JAVA DEVELOPER WORKSHOP

AGENDA

Lab Environment

Introduction to Data Modeling

Travel-sample data model

Connecting to Couchbase

Key/value and CRUD

Working with Parts of a Document

Querying for Documents with N1QL

Full Text Search

Field Level Encryption

Threshold Logging

Batching with RxJava

Spring Boot & Spring Data

LAB ENVIRONMENT

Lab 0: Installing Couchbase

DOWNLOAD

https://www.couchbase.com/downloads

DEPLOYMENT OPTIONS

https://docs.couchbase.com/server/6.0/install/get-started.html

On-Premises (Non-Cloud)	Virtual Machines and Containers	Public Cloud
Deploy Couchbase Server in a traditional data center on bare metal servers.	Deploy Couchbase Server within a virtualized or containerized environment, such as VMware or Docker.	Deploy Couchbase Server in a public cloud, such as Amazon Web Services (AWS), Microsoft Azure, and Google Cloud Platform.

Lab

Lab 0: Installing Couchbase

DOCKER

- Documentation: https://docs.couchbase.com/server/6.0/install/getting-started-docker.html
- Single server deployment for this workshop

```
docker run -d --name cbworkshop -p 8091-8096:8091-8096 -p 11210-11211:11210-11211 couchbase
```

Lab

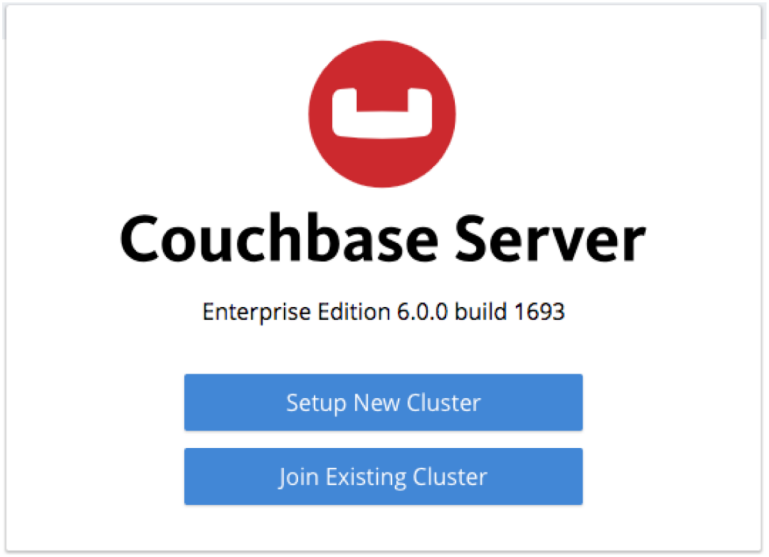
Lab 1: Initial Setup

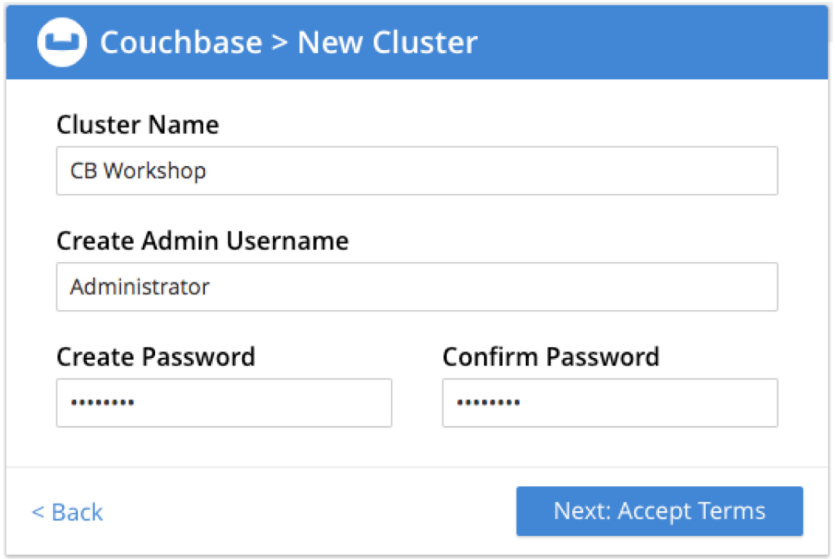
Access UI Web Console: http://localhost:8091/ui/index.html

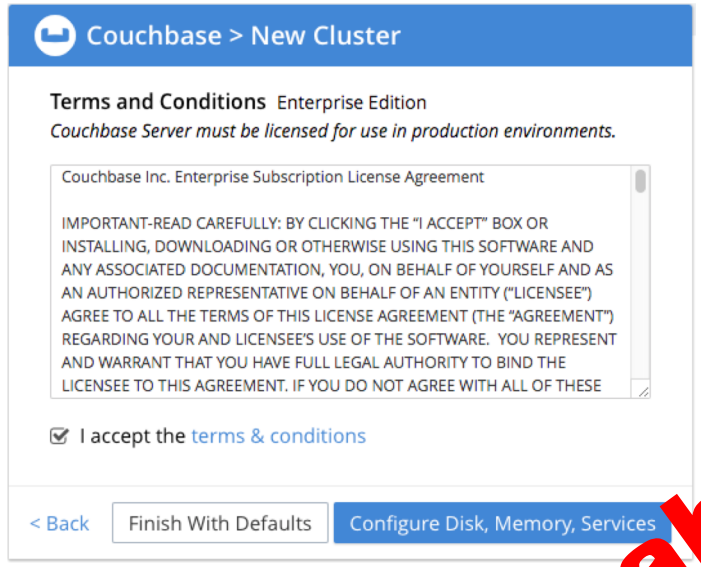
Click “Setup New Cluster”, Enter Cluster Name ”CB Workshop”

