Lab 8: Securing your CockroachDB instance

- Step 1. Generate certificates
- Step 2. Start the cluster
- Step 3. Use the built-in SQL client
- Step 4. Access the DB Console
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Before you begin

Make sure you have already installed CockroachDB.

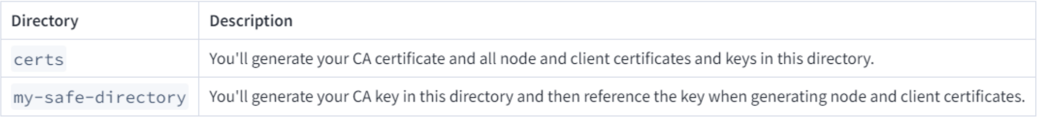
Once you've installed CockroachDB, it's simple to run a secure multi-node cluster locally, using [TLS certificates to encrypt network communication.

Step 1. Generate certificates

You can use either `cockroach cert` commands to generate security certificates. This section features the `cockroach cert` commands.

1. Create two directories:

```
mkdir certs my-safe-directory
```



Directory	Description
`certs`	You'll generate your CA certificate and all node and client certificates and keys in this directory.
`my-safe-directory`	You'll generate your CA key in this directory and then reference the key when generating node and client certificates.

2. Create the CA (Certificate Authority) certificate and key pair:

```
cockroach cert create-ca \
--certs-dir=certs \
--ca-key=my-safe-directory/ca.key
```

3. Create the certificate and key pair for your nodes:

```
cockroach cert create-node \
localhost \
$(hostname) \
--certs-dir=certs \
--ca-key=my-safe-directory/ca.key
```

Because you're running a local cluster and all nodes use the same hostname (`localhost`), you only need a single node certificate. Note that this is different than running a production cluster, where you would need to generate a certificate and key for each node, issued to all common names and IP addresses you might use to refer to the node as well as to any load balancer instances.

4. Create a client certificate and key pair for the `root` user:

```
cockroach cert create-client \
root \
--certs-dir=certs \
--ca-key=my-safe-directory/ca.key
```

Step 2. Start the cluster

1. Use the `cockroach start` command to start the first node:

   ```
   cockroach start \
   --certs-dir=certs \
   --store=node1 \
   --listen-addr=localhost:26257 \
   --http-addr=localhost:8080 \
   --join=localhost:26257,localhost:26258,localhost:26259
   ```

   You'll see a message like the following:

   ```
   *
   * INFO: initial startup completed.
   * Node will now attempt to join a running cluster, or wait for `cockroach
   init`.
   * Client connections will be accepted after this completes successfully.
   * Check the log file(s) for progress.
   *
   ```

2. Take a moment to understand the [flags] you used:

   - The `--certs-dir` directory points to the directory holding certificates and keys.
   - Since this is a purely local cluster, `--listen-addr=localhost:26257` and `--http-addr=localhost:8080` tell the node to listen only on `localhost`, with port `26257` used for internal and client traffic and port `8080` used for HTTP requests from the DB Console.
   - The `--store` flag indicates the location where the node's data and logs are stored.
   - The `--join` flag specifies the addresses and ports of the nodes that will initially comprise your cluster. You'll use this exact `--join` flag when starting other nodes as well.

     For a cluster in a single region, set 3-5 `--join` addresses. Each starting node will attempt to contact one of the join hosts. In case a join host cannot be reached, the node will try another address on the list until it can join the gossip network.

3. In separate terminal windows, start two more nodes:

   ```
   cockroach start \
   --certs-dir=certs \
   --store=node2 \
   --listen-addr=localhost:26258 \
   --http-addr=localhost:8081 \
   --join=localhost:26257,localhost:26258,localhost:26259
   ```

```
cockroach start \
--certs-dir=certs \
--store=node3 \
--listen-addr=localhost:26259 \
--http-addr=localhost:8082 \
--join=localhost:26257,localhost:26258,localhost:26259
```

These commands are the same as before but with unique `--store`, `--listen-addr`, and `--http-addr` flags.

