak maintains separation between authentication concerns and business logic.

Realm Structure

The CN-QS defines two Keycloak realms that mirror its business domains. The AppProvider realm manages authentication for services and users on the provider side of the application. The AppUser realm handles authentication for the consumer side. When components like validators or participant nodes receive requests, they validate the authentication tokens against the appropriate realm.

Keycloak Configuration

The default `.env` configuration includes predefined users in each realm:

- **User "Pat"** (`AUTH_APP_PROVIDER_WALLET_ADMIN_USER_NAME=pat`)
- **UUID**: `553c6754-8879-41c9-ae80-b302f5af92c9` (`AUTH_APP_PROVIDER_WALLET_ADMIN_USER_ID`)

AppUser Realm:

- **User "Alice"** (`AUTH_APP_USER_WALLET_ADMIN_USER_NAME=alice`)
- **UUID**: `92a520cb-2f09-4e55-b465-d178c6cfe5e4` (`AUTH_APP_USER_WALLET_ADMIN_USER_ID`)
- **Password**: `abc123` (`AUTH_APP_USER_WALLET_ADMIN_USER_PASSWORD`)

Customizing Keycloak for Business Needs

You can customize the Keycloak configuration to meet your specific business requirements.

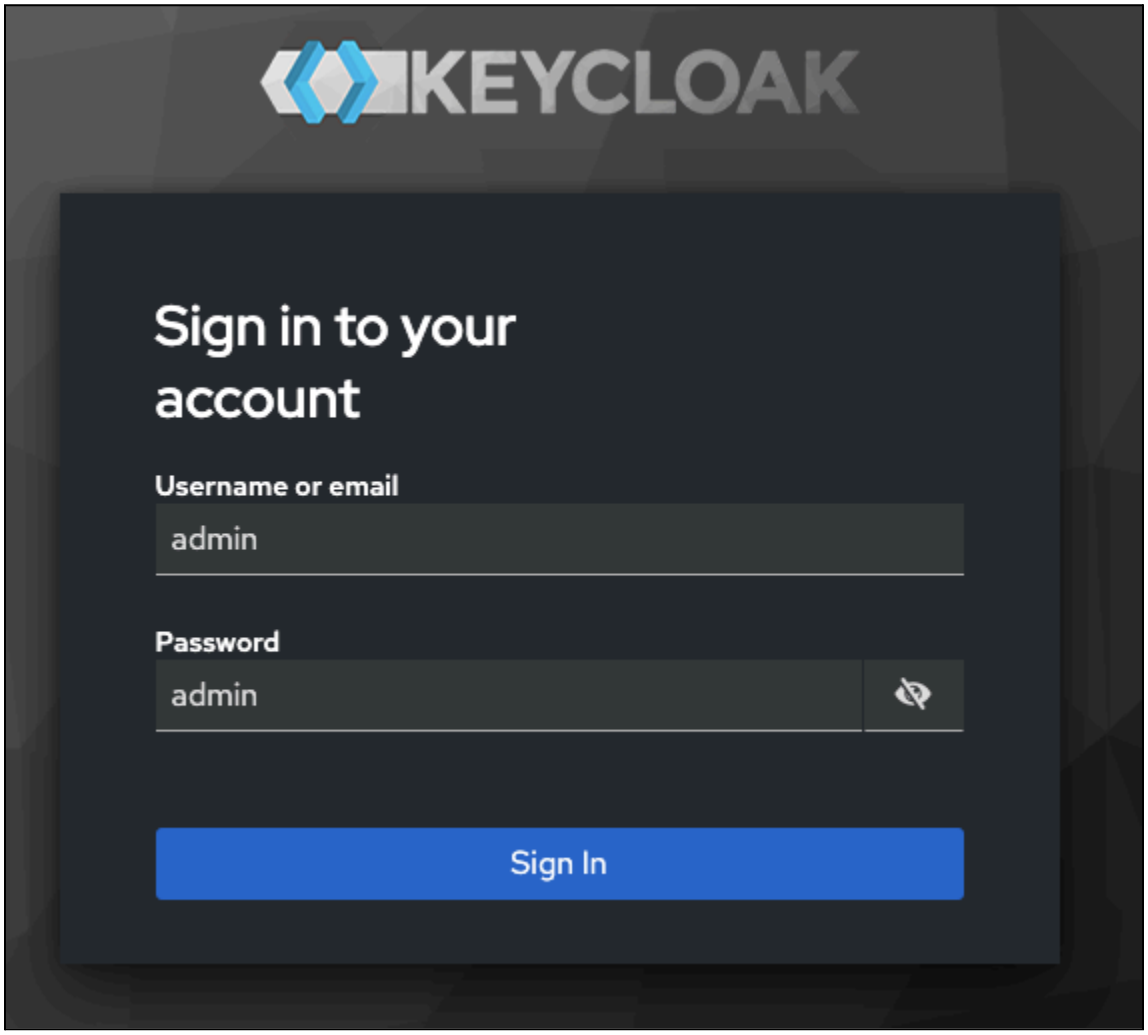
Accessing the Admin Console

The Keycloak Admin Console is available at:

```
http://keycloak.localhost:8082/admin/master/console/#/master
```

To log in use the default credentials:

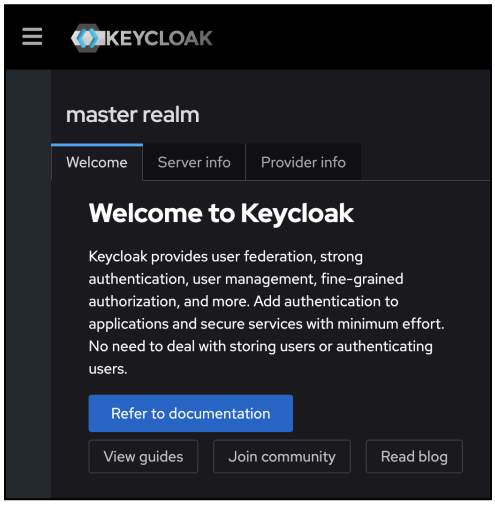
- **Username**: `admin`
- **Password**: `admin`



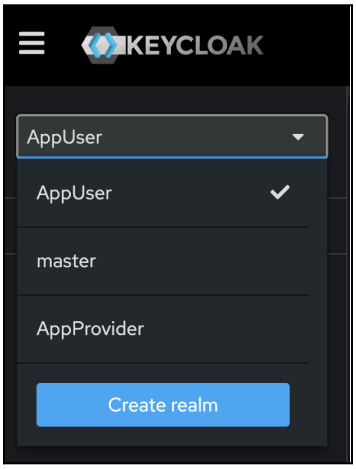
Customization Scenarios

Add a New User

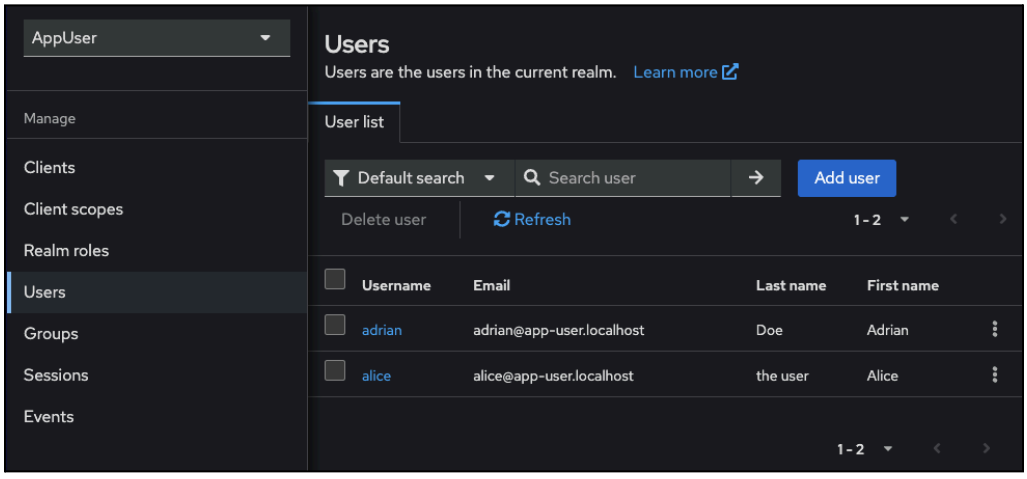
1. Log in to the Keycloak Admin console

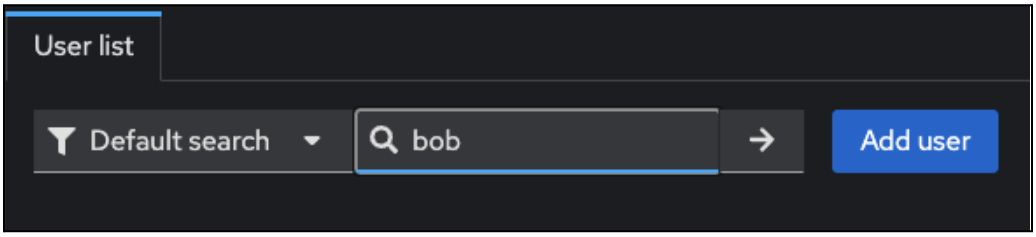