Administration User: Administrator:password

Accept Terms, and Configure Disk, Memory, Services



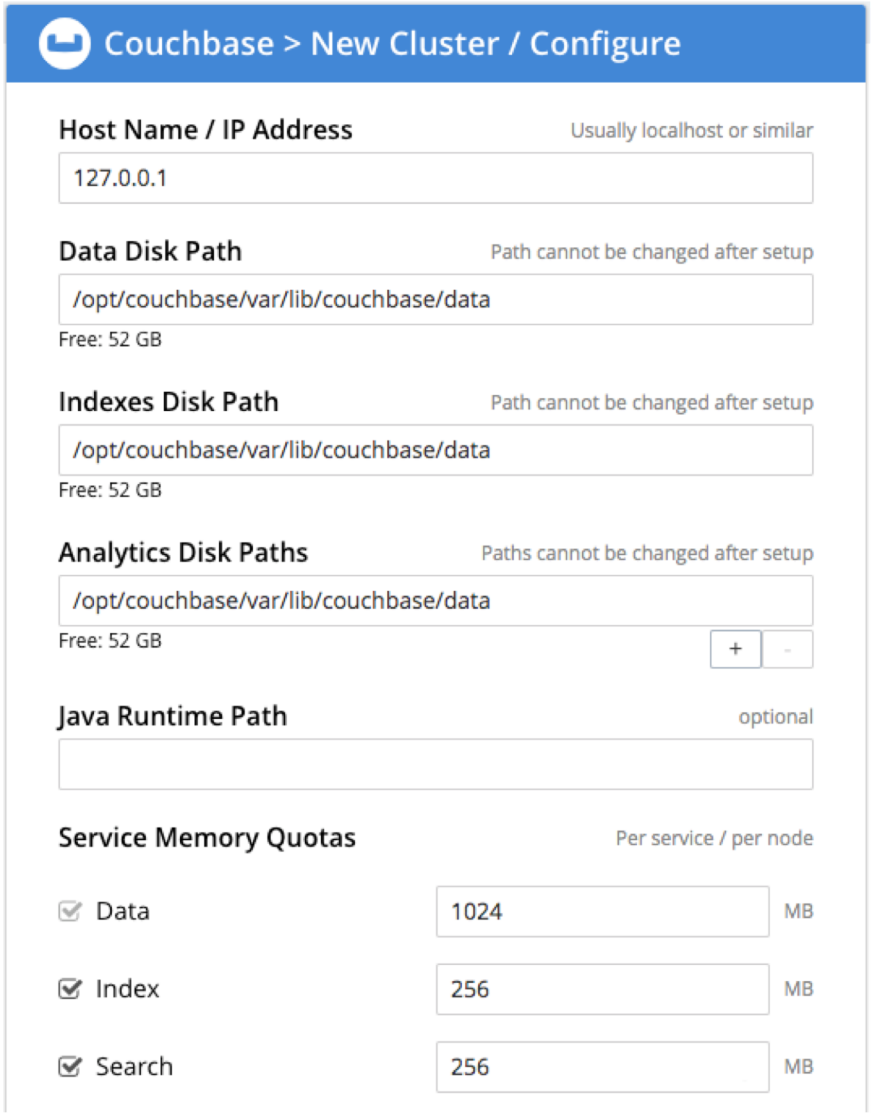


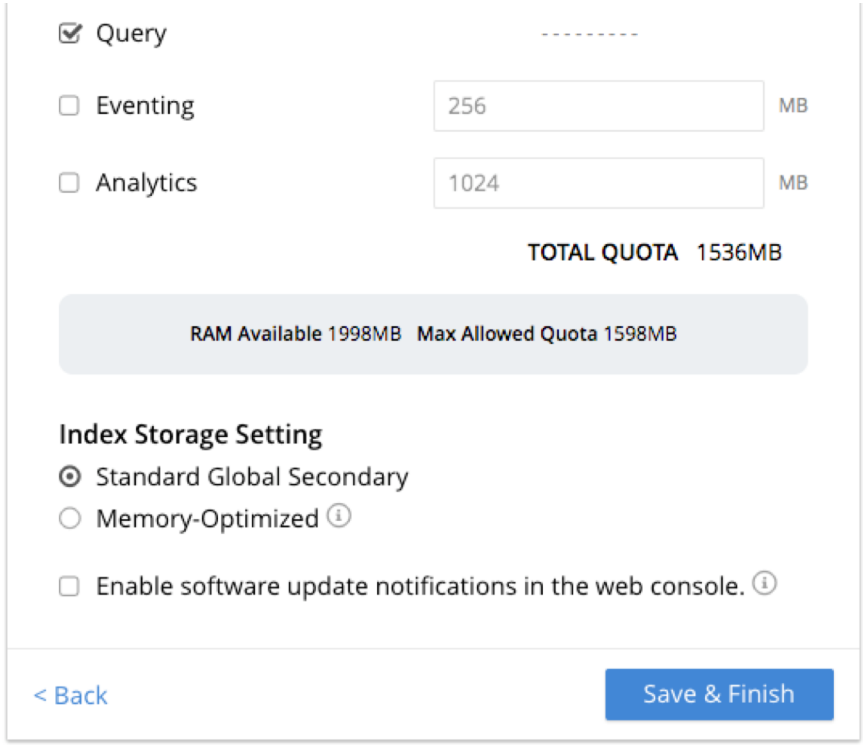


Lab

Lab 1: Initial Setup

- Memory Quotas:
  - Data 1024 Mb
  - Index: 256 Mb
  - Search: 256 Mb
- Uncheck Analytics and Eventing
- Uncheck software updates
- Save & Finish