4. Use the `cockroach init` command to perform a one-time initialization of the cluster, sending the request to any node on the `--join` list:

```
cockroach init --certs-dir=certs --host=localhost:26257
```

You'll see the following message:

```
Cluster successfully initialized
```

At this point, each node also prints helpful [startup details] to its log. For example, the following command retrieves node 1's startup details:

```
grep 'node starting' node1/logs/cockroach.log -A 11
```

The output will look something like this:

```
CockroachDB node starting at
build:               CCL v23.1.13 @ 2023-12-11 00:00:00 (go1.12.6)
webui:               https://localhost:8080
sql:                 postgresql://root@localhost:26257?sslcert=certs%2Fclient.root.crt&sslkey=certs%2Fclient.root.key&sslmode=verify-full&sslrootcert=certs%2Fca.crt
RPC client flags:    cockroach <client cmd> --host=localhost:26257 --certs-dir=certs
logs:                /Users/<username>/node1/logs
temp dir:            /Users/<username>/node1/cockroach-temp966687937
external I/O path:   /Users/<username>/node1/extern
store[0]:            path=/Users/<username>/node1
status:              initialized new cluster
clusterID:           b2537de3-166f-42c4-aae1-742e094b8349
nodeID:              1
```

Step 3. Use the built-in SQL client

Now that your cluster is live, you can use any node as a SQL gateway. To test this out, let's use CockroachDB's built-in SQL client.

1. Run the `cockroach sql` command against node 1:

```
cockroach sql --certs-dir=certs --host=localhost:26257
```

2. Run some basic [CockroachDB SQL statements]:

```
CREATE DATABASE bank;
```

```
CREATE TABLE bank.accounts (id INT PRIMARY KEY, balance DECIMAL);
```

```
INSERT INTO bank.accounts VALUES (1, 1000.50);
```

```
SELECT * FROM bank.accounts;
```

```
  id | balance
+----+---------+
   1 | 1000.50
(1 row)
```

3. Now exit the SQL shell on node 1 and open a new shell on node 2:

   ```
   \q
   ```

   ```
   cockroach sql --certs-dir=certs --host=localhost:26258
   ```

   Note:

   In a real deployment, all nodes would likely use the default port `26257`, and so you wouldn't need to set the port portion of `--host`.

4. Run the same `SELECT` query as before:

   ```
   SELECT * FROM bank.accounts;
   ```

   ```
     id | balance
   +----+---------+
      1 | 1000.50
   (1 row)
   ```

   As you can see, node 1 and node 2 behaved identically as SQL gateways.

5. Now [create a user with a password], which you will need to [access the DB Console]:

   ```
   CREATE USER max WITH PASSWORD 'roach';
   ```

6. Exit the SQL shell on node 2:

   ```
   \q
   ```

Step 4. Access the DB Console

The CockroachDB [DB Console] gives you insight into the overall health of your cluster as well as the performance of the client workload.

1. On secure clusters, [certain pages of the DB Console] can only be accessed by `admin` users.

   Run the `cockroach sql` command against node 1:

```
cockroach sql --certs-dir=certs --host=localhost:26257
```

2. Assign `max` to the `admin` role (you only need to do this once):

```
GRANT admin TO max;
```

3. Exit the SQL shell:

```
\q
```

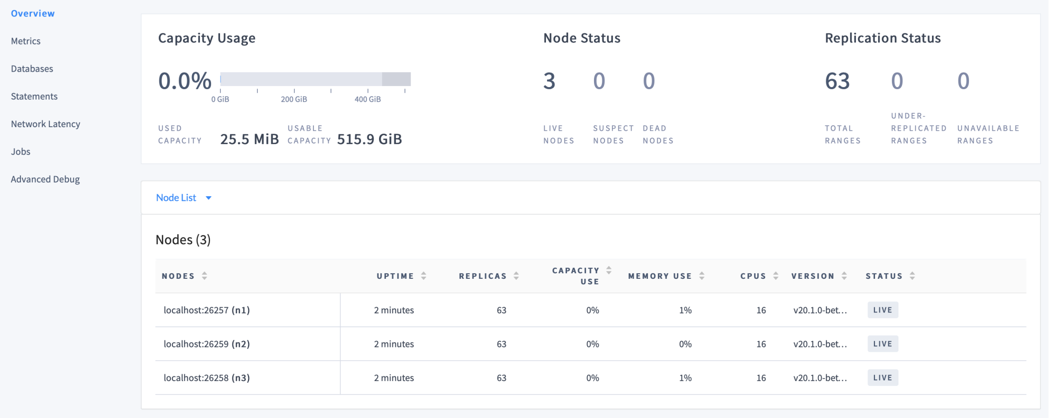
4. Go to [https://localhost:8080]. Note that your browser will consider the CockroachDB-created certificate invalid; you'll need to click through a warning message to get to the UI.