2. Select the appropriate realm (AppProvider or AppUser)

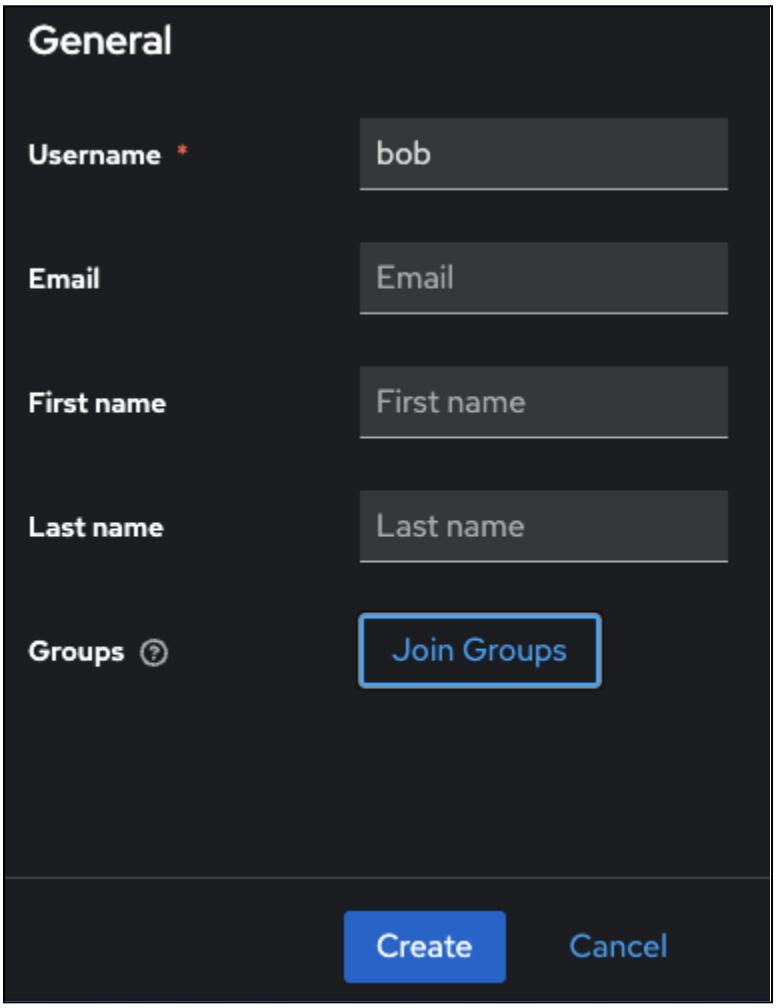


3. Navigate to the “Users” -> “Add user”

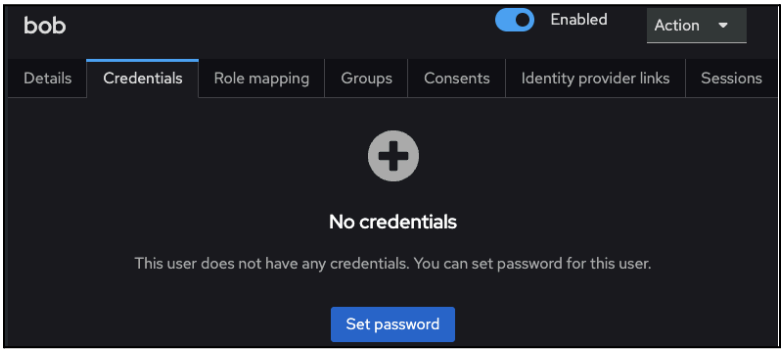


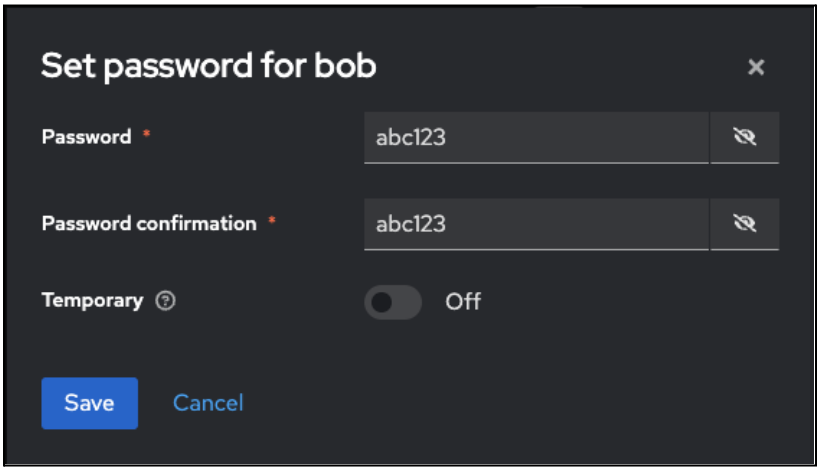


4. Fill in the user details and click **Create**

