Observability & Troubleshooting (Overview)

Canton Network Quickstart Guide | 2025

Version: 0.9.0-2025-02-20

Note: The screenshots in this guide are currently taken from multiple sessions over multiple days and therefore are inconsistent with each other (and in some places the text). This will be rectified once some of the updates to Quickstart currently in flight are committed.

Contents

Overview of Observability

The Canton Network Quickstart deployment configuration includes a full observability suite. Tools preconfigured for monitoring and troubleshooting distributed Canton applications—both in development and production. The observability suite provides three key types of monitoring data:

- **consolidated structured logs** for application and system events
- **distributed traces** that visualize end-to-end transaction flows; and
- **metrics** for monitoring key performance indicators.

The suite allows data types to be correlated with each other to provide insights for root cause analysis. In addition, the Canton Ledger also provides a variety of correlation and tracing ids that permit tracking transaction provenance across multiple organizations and environments.

The LocalNet Configuration

The Quickstart runtime configuration is defined in `.env.local`, which allows each developer to switch between running a LocalNet or DevNet application deployment; and, whether or not to bring up a local deployment of the Observability Stack. This file can be created using `$ make setup`, which wraps the command `$ ./gradlew configureProfiles --no-daemon --console=plain --quiet`, or can be edited manually to set environment variables `LOCALNET_ENABLED` and `OBSERVABILITY_ENABLED` to `true` or `false` as desired.

The LocalNet runtime configuration is handled by `docker-compose` configured in `compose.yaml` using environment variables from `.env` in the `quickstart/` project root directory. As a result the usual Docker commands and tooling applies.

Immediately useful commands you probably already know:

- `$ docker ps` lists the running containers.
- `$ docker logs [-f] <container>` fetches the logs of a container, and follow the logs with the `-f` option
    - If the system is not working well to the extent you do not trust the observability stack (discussed later), `docker logs backend-service` is a good place to start looking for errors that might provide an insight into what has gone wrong
- `$ docker restart <container>` for those instances where a container seems to have become stuck

Observability Overview

The Quickstart application has been built to provide the foundation for a production Daml application. As such it includes a full observability configuration which is helpful to troubleshoot or

debug an application when running on the LocalNet. In order to provide a working demo Quickstart has naturally had to be opinionated regarding the choice of technologies, selecting from modern commonly used technologies. The platform itself is agnostic, and individual components can and should be replaced as required by your team.

The current troubleshooting and debugging services include:

- Local ledger inspection via Daml shell (https://docs.daml.com/tools/daml-shell/index.html)
- Datasource collection and management via **OpenTelemetry**
  - This uses the **OTEL Collector** (https://opentelemetry.io/docs/collector)
- Metrics are aggregated using **Prometheus** (https://prometheus.io/)
- Logs are consolidated using **Loki** (https://grafana.com/oss/loki/)
- Traces are aggregated using **Tempo** (https://grafana.com/oss/tempo/)
- Aggregated observations (metrics, logs, and traces) are viewable via **Grafana** (https://grafana.com/oss/grafana/) which acts to allow hyperlinked exploration of the Observability fields.

Daml Shell

Daml Shell is a terminal application that provides interactive local ledger inspection on top of PQS. Quickstart is configured to launch Daml Shell in a docker container and is configured to connect to the included application provider's PQS instance. This is easiest to access via the toplevel project scripts accessed via `make` from `quickstart/`. To see this in action, build and start the quickstart app then:

Run `$ make create-app-install-request` to use `curl` to submit the `create AppInstallRequest ...` command to the ledger[1] to initiate user onboarding[2]. Then you can use the following Daml Shell commands:

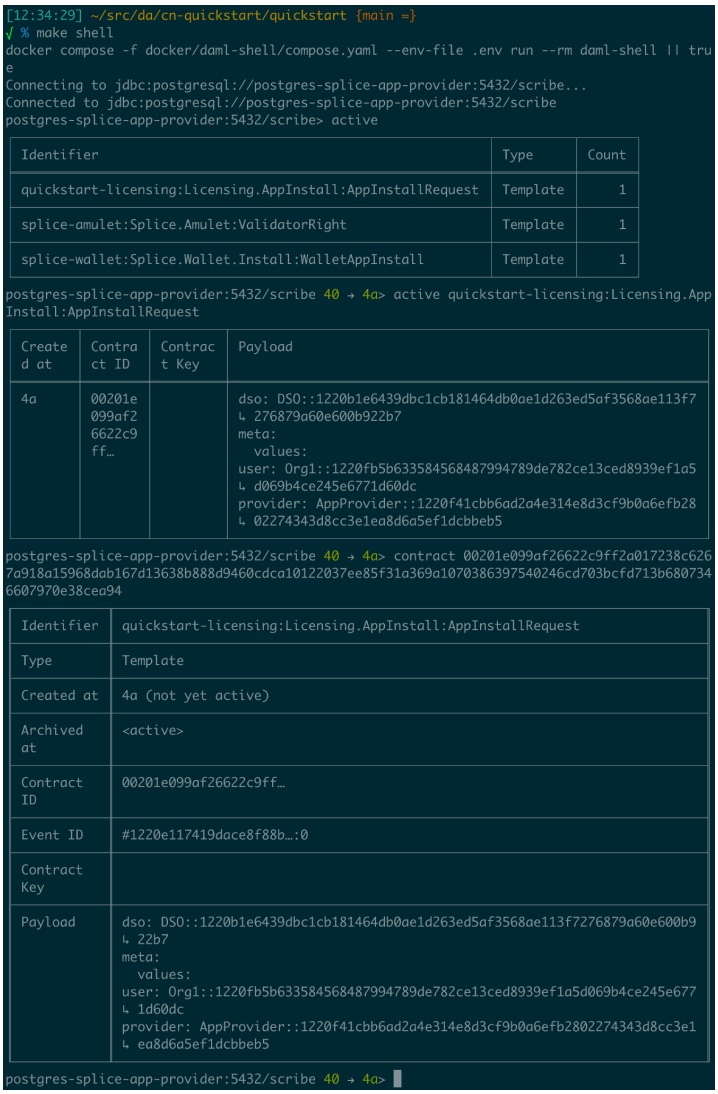
`> active` to see a summary of the contracts you created; and,

`> active quickstart-licensing:Licensing.AppInstall:AppInstallRequest` to see the contract details for any Asset contracts on the ledger; finally,

`> contract [contract-id from the previous command]`[3] to see the full detail of the `AppInstallRequest` contract on the ledger

`> help [command]` provides context help for daml shell commands[4]

[1] Specifically this sends a `CreateCommand` to the `submit-and-wait` service on the Application User's participant node.
[2] See the Canton Network Quickstart Guide "Project Structure" for more details on this
[3] Daml shell has tab completion on most command arguments, including the Template Id argument to `active` and the Contract Id argument to `contract`.
[4] Further documentation is available at https://docs.daml.com/tools/daml-shell/index.html



Grafana

The Grafana interface is accessible via its web interface which is port-mapped to http://localhost:3030/, and can be opened in the current browser from the command line using `make open-observe`.

It is recommended that the focus of your debugging should be on using the trace and log facilities provided by Grafana and ledger inspection using Daml Shell. Ensuring that the exported logs and traces are sufficient to support debugging during development also provides assurance that they will be sufficient to support diagnostics in production.

There is additional access configured into the quickstart that can assist with debugging on LocalNet. To reiterate, best practice is to use the same diagnostic tools for development as you will for production. If you add a log line that then allows you to identify and fix a bug in development, then keeping it around at `trace` or `debug` log levels increases your operational readiness. Conversely, in one sense, using a tool that won't be available in production to debug in development reduces your operational readiness.