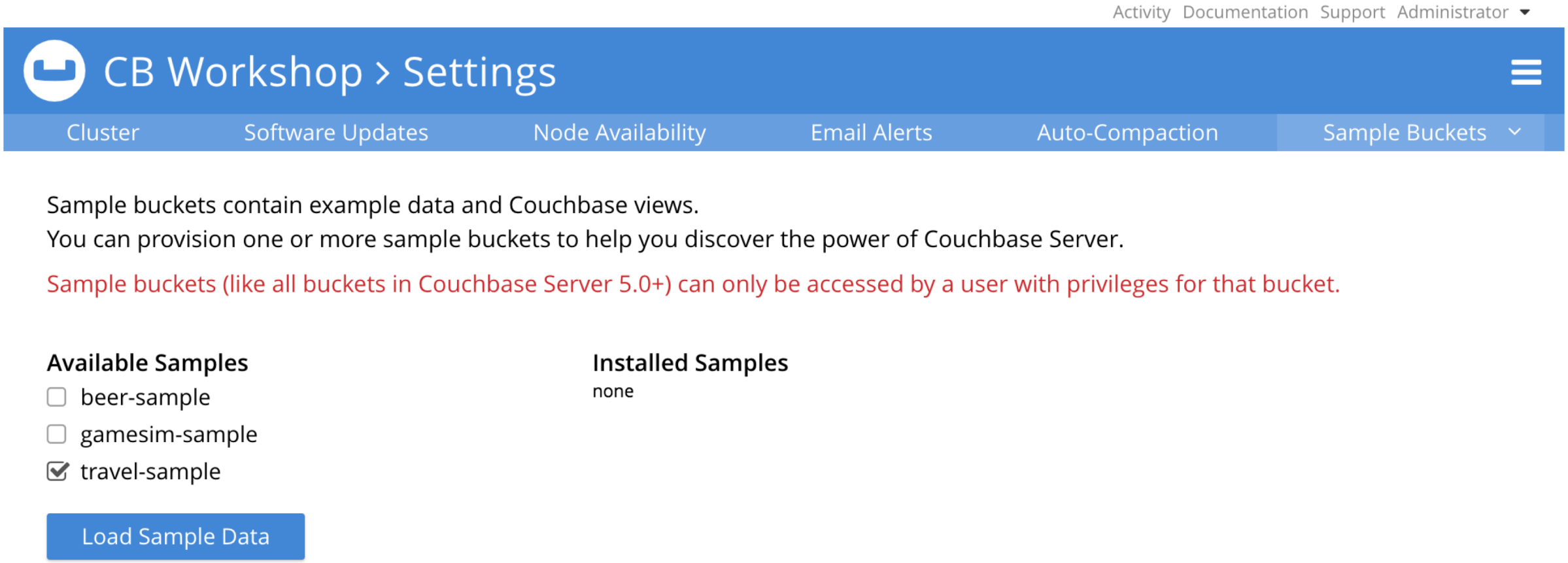




Lab

Lab 1: Initial Setup - Install sample data set

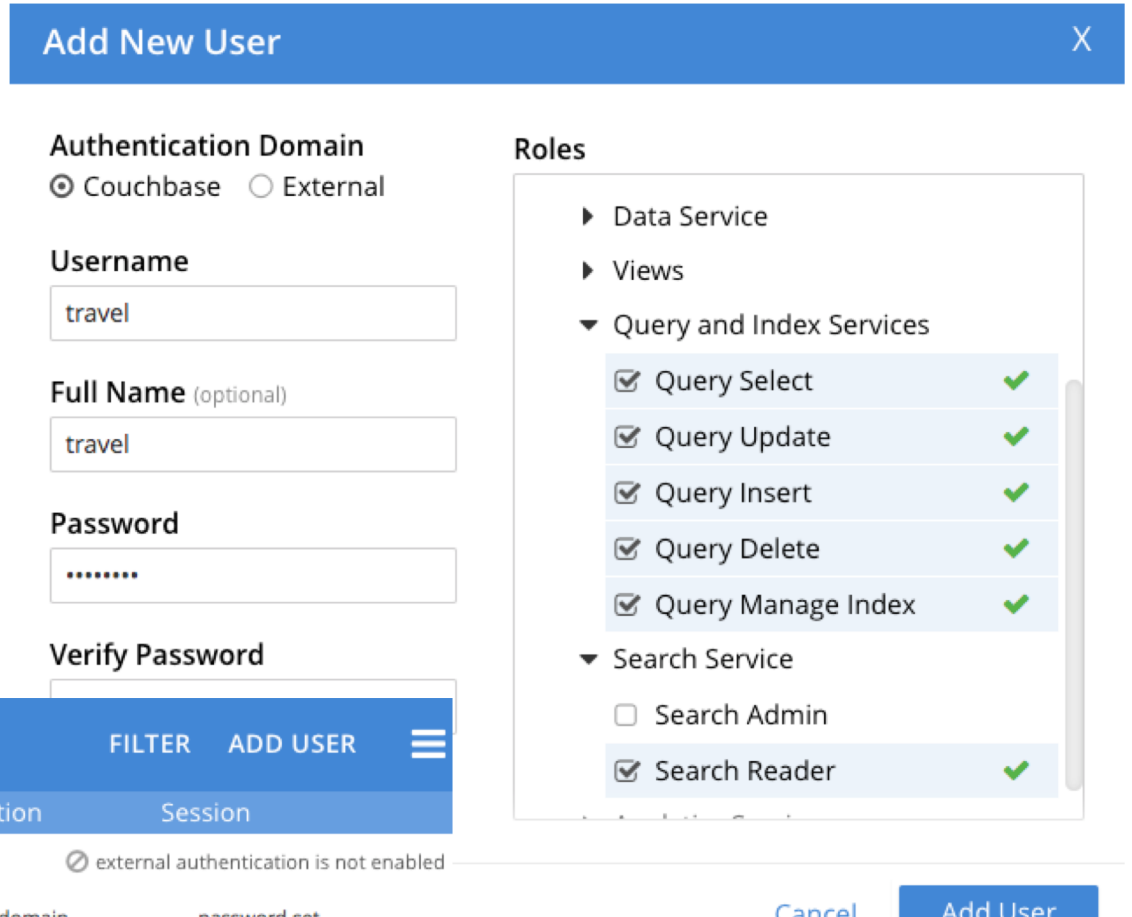
Install travel-sample data set: Admin Console > Settings > Sample Buckets

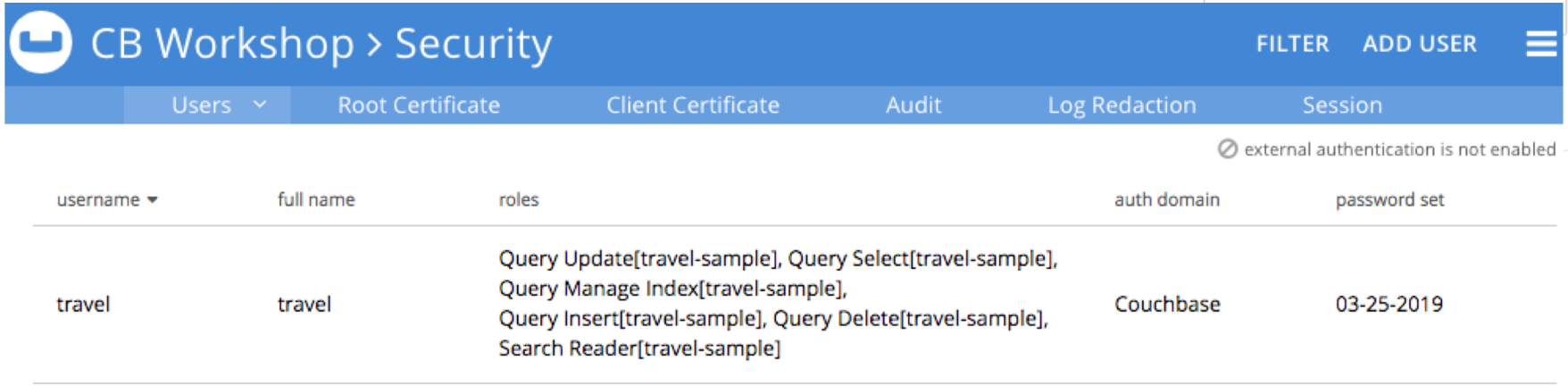


Lab

Lab 1: Initial Setup - Create User

- Username: travel
- Password: password
- Roles:
  - Query Update[travel-sample]
  - Query Select[travel-sample]
  - Query Manage Index[travel-sample]
  - Query Insert[travel-sample]
  - Query Delete[travel-sample]
  - Search Reader[travel-sample]





Lab

Lab 1: Initial Setup - Clone repo

Download the workshop code from this repository:

```
git clone https://github.com/BKaneAtWork/CouchbaseJavaWorkshop
```