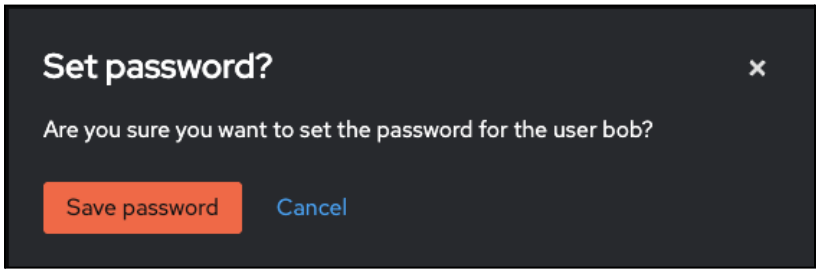


5. Go to the **Credentials** tab to set a password

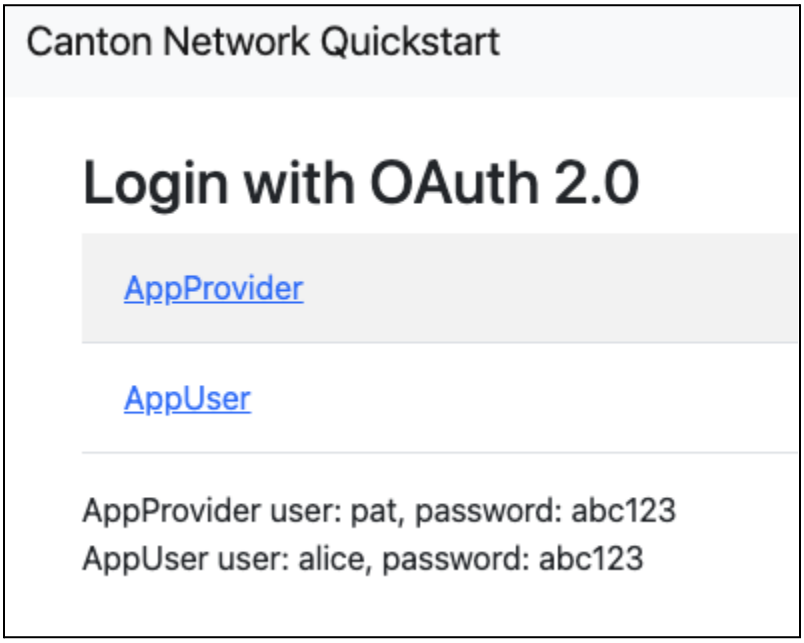


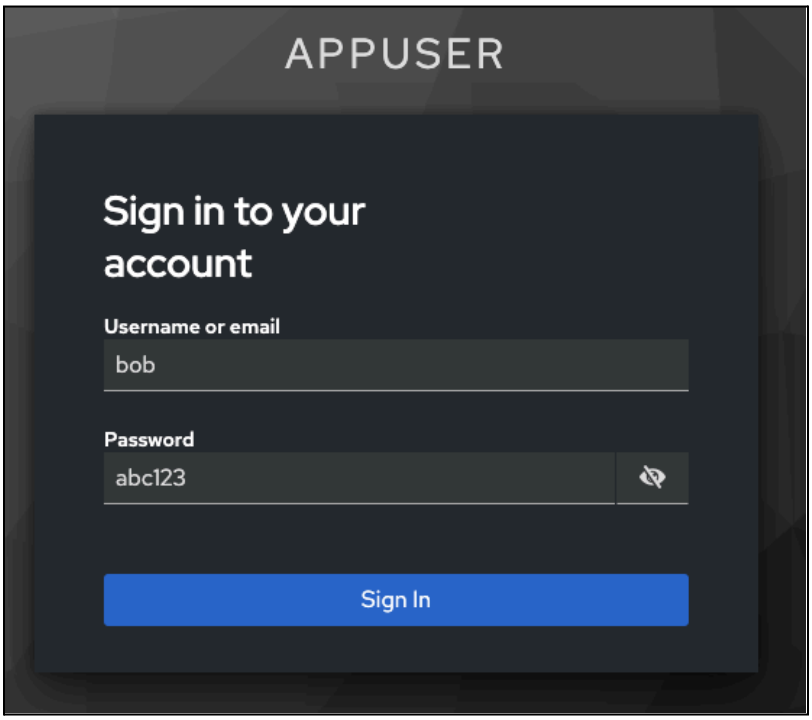


6. Save the password

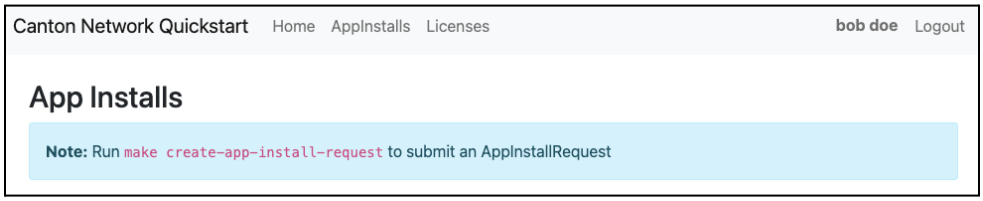