   Note:

   If you are using Google Chrome, and you are getting an error about not being able to reach `localhost` because its certificate has been revoked, go to chrome://flags/#allow-insecure-localhost, enable "Allow invalid certificates for resources loaded from localhost", and then restart the browser. Enabling this Chrome feature degrades security for all sites running on `localhost`, not just CockroachDB's DB Console, so be sure to enable the feature only temporarily.

5. Log in with the username and password you created earlier (`max` / `roach`).

6. On the **Cluster Overview**, notice that three nodes are live, with an identical replica count on each node:



Capacity Usage

0.0%

USED CAPACITY 25.5 MiB USABLE CAPACITY 515.9 GiB

Node Status

3 LIVE NODES
0 SUSPECT NODES
0 DEAD NODES

Replication Status

63 TOTAL RANGES
0 UNDER-REPLICATED RANGES
0 UNAVAILABLE RANGES

Nodes (3)

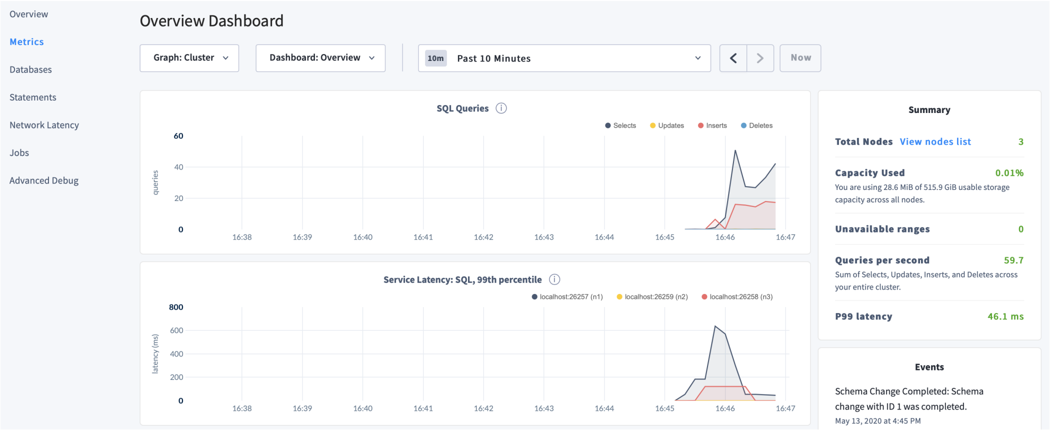
NODES	UPTIME	REPLICAS	CAPACITY USE	MEMORY USE	CPUS	VERSION	STATUS
localhost:26257 **(n1)**	2 minutes	63	0%	1%	16	v20.1.0-bet...	LIVE
localhost:26259 **(n2)**	2 minutes	63	0%	0%	16	v20.1.0-bet...	LIVE
localhost:26258 **(n3)**	2 minutes	63	0%	1%	16	v20.1.0-bet...	LIVE

This demonstrates CockroachDB's automated replication of data via the Raft consensus protocol.

Note:

Capacity metrics can be incorrect when running multiple nodes on a single machine.

7. Click **Metrics** to access a variety of time series dashboards, including graphs of SQL queries and service latency over time:



Summary

Total Nodes View nodes list 3

Capacity Used 0.01%
You are using 28.6 MiB of 515.9 GiB usable storage capacity across all nodes.

Unavailable ranges 0

Queries per second 59.7
Sum of Selects, Updates, Inserts, and Deletes across your entire cluster.

P99 latency 46.1 ms

Events

Schema Change Completed: Schema change with ID 1 was completed.
May 13, 2020 at 4:45 PM

8. Use the **Databases**, **Statements** and **Jobs** pages to view details about your databases and tables, to assess the performance of specific queries, and to monitor the status of long-running operations like schema changes, respectively.