Direct Postgres Access

All persistent state in the example application is stored in one or more postgres databases. You can use the postgres configuration in `.env` to connect directly to these instances.

```
$ docker exec -it <postgres container> psql -v --username <.env
username> --dbname <.env dbname> --password
```

For example: if you connect to the `postgres-splice-app-provider` container (default username `cnadmin`, dbname `scribe`, and password `supersafe`; then you can use the SQL interface to PQS to examine the app-provider's participant's local ledger. The SQL API to PQS is documented in the daml documentation (https://docs.daml.com/query/pqs-user-guide.html#).

Interactive Debugger

If you review the `compose.yaml` file and examine the configuration for backend-service you will see the lines:

```
  backend-service:
    environment:
      ...
      JAVA_TOOL_OPTIONS: "-javaagent:/otel-agent.jar
-agentlib:jdwp=transport=dt_socket,server=y,suspend=n,address=*:5005"

    ports:
      - "${BACKEND_PORT}:8080"
      - "5055:5005"
```

This enables remote debugging of the java component backend in the user application (backend-service). You can use this to connect an IDE Debugger to the service at runtime if required. Keep in mind that we recommend your first resort be Grafana and the consolidated logs in Loki, as this ensures the system remains debugable in production.

Observability and Tracing

Faulty distributed systems can be notoriously hard to diagnose. Quickstart provides, at the start of a project, the sort of observability and diagnostics facilities often only developed toward the end of the project. Simplifying diagnostics for new Canton Network Applications from the outset of each project is one of the motivations behind the development of Quickstart.

The links in the overview include the official user and reference documentation for the various tools included in Quickstart. While there is no substitute for the official documentation, it is hoped the following tour of the capabilities configured into Quickstart can provide a starting point for your own experimentation.

Correlation Identifiers

Inspecting any distributed system invariably begins by correlating identifiers—Canton is no different in that regard. Canton can accept and/or generate a number of identifiers suitable for correlating across both time, various nodes, and the evolving state of the ledger.

A few of the key identifiers to be aware of are:

Useful Correlation Identifiers

Identifier	Specified by	Scope
ApplicationId	The Ledger Client	Identifies the ledger client during command submission and processing.
WorkflowId	The Ledger Client	Identifies the business process. Persisted to the ledger
CommandId	The Ledger Client	Identifies the business "act" associated with a ledger command. Persisted to the ledger. Visible only to the submitting party. Common across retries.
SubmissionId	The Ledger Client	Identifies an individual ledger submission to a participant node.
TransactionId	Daml Ledger	Global identifier for a committed transaction to the ledger. Only visible to participant nodes that witness or are informed of the transaction[5].

[5] A key differentiator of Canton from all other level one blockchains is that it offers privacy. It does this by enforcing right-to-know. rather than via secrecy-via-obscurity and/or via pseudo-anonymity. Canton provides two privacy guarantees: Even in encrypted form (sub-)transactions are only transmitted to participant nodes with a right to be informed of them; and, participant nodes will be informed of every (sub-)transaction they have a right to be informed of. For details on how Canton defines "right" and other aspects of this see the Daml Ledger Privacy Model (https://docs.daml.com/concepts/ledger-model/ledger-privacy.html#privacy)

Useful Correlation Identifiers

Identifier	Specified by	Scope
Ledger EventId	Daml Ledger	Global identifier for a node within a committed transaction tree corresponding to a ledger event.
Trace/Span Id[6]	Ledger Client (or upstream)	Accepted by GRPC/HTTP ledger interfaces and honoured throughout the Canton Network code. Where one is not provided may sometimes be generated internally to provide tracing support within the network.
Ledger Offset	Participant Node	The height of a transaction within the local linearization of the ledger by a participant node[7].
ContractId	Daml Ledger	Global identifier for a contract that was created successfully on the ledger at some point. If the contract has been subsequently archived the id remains a stable and valid way to refer to it even though the associated contract can no longer be used.
TemplateId	Daml Application	Combined with a PackageId this provides a global identifier for a Daml smart contract.
Party Id	Participant Node	Global, potentially non-unique, identifier for a legal entity on the Canton ledger[8].

The goal of the observability configuration is to make it easier to navigate through the provenance of any state or event in the wider system. Any or all of these identifiers can be used to correlate a combination of logs, metrics, state. Three of these in particular are intended to be set to corresponding business identifiers derived from your specific business domain — `application-id`, `workflow-id`, and `command-id`.

Navigation is enabled by the use of structured logs from as many components as possible[9]. It is recommended that your custom components likewise emit structured logs for more accurate consumption by OpenTelemetery.

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[6] Distributed tracing is essential to efficient debugging and diagnosis of any distributed application. While technically distinct identifiers Trace and Span Ids are closely linked. If unfamiliar with their use OpenTelemetry has a good primer (https://opentelemetry.io/docs/concepts/signals/traces/), Grafana has a reasonable demo (https://grafana.com/docs/tempo/latest/introduction/), and we demonstrate their use later in this guide.
[7] Equivalent to "blockheight" in other public blockchains that do not support privacy. As privacy dictates that each participant node sees a different projection of the global blockchain, the offset is not comparable across different Participant Nodes. It is commonly the preferred id when dealing with a single participant node due to being a simple, monotonic, total-order on ledger events witnessed by a Participant Node.
[8] By virtue of their role in the ledger model, all parties are (and the associated entity must be) capable of authorizing a (sub-)transaction or ledger event. See the Daml Ledger Authorization Model for details (https://docs.daml.com/concepts/ledger-model/ledger-integrity.html#authorization)
[9] Where loggers cannot be configured to emit structured logs directly, log parsers are used to convert raw log files in the usual manner. This is primarily done in the OTEL Collector configuration.

Direct Ledger Inspection using Correlation Identifiers

Starting from `$ make stop clean-all && make build start`, we proceed with initiating the example application app-user onboarding:

```
√ % make create-app-install-request | cat -n
  1 docker compose -f docker/app-user-shell/compose.yaml --env-file .env run --rm
create-app-install-request || true
  2 get_token ledger-api-user AppProvider
  3 get_user_party AppProvider participant-app-provider
  4 http://participant-app-provider:7575/v2/users/AppProvider
  5 get_token ledger-api-user Org1
  6 get_user_party Org1 participant-app-user
  7 http://participant-app-user:7575/v2/users/Org1
  8 get_token administrator Org1
  9 http://validator-app-user:5003/api/validator/v0/scan-proxy/dso-party-id
 10 http://participant-app-user:7575/v2/commands/submit-and-wait
 11 --data-raw {
 12         "commands" : [
 13            { "CreateCommand" : {
 14                 "template_id": "#quickstart-licensing:Licensing.AppInstall:AppInstallRequest",
 15                 "create_arguments": {
 16                     "dso":
"DSO::1220015e721c8ec5c1a5868b418442f064530e367c2587a9b43bd66f58c7bfddfec4",
 17                     "provider":
"AppProvider::12202fe7b2bf950dca3858b880d9ee0dd58249af8821ff2330ea1b80420852e816ff",
 18                     "user":
"Org1::122072b20a515d939910f9412f915cff8c1a7a427ddde76c6d0b7646d0022d4d4551",
 19                     "meta": {"values": []}
 20                 }
 21             }
 22            }
 23
 24         ],
 25         "workflow_id" : "create-app-install-request",
 26         "application_id": "ledger-api-user",
 27         "command_id": "create-app-install-request",
 28         "deduplication_period": { "Empty": {} },
 29         "act_as": ["Org1::122072b20a515d939910f9412f915cff8c1a7a427ddde76c6d0b7646d0022d4d4551"],
 30         "read_as": ["Org1::122072b20a515d939910f9412f915cff8c1a7a427ddde76c6d0b7646d0022d4d4551"],
 31         "submission_id": "create-app-install-request",
 32         "disclosed_contracts": [],
 33         "domain_id": "",
 34         "package_id_selection_preference": []
 35     }
 36 {"update_id":
"1220e48d6d59af99a1b61eca414fe25766c342bb4e7d8d485e049a11a7f2267ed5c0","completion_offset":73}
```