7. You can now sign in using the new user and their password.
    a. Click **AppUser**



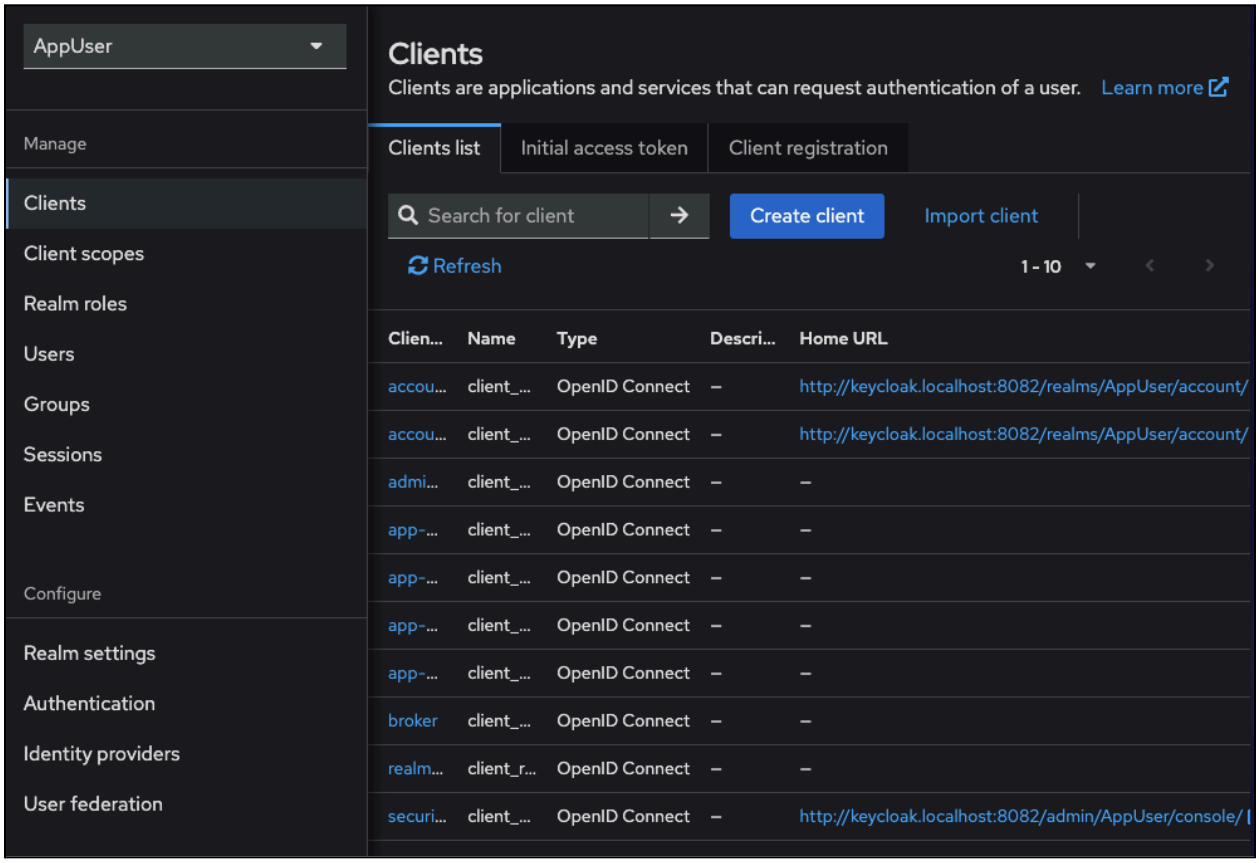


8. Bob is now a user

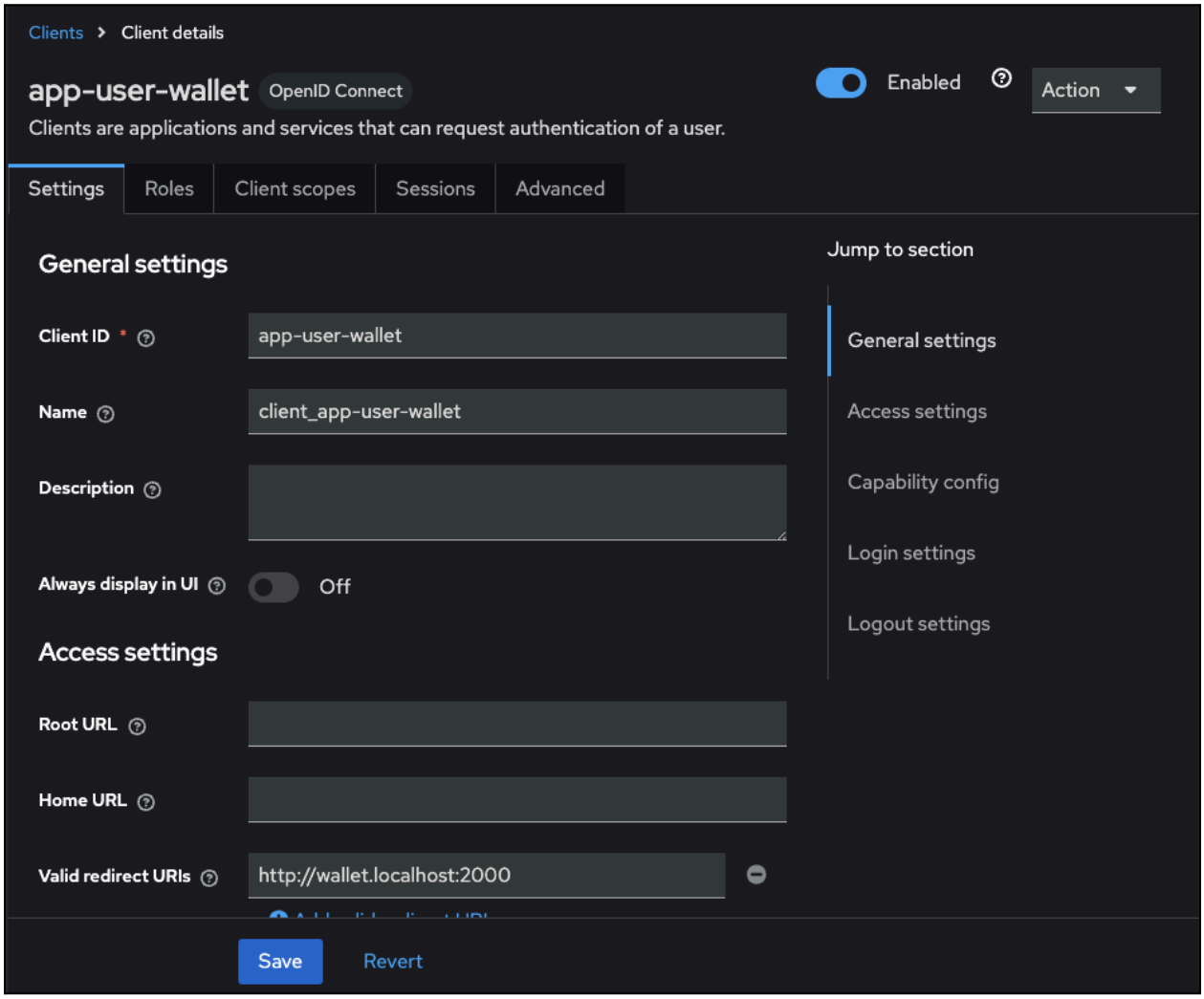


Modify Client Settings

1. Select the appropriate realm
2. Navigate to **Clients** -> Select the client to modify