Build a simple executable jar:

```
cd CouchbaseJavaWorkshop
mvn clean compile assembly:single
```

Run main class:

```
java -classpath target/CbDevWorkshop-0.0.1-SNAPSHOT-jar-with-dependencies.jar -
Dcbworkshop.clusteraddress=localhost -Dcbworkshop.user=travel -
Dcbworkshop.password=password -Dcbworkshop.bucket=travel-sample com.cbworkshop.MainLab
```

Scripts to run the java class (update env variables to match your environment):

- Mac: wrapper.sh
- Windows: wrapper.bat

Lab

INTRODUCTION TO DATA MODELING

The Plan – Introduction to Data Modeling

- Designing a Document Key
- Embedding Data as Complex JSON in Documents
- Create References Between Documents

Designing a Document Key

- Key design is as important as document design.
- There are three broad types of key:
  - Human readable, natural: e.g. an email address
  - Surrogate, computer generated, random: e.g. UUID
  - Compound: e.g. UUID with a natural portion

Human Readable Document Keys

```
key: nic@couchbase.com
```

```
{
    "name": ”Nic Raboy",
    ”email”: ”nic@couchbase.com",
    "address": ”450 Mission Street",
    "city": ”San Francisco”,
    “state”: “CA”
}
```

Generated Document Keys

```
key: f8d8d616-6ce0-4344-9793-4ec5a676c223
```

```
{
    "name": ”Nic Raboy",
    ”email”: ”nic@couchbase.com",
    "address": ”450 Mission Street",
    "city": ”San Francisco”,
    “state”: “CA”
}
```

Compound Document Keys

```
key: profile::f8d8d616-6ce0-4344-9793-4ec5a676c223
```

```
{
    "name": ”Nic Raboy",
    ”email”: ”nic@couchbase.com",
    "address": ”450 Mission Street",
    "city": ”San Francisco”,
    “state”: “CA”
}
```

Counter Document Keys

```
key: msg::66565
```

```
{
    ”date": ”2018-01-02 23:55:55",
    ”user”: ”nic@couchbase.com",
    ”msg”: “This is a test message”
}
```

Counters documentation:
https://docs.couchbase.com/java-sdk/2.7/core-operations.html#devguide_kvcore_counter_generic

```
// Java
// Create the counter
bucket.counter(“myCounter”, 0, 20);

// Use counter for new key
String id = ”msg::" + bucket.counter(“myCounter”, 1).content();
```

Mixed Document Key Example

```
key: profile::f8d8d616-6ce0-4344
```

```
{
    "name": ”Nic Raboy",
    ”email”: ”nic@couchbase.com",
    "address": ”450 Mission Street",
    "city": ”San Francisco”,
    “state”: “CA”
}
```

```
key: facebook::1234
```

```
{
    “profile”: “f8d8d616-6ce0-4344”
}
```

```
key: twitter::1234
```

```
{
    “profile”: “f8d8d616-6ce0-4344”
}
```

Relational Databases

Customers		
customer	**firstname**	**lastname**
2342	Nic	Raboy

Products	
product	**name**
7182	Nintendo Switch

Orders		
order	**total**	**customer**
1234	$299.99	2342

Invoice		
order	**product**	**quantity**
1234	7182	2

```
SELECT
    c.firstname, c.lastname, p.name, o.total
FROM invoice AS i
JOIN order AS o ON i.order = o.order
JOIN product AS p ON i.product = p.product
JOIN customer AS c ON o.customer = c.customer
```

The Embedded Approach

Customers		
customer	**firstname**	**lastname**
2342	Nic	Raboy

Products	
product	**name**
7182	Nintendo Switch

Orders		
order	**total**	**customer**
1234	$299.99	2342

Invoice		
order	**product**	**quantity**
1234	7182	2

```
{
    "order": 1234,
    "customer": {
        "customer": "2342",
        "firstname": "Nic",
        "lastname": "Raboy"
    },
    "products": [
        {
            "product": 7182,
            "name": "Nintendo Switch”,
            "quantity": 2
        }
    ],
    "total": "$299.99"
}
```

The Referenced Approach

Customers		
customer	**firstname**	**lastname**
2342	Nic	Raboy

Products	
product	**name**
7182	Nintendo Switch

Orders		
order	**total**	**customer**
1234	$299.99	2342

Invoice		
order	**product**	**quantity**
1234	7182	2

```
{
    "firstname": "Nic",
    "lastname": "Raboy"
}
```

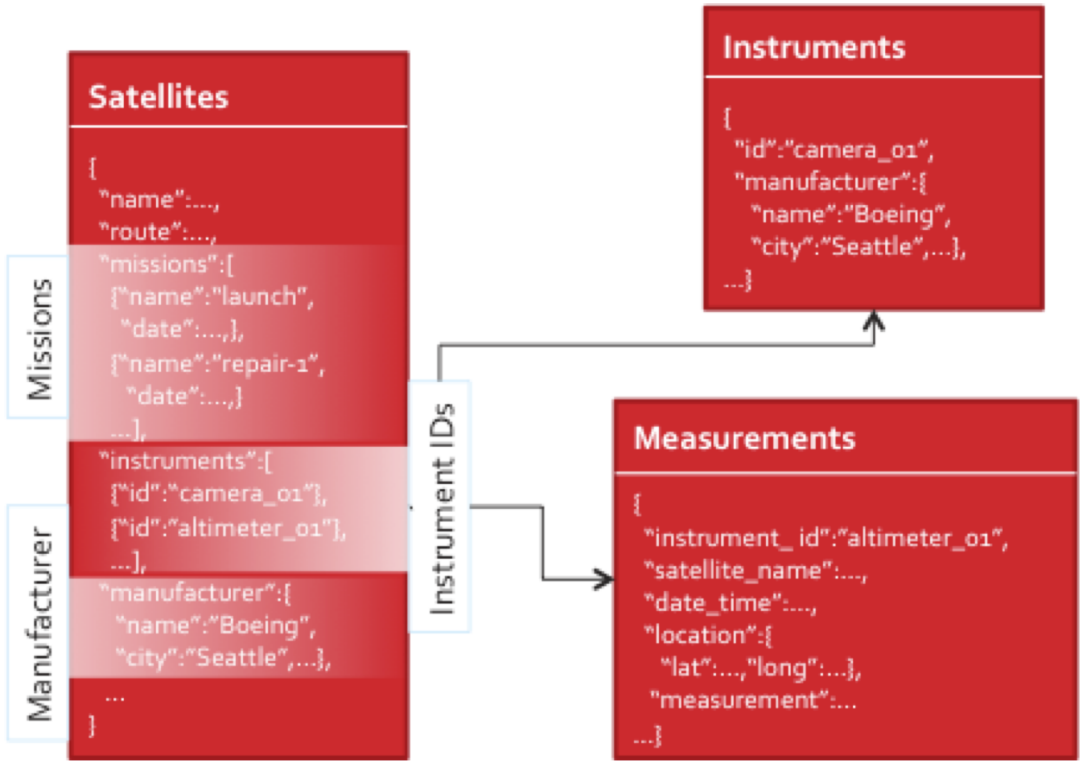
```
{
    "name": "Nintendo Switch"
}
```

```
{
    "customer": 2342
    "total": "$299.99"
}
```

```
{
    "order": 1234,
    "product": 7182,
    "quantity": 2
}
```