This is the output of a script submitting a create command to the app-user's participant node, it already contains number of the correlation ids mentioned above:

14	TemplateId	`#quickstart-licensing:Licensing.AppInstall:AppInstallRequest`

16-18	Party Ids	`DSO::1220015e721c8ec5c1a5868b...ddfec4`
		`AppProvider::12202fe7b2bf950d...e816ff`
		`Org1::122072b20a515d939910f94...4d4551`

25	Workflow Id	`create-app-install-request`
26	Application Id	`ledger-api-user`
27	Command Id	`create-app-install-request`
31	Submission Id	`create-app-install-request`
36	Transaction Id	`1220e48d6d59af99a1b61eca414fe...7ed5c0`

We can immediately use the transaction id in Daml Shell to view the associated ledger transaction:

```
√ % make shell
docker compose -f docker/daml-shell/compose.yaml --env-file .env run --rm daml-shell || true
Connecting to jdbc:postgresql://postgres-splice-app-provider:5432/scribe...
Connected to jdbc:postgresql://postgres-splice-app-provider:5432/scribe
postgres-splice-app-provider:5432/scribe> transaction
1220e48d6d59af99a1b61eca414fe25766c342bb4e7d8d485e049a11a7f2267ed5c0
transactionId: 1220e48d6d59af99a1b6..., offset: 48, workflowId: create-app-install-request -
Feb 17, 2025, 5:26:09 AM
+ #1220e48d6d59af99a1b6...:0 quickstart-licensing:Licensing.AppInstall:AppInstallRequest
(005c17f89b7fd1d5fde9...) {"dso":
"DSO::1220015e721c8ec5c1a5868b418442f064530e367c2587a9b43bd66f58c7bfddfec4", "meta":
{"values": []}, "user":
"Org1::122072b20a515d939910f9412f915cff8c1a7a427ddde76c6d0b7646d0022d4d4551", "provider":
"AppProvider::12202fe7b2bf950dca3858b880d9ee0dd58249af8821ff2330ea1b80420852e816ff"}
postgres-splice-app-provider:5432/scribe 3f → 48>
```

From here we can get more identifiers:

Ledger Offset	`48`
Ledger Event Id	`#122026e55e3f82e27542...:0`
Contract Id	`00cb53139ff0eb7ec57b...`

The Workflow Id, Template Id, and Party Ids are also visible here. The ledger offset can be very useful if you are going to query PQS or the Ledger API directly for more information. The Contract Id can be used to immediately display the contract in Daml Shell:

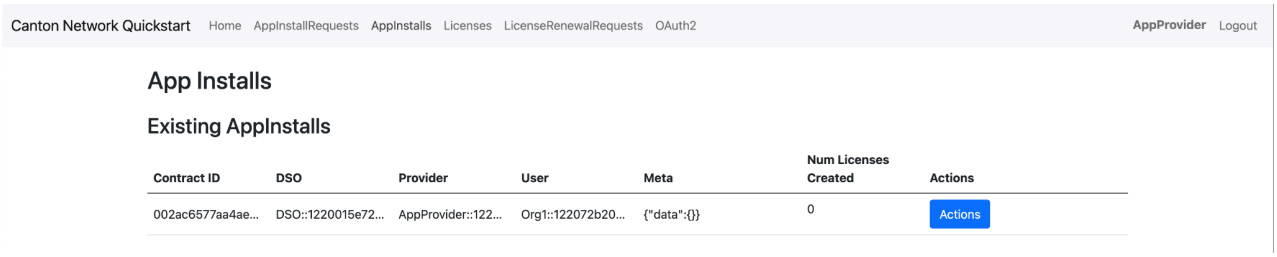
```
postgres-splice-app-provider:5432/scribe 3f → 48> contract
005c17f89b7fd1d5fde9c548740c32924edeeddacc6320256892636b4e3b7d66aaca101220777c5420863adb012c4f38847049346014c44eba7cd54bf
```

```
58950dd6a18679053
╓──────────────────╥──────────────────────────────────────────────────────────────────────────────
║ Identifier       ║ quickstart-licensing:Licensing.AppInstall:AppInstallRequest              ║
╟──────────────────╫──────────────────────────────────────────────────────────────────────────────
║ Type             ║ Template                                                                 ║
╟──────────────────╫──────────────────────────────────────────────────────────────────────────────
║ Created at       ║ 48 (not yet active)                                                      ║
╟──────────────────╫──────────────────────────────────────────────────────────────────────────────
║ Archived at      ║ <active>                                                                 ║
╟──────────────────╫──────────────────────────────────────────────────────────────────────────────
║ Contract ID      ║ 005c17f89b7fd1d5fde9...                                                  ║
╟──────────────────╫──────────────────────────────────────────────────────────────────────────────
║ Event ID         ║ #1220e48d6d59af99a1b6...:0                                               ║
╟──────────────────╫──────────────────────────────────────────────────────────────────────────────
║ Contract Key     ║                                                                          ║
╟──────────────────╫──────────────────────────────────────────────────────────────────────────────
║ Payload          ║ dso: DSO::1220015e721c8ec5c1a5868b418442f064530e367c2587a9b43bd66f58c7bfddfec4 ║
║                  ║ meta:                                                                    ║
║                  ║   values:                                                                ║
║                  ║ user: Org1::122072b20a515d939910f9412f915cff8c1a7a427ddde76c6d0b7646d0022d4d4551 ║
║                  ║ provider: AppProvider::12202fe7b2bf950dca3858b880d9ee0dd58249af8821ff2330ea1b80420852e816ff ║
╙──────────────────╨──────────────────────────────────────────────────────────────────────────────
postgres-splice-app-provider:5432/scribe 3f → 48>
```

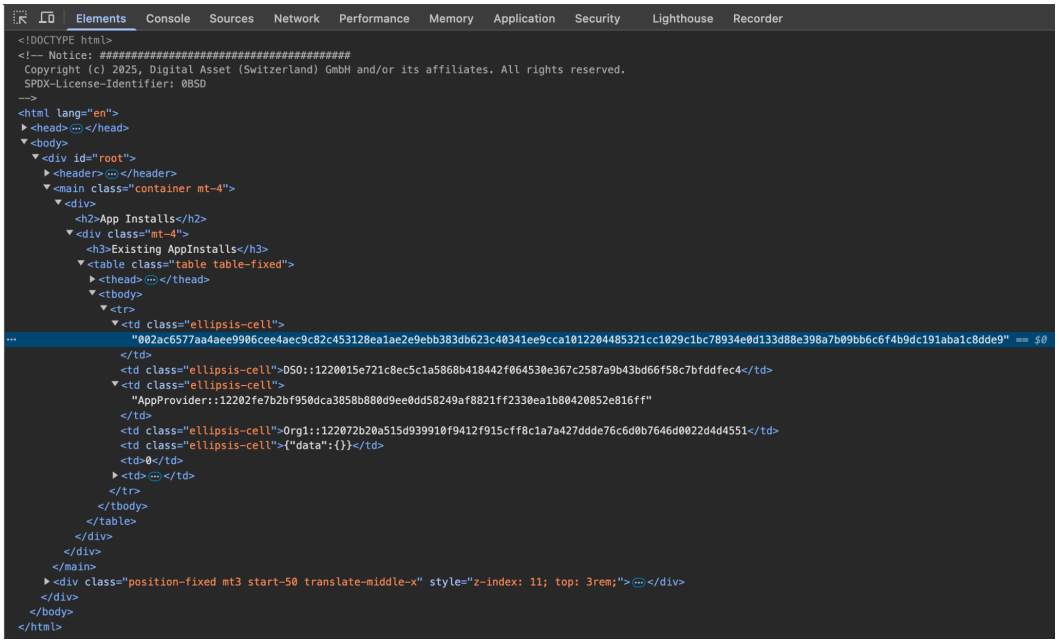
If the problem is in fact a bug in your smart contract, then exploring the transaction and related provenance within Daml Shell and utilizing the Daml IDE to synthesize and rerun the relevant transactions will normally be sufficient to identify the issue. However, if only due to the comparative lines of code, the root cause of most issues will be off ledger. Consequently, significant value in these identifiers derives from correlating these identifiers with the consolidated logs and other information collected through Open Telemetry.