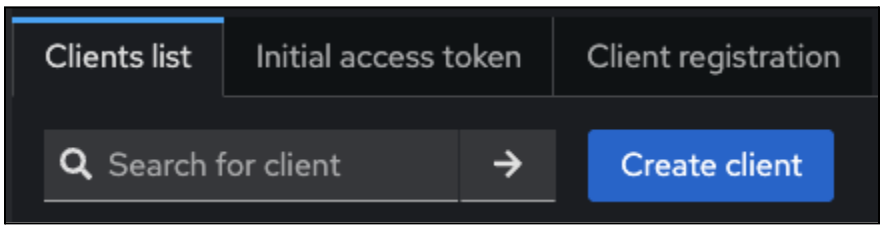
3. Update settings per your needs



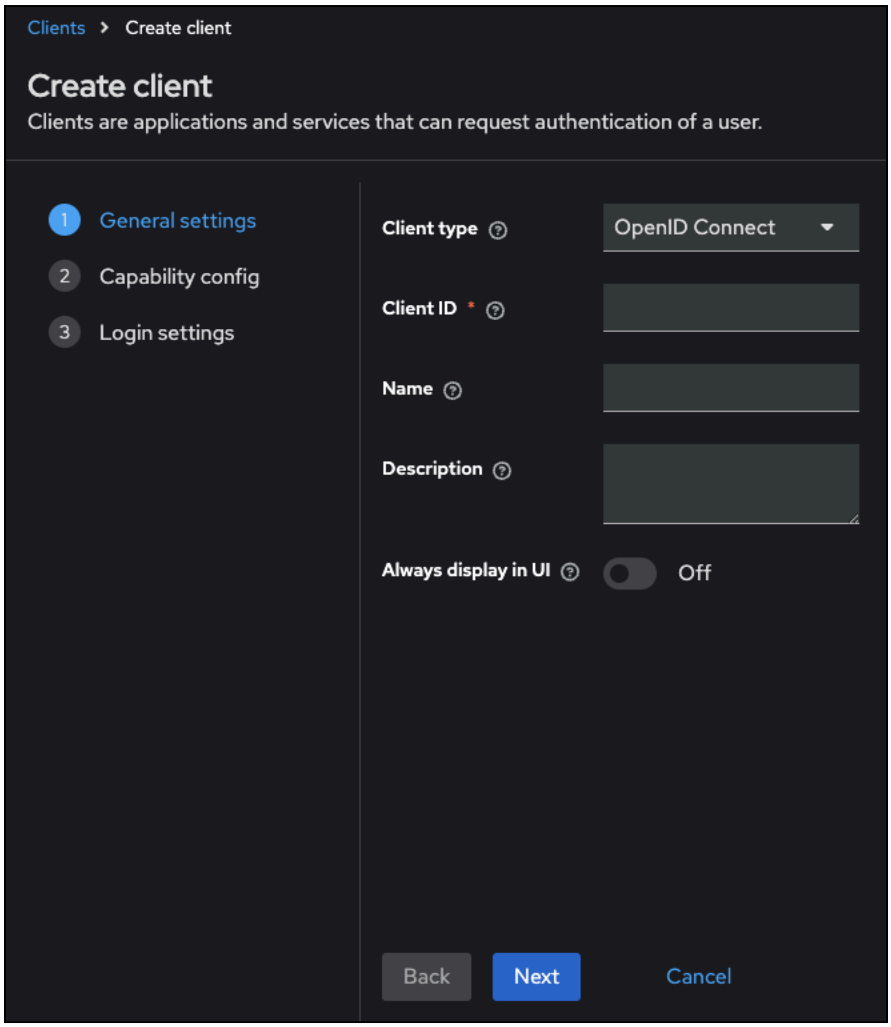
4. Save changes

Add a New Client

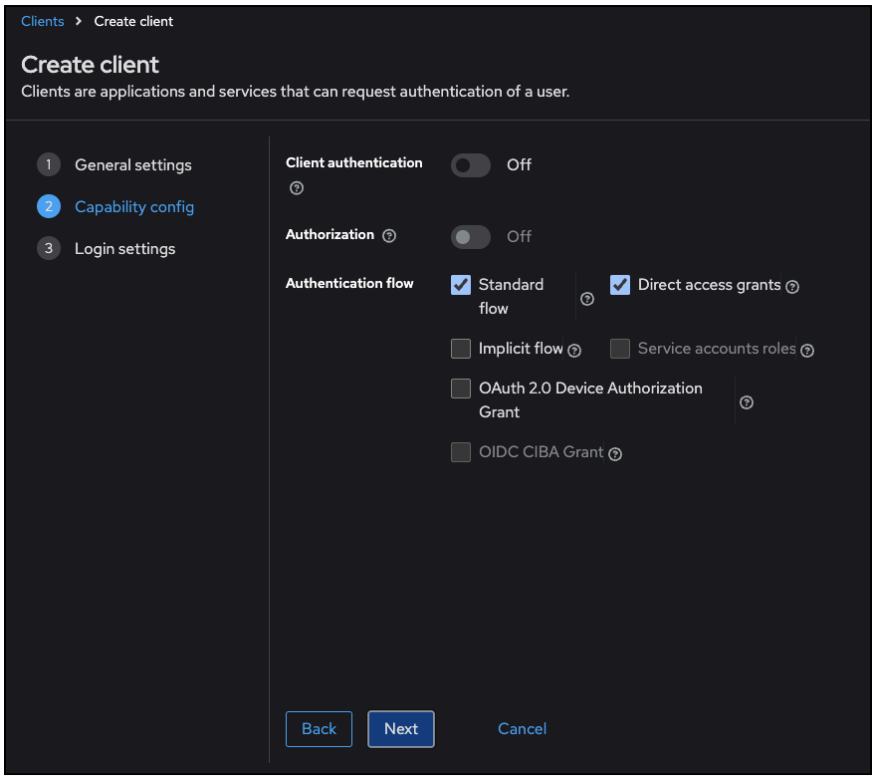
1. Select the appropriate realm
2. Navigate to “Clients” -> “Create”