Embedding vs Referencing

- Embed When
  - Both docs **are** frequently accessed together
  - You need strict consistency between both docs
- Reference When
  - Both docs **aren't** frequently access together
  - You need strict consistency for the referenced information
  - Need to optimize for performance and referenced doc is large



Evolving Data Models

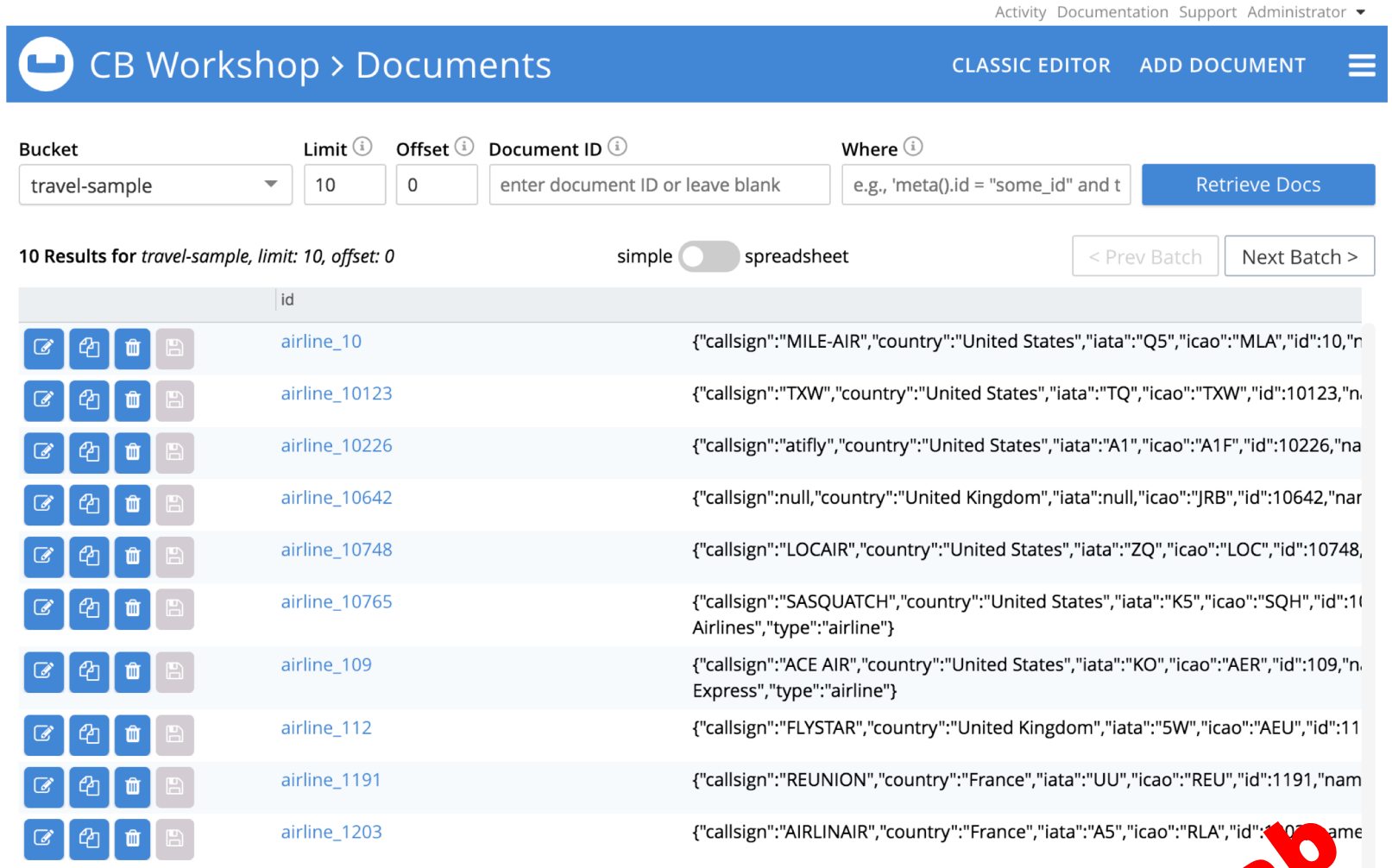
Change your code and you are good to go!

- Schema is App Driven in Couchbase Server
  - OK to maintain multiple versions of the schema
- Schema Changes with Couchbase Server
  - No Explicit Server Action Required by DBA
  - No Downtime required to update existing data to new shape