Correlated Logs and Traces using Correlation Identifiers

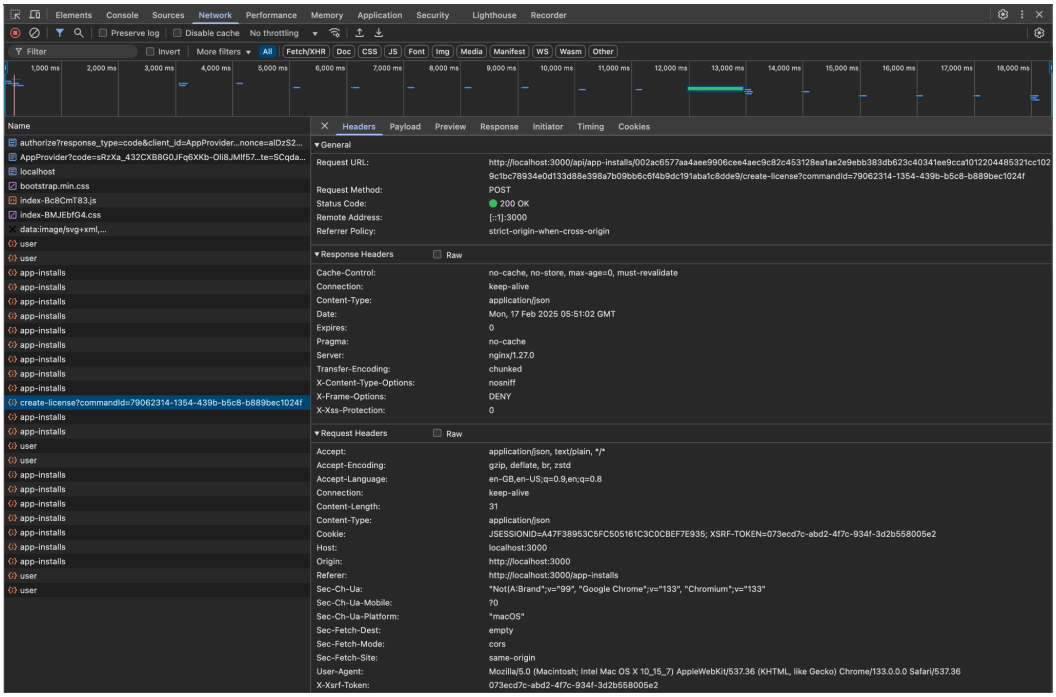
To advance the example, we log in as the AppProvider and accept the `AppInstallRequest`, resulting in:



The usual browser-based developer inspection tools can extract the relevant correlation ids:

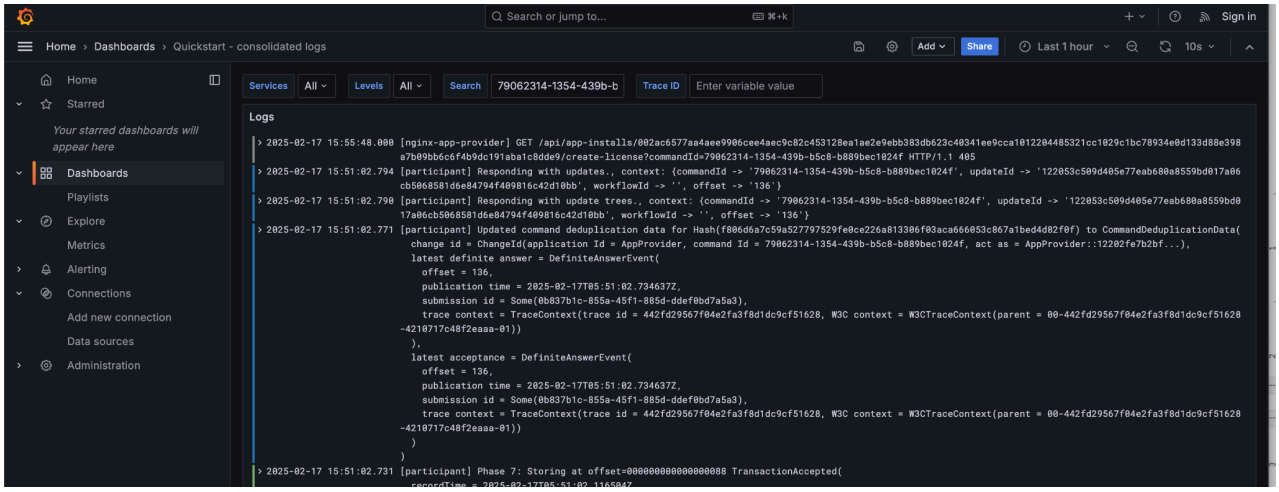


We can also see the HTTP call to the Backend-Service when we issue a new license, and again the response to the call provides additional identifiers.



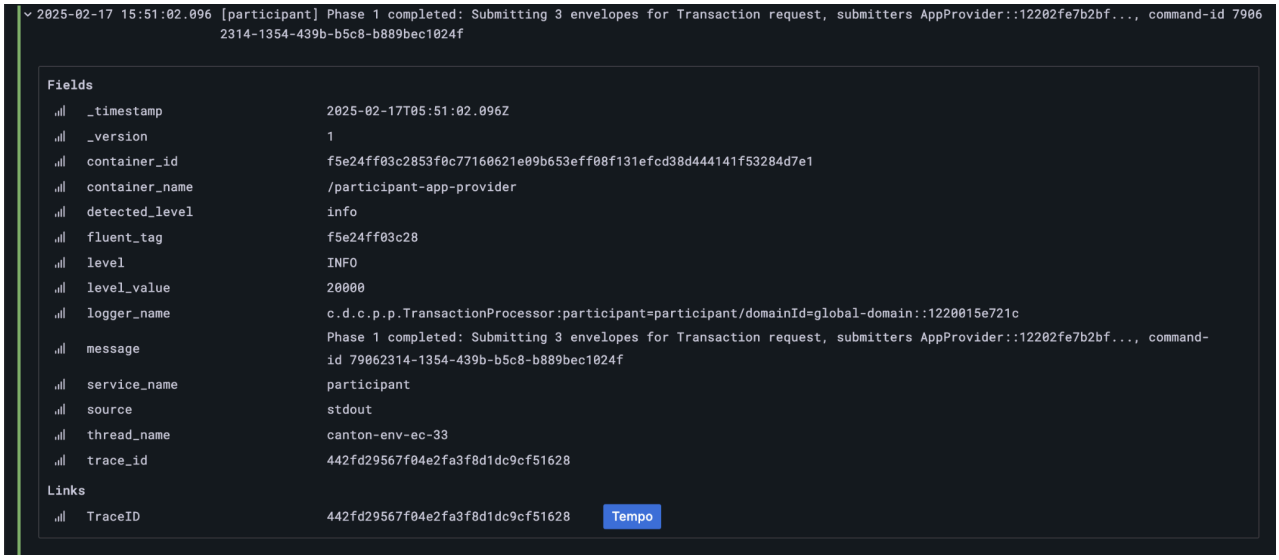
Command Id		79062314-1354-439b-b5c8-b889bec1024f
Contract Id	*AppInstall*	002ac6577aa4aee9906cee4aec9c82c45312...
Contract Id	*License*	79062314-1354-439b-b5c8-b889bec1024f