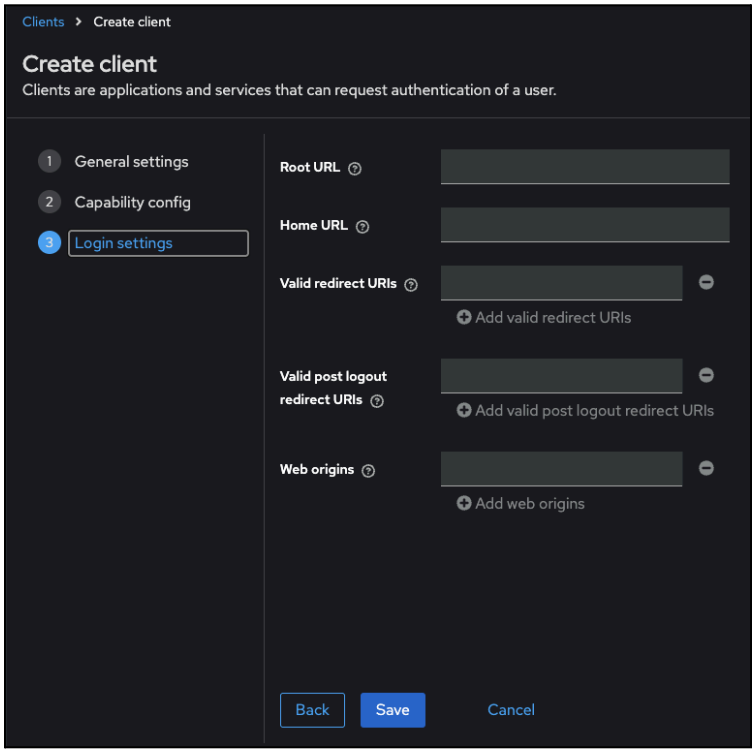


3. Configure the client general settings. Click **Next** for additional configuration options



4. Configure additional settings





5. Save the client

Update Environment Variables

After making changes to Keycloak configuration, you may need to update the corresponding environment variables in the `.env` file:

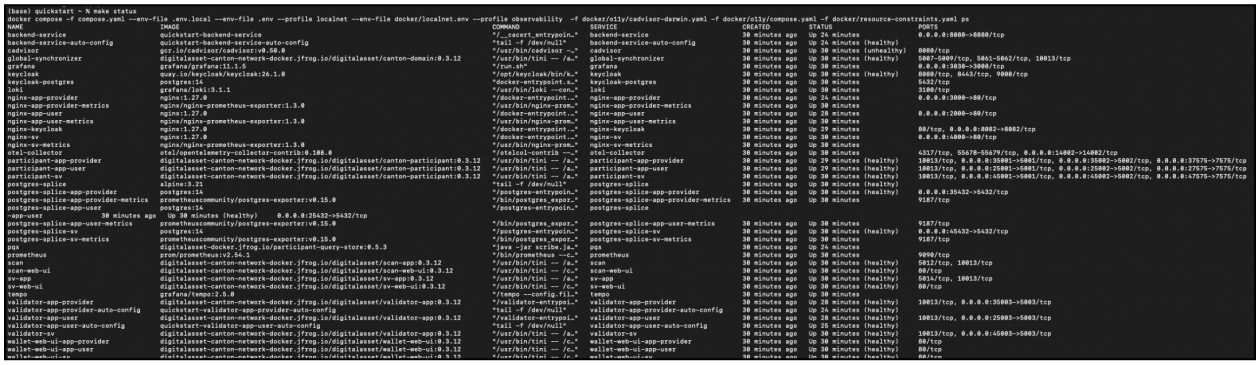
1. The Keycloak user must have the same ID as the ledger user's ID.
2. For client changes, update the corresponding client ID and secret
3. For user changes, update the corresponding user ID and credentials
4. Restart the services to apply the changes:

```
make stop && make start
```

Troubleshooting

Login Failures:

1. Verify Keycloak is running: `make status`



Find **keycloak** near **grafana** and **loki** in the list.
Keycloak should show as “healthy”