TRAVEL-SAMPLE DATA MODEL

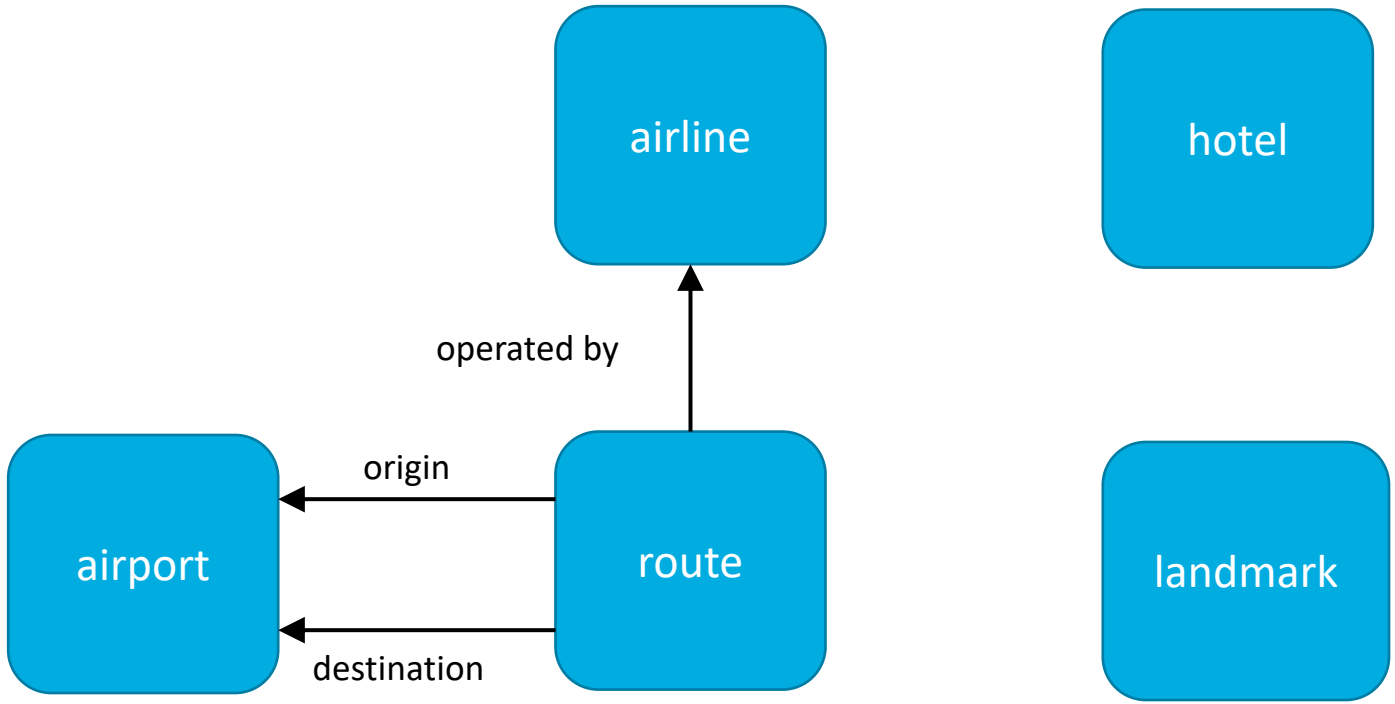
Lab 2: Browse documents from the UI Console

- Console > Buckets > travel-sample > Documents
- Try Document ID: **route_10003**
- Try Where: **city = "Houston"**
- Create document: Add Document >
  - Document ID: **k_1**
  - Value: **{"name": "luis"}**
- Delete document ID k_1



Lab

Travel-sample data model



Travel-sample data model: airline

- Sample key: airline_10123

airline

```
{
   "callsign": "TXW",
   "country": "United States",
   "iata": "TQ",
   "icao": "TXW",
   "id": 10123,
   "name": "Texas Wings",
   "type": "airline”
}
```

Travel-sample data model: airport

- Sample key: airport_1256

```
{
   "airportname": "Les Loges",
   "city": "Nangis",
   "country": "France",
   "faa": null,
   "geo": {
      "alt": 428,
      "lat": 48.596219,
      "lon": 3.006786},
   "icao": "LFAI",
   "id": 1256,
   "type": "airport",
   "tz": "Europe/Paris"
}
```

Travel-sample data model: route

- Sample key: route_10004


```
{
    "airline": "AF",
    "airlineid": "airline_137",
    "destinationairport": "AMS",
    "distance": 9442.50092891188,
    "equipment": "777",
    "id": 10004,
    "sourceairport": "TPE",
    "stops": 0,
    "type": "route",
```



```
"schedule": [
 {
   "day": 0,
   "flight": "AF545",
   "utc": "13:22:00"
 },
 {
   "day": 0,
   "flight": "AF350",
   "utc": "01:21:00"
 },
 ... ,
 {
   "day": 6,
   "flight": "AF250",
   "utc": "02:32:00"
 }]
}
```

Travel-sample data model: hotel

- Sample key: hotel_10063


```
{
   "address": "6 rue aux Juifs",
   "alias": "Les Rouges Gorges",
   "checkin": null,
   "checkout": null,
   "city": "Giverny",
   "country": "France",
   "description": "The rustic style ...
",
   "directions": "27620 Giverny",
   "email": null,
   "fax": null,
   "free_breakfast": false,
   "free_internet": true,
   "free_parking": true,
   "geo": {
      "accuracy": "APPROXIMATE",
      "lat": 49.078069,
      "lon": 1.520866
   },
   "id": 10063,
   "name": "The Robins",
   "pets_ok": false,
   "phone": null,
   "price": "60 / 70 euros",
   "public_likes": [],
   "reviews": [ ... ],
   "state": "Haute-Normandie",
   "title": "Giverny",
   "tollfree": null,
   "type": "hotel",
   "url":
"http://givernyguesthouse.com/robin.h
tm",
   "vacancy": true
}
```

Travel-sample data model: landmark

- Sample key: landmark_10023


```
{
   "activity": "eat",
   "address": "3 King Street, ME6 1EY",
   "alt": null,
   "city": "Gillingham",
   "content": "Chinese restaurant just off the High Street.",
   "country": "United Kingdom",
   "directions": null,
   "email": null,
   "geo": {
      "accuracy": "RANGE_INTERPOLATED",
      "lat": 51.38697,
      "lon": 0.54852  },
   "hours": null,
   "id": 10023,
   "image": null,
   "name": "Beijing Inn",
   "phone": null,
   "price": null,
   "state": null,
   "title": "Gillingham (Kent)",
   "tollfree": null,
   "type": "landmark",
   "url": http://beijinginn.co.uk/div/
}
```

CONNECTION BEST PRACTICES

Connection Basics

- Before you can perform KV CRUD, View and/or N1QL Queries

1. You first must connect your application to your cluster
2. From the cluster connection you can obtain a reference to a Bucket
    - The Bucket is your entry point for the whole storage API
    - Each bucket instance connects to each server:
        - KV 11210/11211
        - Views 8092
        - N1QL 8093
        - Search 8094
        - 8091 is used on demand (fallback)
    - These connections are persistent
3. Both Cluster and Bucket instances are **thread-safe** and **must** be reused across your application
    - **DO NOT** create new Cluster and Bucket instances per request
    - Impact of not following best practices:
        - Connection starvation
        - Performance issues

Connection Bootstrap Process

1. Connect to the cluster using the Cluster class
   - Default connection is made on 127.0.0.1
   - To connect to your cluster you need to specify at least one Couchbase endpoint
   - Endpoints can be IP addresses or FQDNs
   - **Best Practice:** Use FQDNs
   - **Best Practice:** Supply at least 3 Couchbase endpoints as a seed
   - Specify a **username** and **password** configured with access to desired **bucket** through **RBAC**
2. Using the cluster instance connect to a bucket
   - By default, the bucket connection will connect to the “default bucket” (on 11211)
   - Must supply the **bucket name**
   - The bucket will connect to one of the Couchbase servers in the seed list (1st one in the list)
3. The Couchbase server will return a **CLUSTER MAP**
   - Using the **CLUSTER MAP**, the bucket instance will create connections to each Couchbase server
   - Once the SDK has successfully connected to one node the bootstrap information will be discarded in favor of an up-to-date list of nodes from the cluster

Key/Value – API DML Methods (Retrieval)

- **get-**Retrieves a document or binary key/value.
- **getAndLock-**Lock the document or binary key/value on the server and retrieve it. When an document is locked, its CAS changes and subsequent operations on the document (without providing the current CAS) will fail until the lock is no longer held.
- **getFromReplica-**Get a document binary key/value from a replica server in your cluster.
- **search-** Returns an object which may be iterated over to retrieve search results.
- **unlock-**Unlock a previously locked document or binary key/value on within a bucket.