Step 5. Simulate node maintenance

1. In a new terminal, gracefully shut down a node. This is normally done prior to node maintenance:

   Get the process IDs of the nodes:

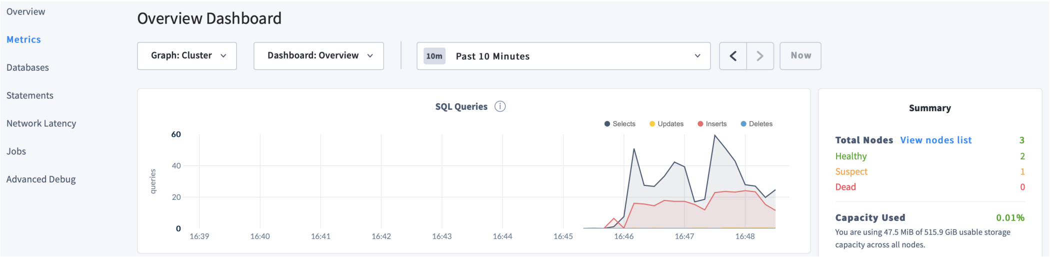
   ```
   ps -ef | grep cockroach | grep -v grep
   ```

   ```
     501  4482     1   0  2:41PM ttys000    0:09.78 cockroach start --certs-
   dir=certs --store=node1 --listen-addr=localhost:26257 --http-
   addr=localhost:8080 --join=localhost:26257,localhost:26258,localhost:26259
     501  4497     1   0  2:41PM ttys000    0:08.54 cockroach start --certs-
   dir=certs --store=node2 --listen-addr=localhost:26258 --http-
   addr=localhost:8081 --join=localhost:26257,localhost:26258,localhost:26259
     501  4503     1   0  2:41PM ttys000    0:08.54 cockroach start --certs-
   dir=certs --store=node3 --listen-addr=localhost:26259 --http-
   addr=localhost:8082 --join=localhost:26257,localhost:26258,localhost:26259
   ```

   Gracefully shut down node 3, specifying its process ID:

   ```
   kill -TERM UPDATE_HERE
   ```

2. Back in the DB Console, despite one node being "suspect", notice the continued SQL traffic:



Summary

Total Nodes View nodes list 3
Healthy 2
Suspect 1
Dead 0

Capacity Used 0.01%
You are using 47.5 MiB of 515.9 GiB usable storage capacity across all nodes.

3. Restart node 3:

```
cockroach start \
--certs-dir=certs \
--store=node3 \
--listen-addr=localhost:26259 \
--http-addr=localhost:8082 \
--join=localhost:26257,localhost:26258,localhost:26259
```

Step 6. Stop the cluster

1. When you're done with your test cluster, stop the nodes.

   Get the process IDs of the nodes:

   ```
   ps -ef | grep cockroach | grep -v grep
   ```

   ```
     501  4482     1   0  2:41PM ttys000    0:09.78 cockroach start --certs-
   dir=certs --store=node1 --listen-addr=localhost:26257 --http-
   addr=localhost:8080 --join=localhost:26257,localhost:26258,localhost:26259
     501  4497     1   0  2:41PM ttys000    0:08.54 cockroach start --certs-
   dir=certs --store=node2 --listen-addr=localhost:26258 --http-
   addr=localhost:8081 --join=localhost:26257,localhost:26258,localhost:26259
     501  4503     1   0  2:41PM ttys000    0:08.54 cockroach start --certs-
   dir=certs --store=node3 --listen-addr=localhost:26259 --http-
   addr=localhost:8082 --join=localhost:26257,localhost:26258,localhost:26259
   ```

   Gracefully shut down each node, specifying its process ID:

   ```
   kill -TERM UPDATE_PROCESSID_NODE1
   ```

   ```
   kill -TERM UPDATE_PROCESSID_NODE2
   ```

   ```
   kill -TERM UPDATE_PROCESSID_NODE3
   ```

2. If you do not plan to restart the cluster, you may want to remove the nodes' data stores and the certificate directories:

   ```
   rm -rf node1 node2 node3 certs my-safe-directory
   ```