As we have already seen, contract ids can be used in Daml Shell to inspect the contracts directly. In addition, due to the way the OpenAPI interface for the Backend has been designed, the Command Id is visible as a query parameter to the POST. We can use this to query the consolidated logs in Grafana:

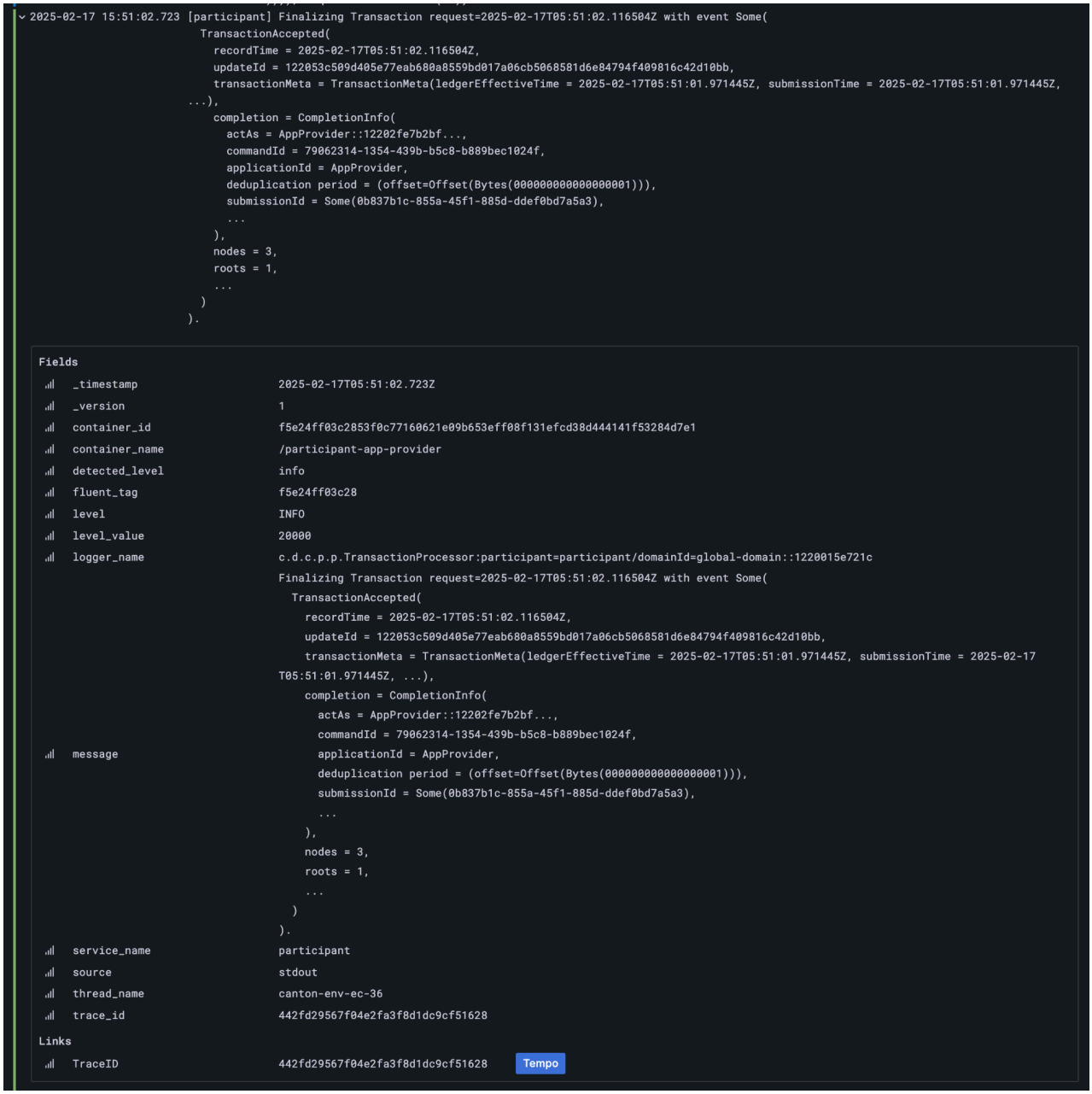


The command-id has provided logs from the App-Provider's Nginx reverse proxy in front of the backend and their Participant Node. We can verify the Nginx log matches the request we saw from the browser:

Critically, we can also see in the same aggregated log the entries that indicate the Participant Node submitting the transaction to the Canton Synchronization Domain:

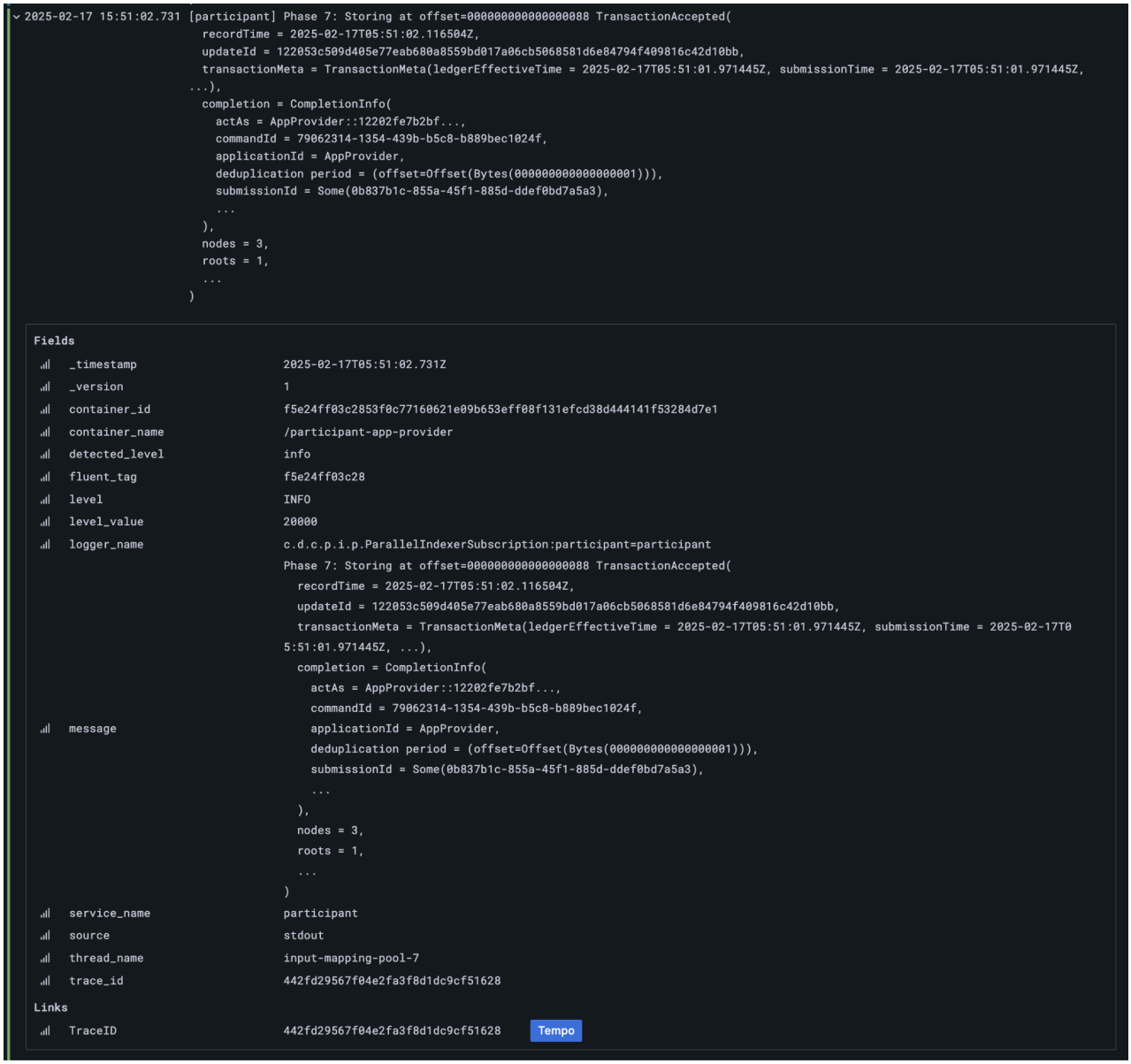


Was notified that the transaction was successfully committed to the Canton Ledger:



And finally added to the App-Provider's local ledger:[10]

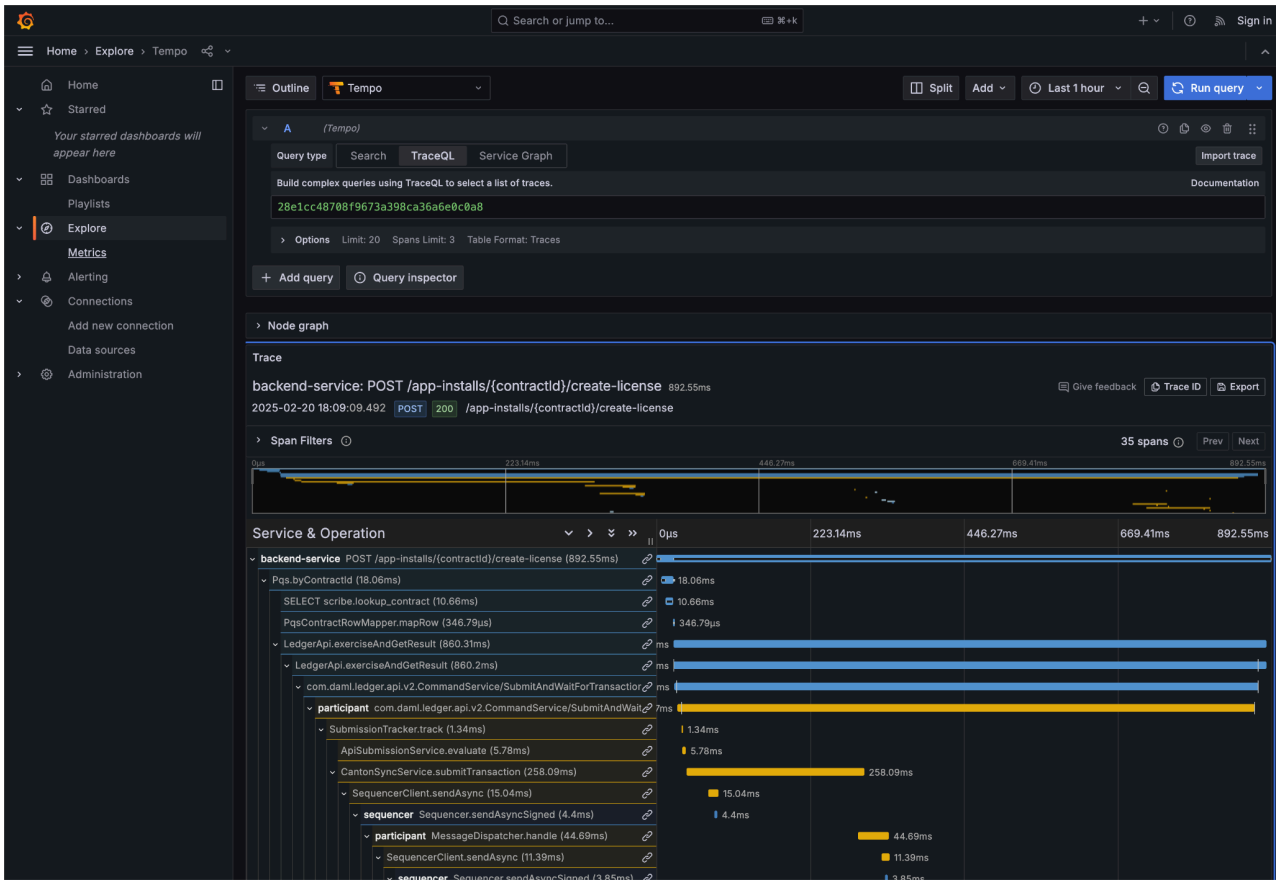
[10] This is an example of an important feature of the Canton Network. The participant node is only aware of the existence of this transaction because it is authorized to be informed of the transaction by the relevant Daml Smart Contracts and the privacy semantics of the Daml Ledger Model. Privacy is guaranteed, not because the contract data is obscured as cyphertext; but, because the ledger model ensures participants without a verified right to know do not receive the transaction in any form.



Note that from these we can obtain additional correlation ids, any of which could have been used to find these log lines:

Ledger Offset	`000000000000000088`
Transaction Id	`122053c509d405e77eab680a855…2d10bb`
Submission Id	`0b837b1c-855a-45f1-885d-ddef0bd7a5a3`
Trace Id	`442fd29567f04e2fa3f8d1dc9cf51628`

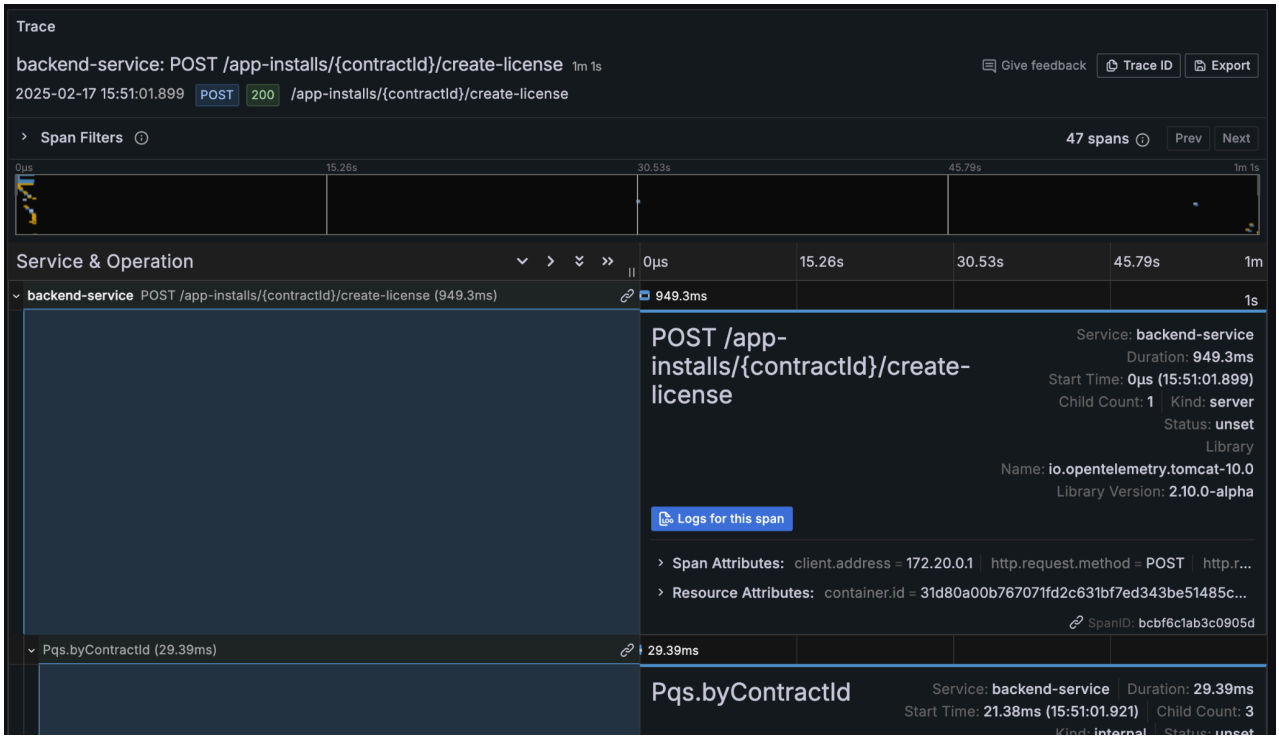
In particular the Trace Id is invaluable because it can link us directly into Tempo to see the distributed operation spans:



Here we can see the flow of the create license operation behind the backend reverse proxy:

- Initial POST handler in the Backend Service
- Backend query against PQS to retrieve the AppInstall contract
- Call to the App-Provider Ledger API from the Backend Service
- Preparation of the Transaction by the Participant Node and submission to the Canton Network

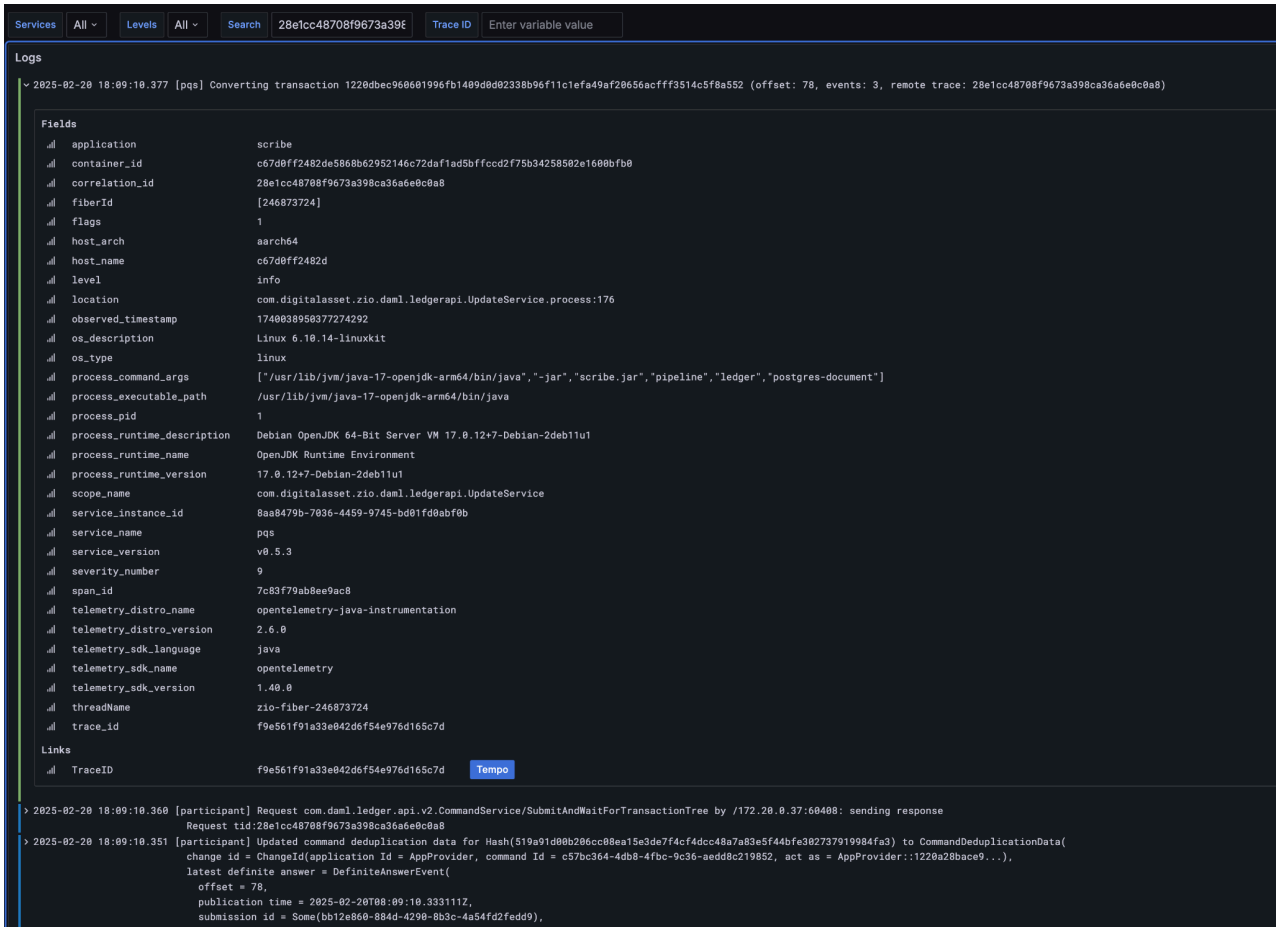
One very powerful aspect of the Grafana suite is the degree to which it integrates the various observability tools in the quickstart stack. We have already seen this with the link from the consolidated logs to Tempo; however, it also runs the other way. Expanding a span in Tempo provides a link to “Logs for this span”.



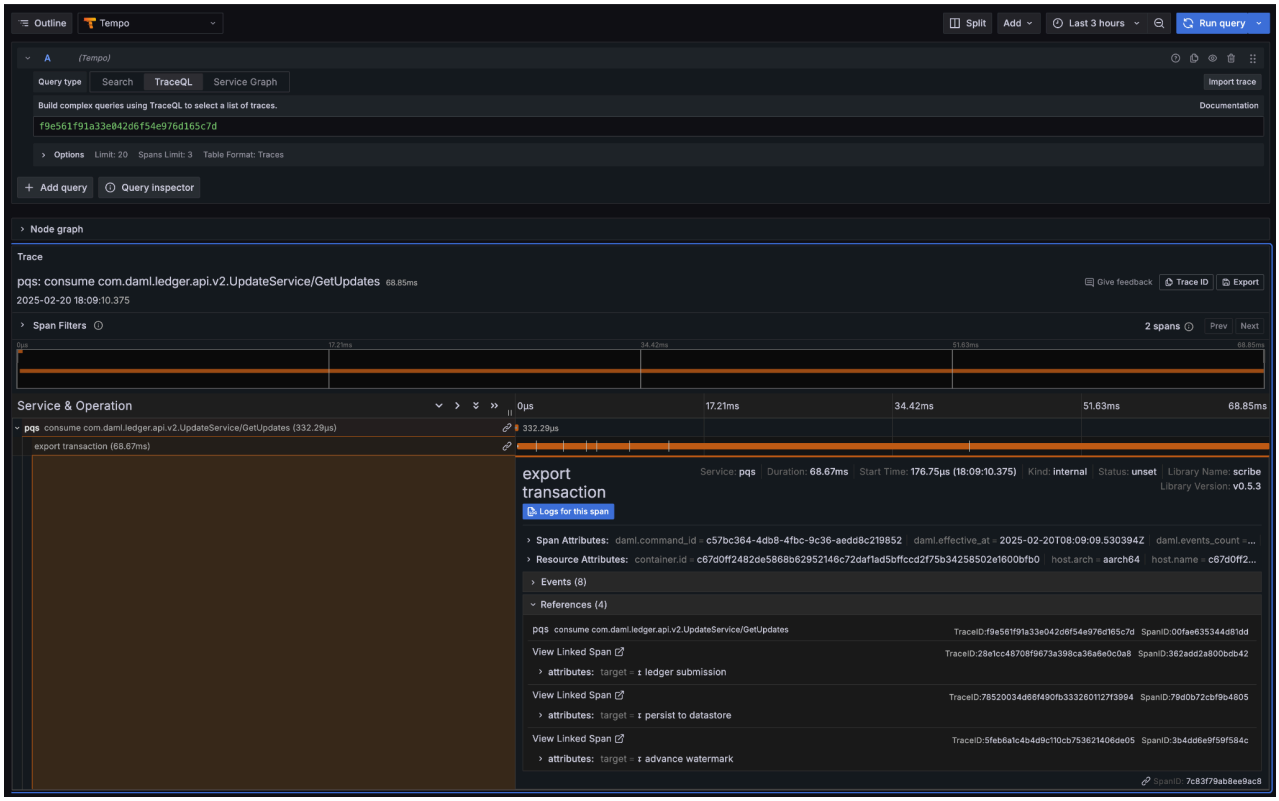
These link to the logs for the specific component (backend-service, participant, sequencer, etc) correlated to this span.