Key/Value – API DML Methods (Create/Delete/Update)

- **insert-**Insert a document or binary key/value. Fails if the item exists.
- **upsert-**Stores a document or binary key/value to the bucket, or updates if a document exists.
- **replace-**Replaces a document or binary key/value in a bucket. Fails if the item doesn't exist.
- **remove-**Deletes an item from the bucket. Fails if the item doesn't exist
- **append/prepend-**Appends or prepends in place the value of a binary k/v item. Does NOT work with documents
- **touch-**Updates the TTL of a document.
- **getAndTouch-**Retrieves a document or binary key/value and updates the expiry of the item at the same time.
- **counter-**Increments or decrements a key's numeric value.

JAVA SDK
CONNECTING TO COUCHBASE

Including the SDK

For the labs, we'll use Maven. Edit the SDK version in the pom.xml:

```
<dependencies>
    <dependency>
        <groupId>com.couchbase.client</groupId>
        <artifactId>java-client</artifactId>
        <version>2.7.4</version>
    </dependency>
</dependencies>
```

TIP. Check latest version available here:

https://docs.couchbase.com/java-sdk/2.7/start-using-sdk.html

Connection Basics

```
import com.couchbase.client.java.Cluster;
import com.couchbase.client.java.CouchbaseCluster;
import com.couchbase.client.java.Bucket;
…
Cluster cluster = CouchbaseCluster.create(”<host>");
cluster.authenticate("<username>", "<password>");
Bucket bucket = cluster.openBucket("<bucket-name>");
```

- Not like a JDBC Pool
- Reuse Bucket object
- Singleton pattern

Lab 3: Couchbase Connection

- Use source file: MainLab.java
- Implement method: initConnection()
  - Create a CouchbaseEnvironment and set non-default timeout values:

```
CouchbaseEnvironment env = DefaultCouchbaseEnvironment.builder()
    .operationTracingEnabled(false)
    .socketConnectTimeout(15000)
    .connectTimeout(15000)
    .kvTimeout(15000)
    .continuousKeepAliveEnabled(true)
    .keepAliveInterval(10000)
    .build();
```

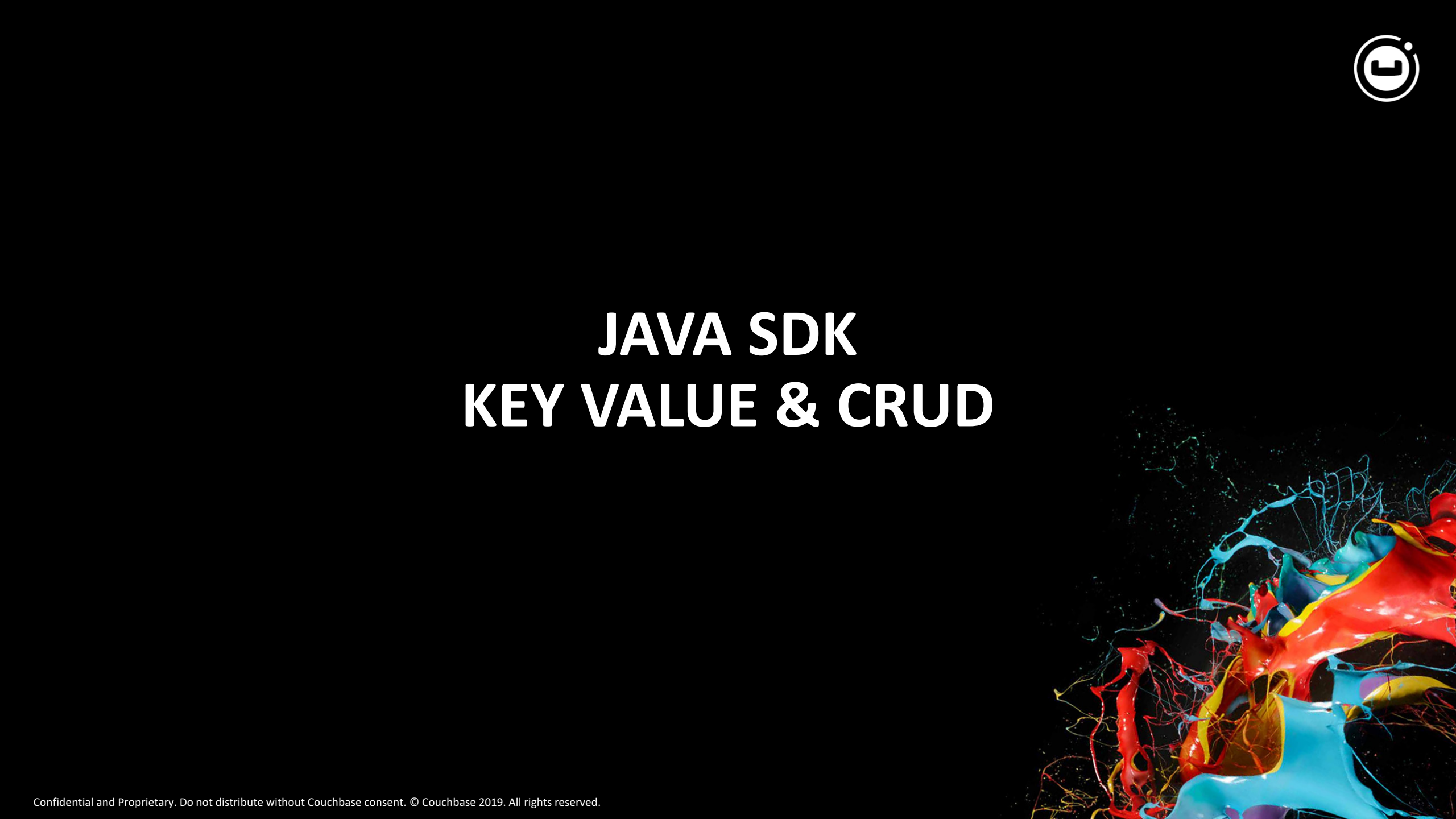
  - Initialize the connection to the cluster and open the travel-sample bucket (using system properties):

```
Cluster cluster = CouchbaseCluster.create(env, clusterAddress);
cluster.authenticate(user, password);
bucket = cluster.openBucket(bucketName);
```