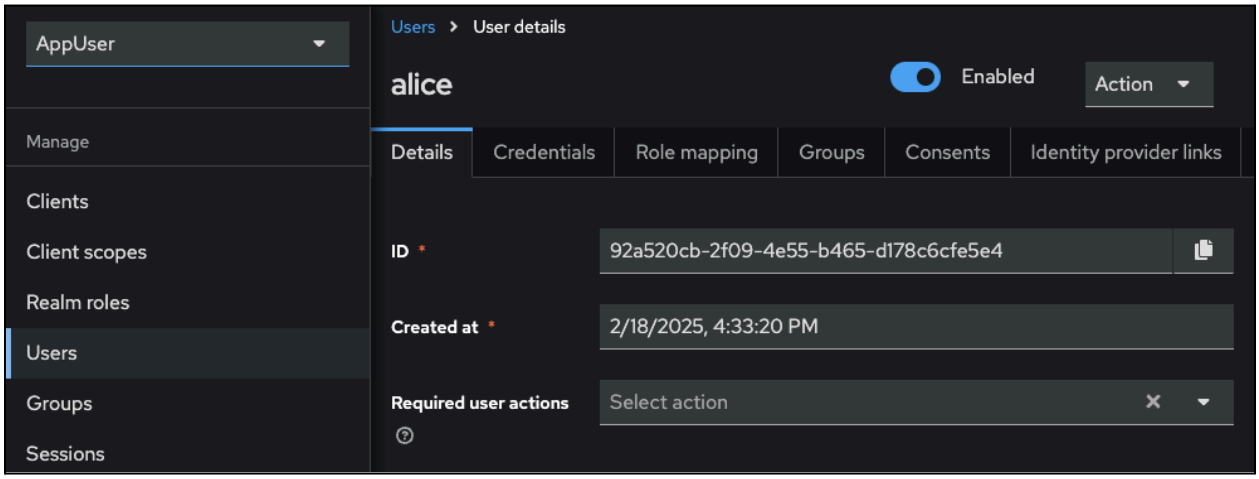
2. Check keycloak credentials in `.env` file

```
AUTH_APP_USER_ISSUER_URL_BACKEND=http://nginx-keycloak:8082/realms/AppUser
# for backend
AUTH_APP_USER_ISSUER_URL=http://keycloak.localhost:8082/realms/AppUser
# for backend, wallet-ui
AUTH_APP_PROVIDER_ISSUER_URL=http://keycloak.localhost:8082/realms/AppProvider
# for backend oidc client conf, wallet-ui
AUTH_APP_PROVIDER_ISSUER_URL_BACKEND=http://nginx-keycloak:8082/realms/AppProvider
# for backends
```

3. Check that the Keycloak user ID matches the ledger user ID
    a. App User

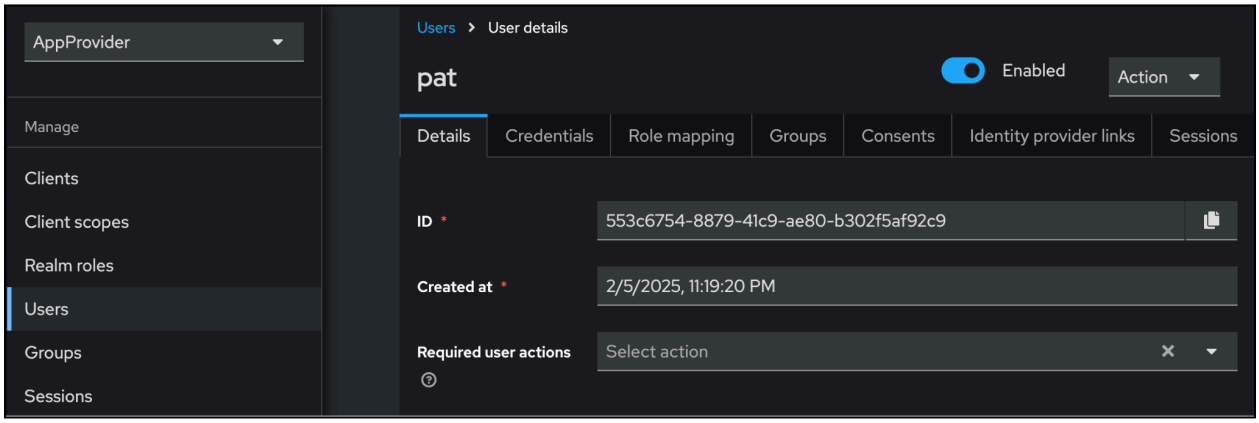
i. Compare the **ID** value in Keycloak's User Details with the `AUTH_APP_USER_WALLET_ADMIN_USER_ID` value in `.env`.

```
AUTH_APP_USER_WALLET_ADMIN_USER_ID=92a520cb-2f09-4e55-b465-d178c6cfe5e4
```



b. App Provider
Compare the **ID** value in Keycloak's User Details with the `AUTH_APP_PROVIDER_WALLET_ADMIN_USER_ID` value in `.env`.

```
AUTH_APP_PROVIDER_WALLET_ADMIN_USER_ID=553c6754-8879-41c9-ae80-b302f5af92c9
```



Learn more about using Keycloak through their documentation portal:

[Keycloak Official Documentation]
[Keycloak Server Administration Guide]
[Securing Applications with Keycloak]

Next Steps

You've completed a business operation in the CN-QS and have been introduced to the basics of the Canton Console, Daml Shell, the SV UIs, the GS, and Keycloak.

Learn more about Daml Shell and the project structure in the Project Structure Guide.