Using different correlation ids can allow us to navigate and explore the history of our distributed application. We have seen the transaction committed to the ACS within the participant node; however, PQS also logs identifiers associated with the transactions it indexes.

The transactionId and the traceId can both be used to broaden our understanding of the create-license backend operation and what followed after.



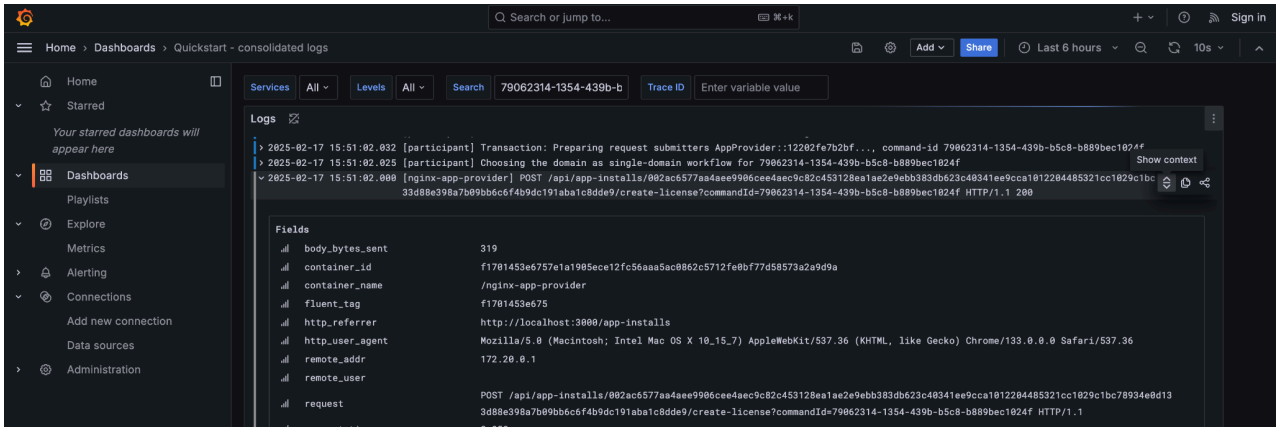
PQS ingestion is a distinct operation performed by a background process. The traceId for this log is therefore distinct; however it still links back to the trace and transaction identifiers associated with the ledger data it is ingesting. You can see this if you follow the Tempo link:



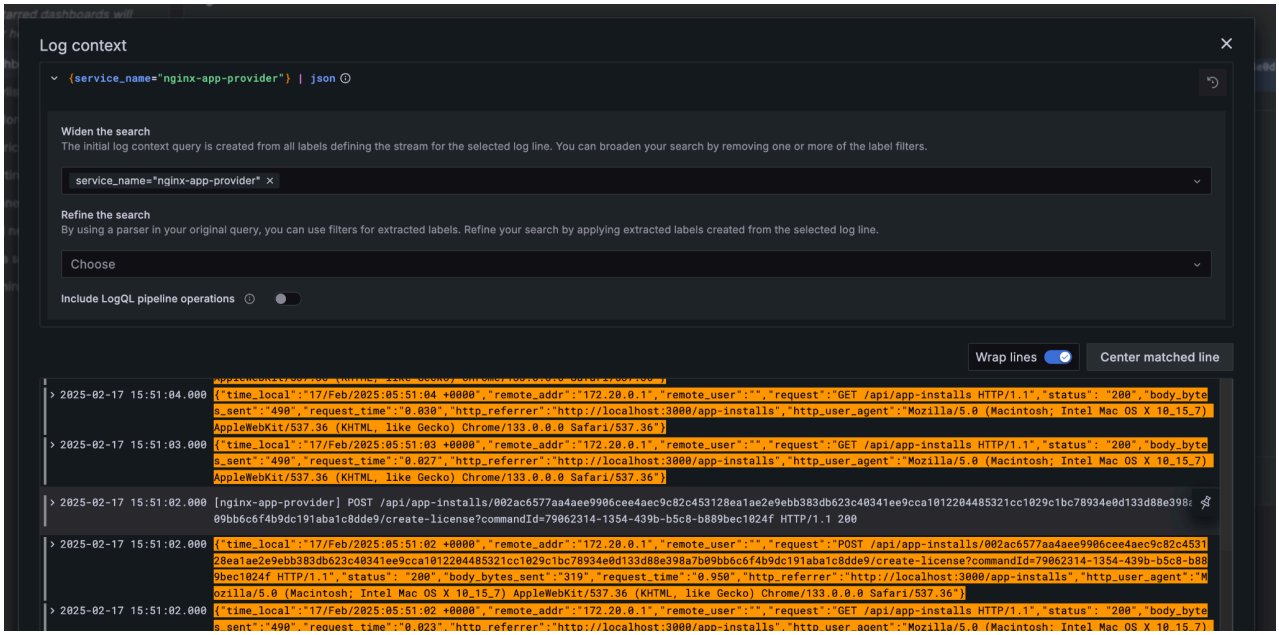
The expanded “references” section in the “export transaction” span include links to traces for related PQS processes and also, critically, the trace for command submission that resulted in the transaction. The link takes us directly to that trace, which in this case is the same one we just came from.

Querying and navigating through correlated logs, traces, and spans makes understanding the multiple moving parts involved in a Canton Network Application much easier. Keep in mind that you can only navigate logs and traces that have been emitted; and, query identifiers that have been included or attached. Therefore we highly recommend you periodically take the time to look for opportunities to enrich and expand the logging within your application.

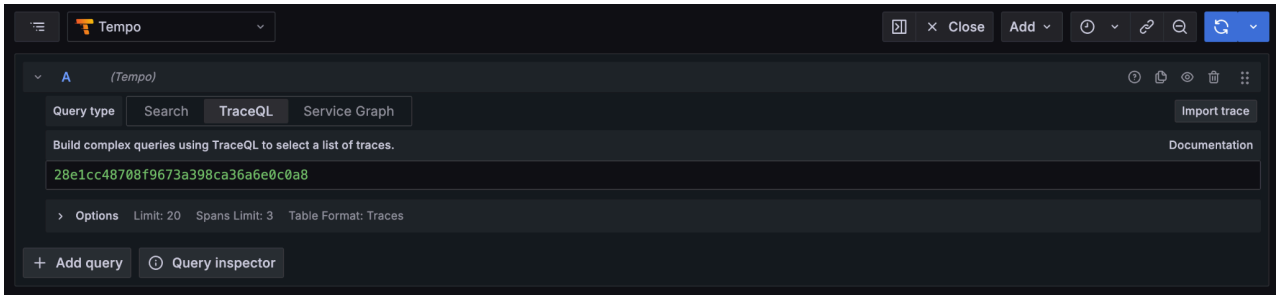
One final thing that isn’t visible immediately, but is whenever you hover over any log line is the option to view the log context for that line:



This will pop up a window with a full unfiltered view of the component's logs for that time, with the relevant line highlighted. In the case of the Nginix log line, this provides a single click view of the other traffic being served at the same time:



It is also worth keeping in mind that Grafana exposes access to the raw queries for Tempo and Loki, and also Prometheus (not shown). It is well worth the time to experiment with these and discover how to probe the unified metrics, traces, and logs available via the observability stack:



A starting point for finding documentation on these see:

- Loki: https://grafana.com/docs/loki/latest/query/
- Tempo: https://grafana.com/docs/tempo/latest/traceql/
- Prometheus: https://grafana.com/docs/grafana/latest/datasources/prometheus/query-editor/