Lab 3: Couchbase Connection

- Build JAR
- Run application
- Check output:

```
INFO: CouchbaseEnvironment: {sslEnabled=false, sslKeystoreFile='null', sslTruststoreFile='null',
sslKeystorePassword=false, sslTruststorePassword=false, sslKeystore=null, sslTruststore=null, bootstrapHttpEnabled=true,
bootstrapCarrierEnabled=true, bootstrapHttpDirectPort=8091, bootstrapHttpSslPort=18091, bootstrapCarrierDirectPort=11210,
bootstrapCarrierSslPort=11207, ioPoolSize=8, computationPoolSize=8, responseBufferSize=16384, requestBufferSize=16384,
kvServiceEndpoints=1, viewServiceEndpoints=12, queryServiceEndpoints=12, searchServiceEndpoints=12,
configPollInterval=2500, configPollFloorInterval=50, ioPool=NioEventLoopGroup, kvIoPool=null, viewIoPool=null,
searchIoPool=null, queryIoPool=null, coreScheduler=CoreScheduler,
memcachedHashingStrategy=DefaultMemcachedHashingStrategy, eventBus=DefaultEventBus, packageNameAndVersion=couchbase-java-
client/2.7.4 (git: 2.7.4, core: 1.7.4), retryStrategy=BestEffort, maxRequestLifetime=75000,
retryDelay=ExponentialDelay{growBy 1.0 MICROSECONDS, powers of 2; lower=100, upper=100000},
reconnectDelay=ExponentialDelay{growBy 1.0 MILLISECONDS, powers of 2; lower=32, upper=4096},
observeIntervalDelay=ExponentialDelay{growBy 1.0 MICROSECONDS, powers of 2; lower=10, upper=100000},
keepAliveInterval=30000, continuousKeepAliveEnabled=true, keepAliveErrorThreshold=4, keepAliveTimeout=2500,
autoreleaseAfter=2000, bufferPoolingEnabled=true, tcpNodelayEnabled=true, mutationTokensEnabled=false,
socketConnectTimeout=15000, callbacksOnIoPool=false, disconnectTimeout=25000,
requestBufferWaitStrategy=com.couchbase.client.core.env.DefaultCoreEnvironment$2@5d624da6, certAuthEnabled=false,
coreSendHook=null, forceSaslPlain=false, queryTimeout=75000, viewTimeout=75000, searchTimeout=75000,
analyticsTimeout=75000, kvTimeout=15000, connectTimeout=15000, dnsSrvEnabled=false}
Jul 09, 2018 10:27:08 PM com.couchbase.client.core.node.CouchbaseNode signalConnected
INFO: Connected to Node 127.0.0.1/localhost
Jul 09, 2018 10:27:08 PM com.couchbase.client.core.config.DefaultConfigurationProvider$8 call
INFO: Opened bucket travel-sample
```



JAVA SDK
KEY VALUE & CRUD

Creating Documents

- Data can be flat or complex
- Document keys can be custom, automatically generated, or incrementing
- The `insert` operator will create new documents if the key does not already exist
- The `upsert` operator will create or replace

```
JsonObject data = JsonObject.create()
    .put("firstname", "Nic")
    .put("lastname", "Raboy");
JsonArray address = JsonArray.create()
    .add(JsonObject.create().put("city", "Mountain View").put("state", "CA"))
    .add(JsonObject.create().put("city", "San Francisco").put("state", "CA"));
data.put("address", address);
bucket.insert(JsonDocument.create("person-1", data));
```

Retrieving Documents by Key

- Data can be retrieved using a key-value lookup or with a N1QL query
- Lookups are significantly faster than indexed queries with N1QL
- Java can be asynchronous (non-blocking) with RxJava or synchronous

```
// Java
bucket.get("person-1").content();
```

Durability Requirements

- Durability requirements may be present as an extra option to mutation operations (insert/upsert).

  The *level of durability* is configurable depending on the needs of the application.

- The level of durability may be expressed in two values:
  - The *replication* factor of the operation: how many replicas must this operation be propagated to. This is specified as the ReplicateTo option in most SDKs.
  - The *persistence* of the modification: how many persisted copies of the modified record must exist. Often found as a PersistTo option.
- Performance impact: operation times and latencies will increase when waiting on the speed of the network and the speed of the disk.

Lab 4: Create Object

- Implement method: create(String[] words)
- In this method, a JSON document for a message is composed, like this:

Key:
msg::some_text

```
{
   "timestamp": 1511184840248,
   "from": "luis",
   "to": "daniel",
   "type": "msg"
}
```

- Add a type attribute with value “msg” to the JSON doc and insert/upsert the document to the bucket

```
json.put("type", "msg");
bucket.insert(JsonDocument.create(key, json));
//bucket.upsert(JsonDocument.create(key, json));
```

Lab

Lab 4: Create Object

- Build JAR
- Run application
- Try the create method (“create [key from to] ”) several times and see results in console
- Repeat with the same key (an error should appear)

```
# create msg1 Brian Bill
Document created with key: msg::msg1
# create msg2 Brian Bob
Document created with key: msg::msg2
# create msg2 Brian Bob
com.couchbase.client.java.error.DocumentAlreadyExistsException
```

- Repeat with bucket.upsert instead of bucket.insert and observe the results

```
# create msg2 Brian Brandi
Document created with key: msg::msg2
# create msg2 Brian Brandi
Document created with key: msg::msg2
```

Lab

Lab 5: Read Object

- Implement method: read(String[] words)
- Parameter for key is read from command line
- Read the document for the specified key from bucket into a JsonDocument doc, then uncomment the line to write it to STDOUT:

```
JsonDocument doc = bucket.get(key);
```

- Rebuild the JAR and run the application
- Test with values: airline_10226, route_10009, hotel_10904

```
# read airline_10226
{"country":"United States","iata":"A1","callsign":"atifly","name":"Atifly",
"icao":"A1F","id":10226,"type":"airline"}
# read route_10009
{"schedule":[{"flight":"AF665","utc":"13:22:00","day":0},{"flight":"AF232","utc":"16:10:
00","day":1},{"flight":"AF137","utc":"09:29:00","day":1},{"flight":"AF399",…
```

- **Bonus**: implement code to output a friendly message when document is not found

Lab

Lab 6: Update Object

- Implement method: update(String[] words):
- Parameter for key is read from command line
- Read the document, modify attribute “name” to UPPERCASE the value, then use replace to modify the document:

```
JsonDocument doc = bucket.get(key);
String name = doc.content().getString("name");
doc.content().put("name", name.toUpperCase());
bucket.replace(doc);
```

- Rebuild the JAR and run the application
- Test with key airline_10642 by reading and updating, then re-reading:

```
# read airline_10642
{"country":"United Kingdom","iata":null,"callsign":null,"name":"Jc
royal.britannica","icao":"JRB","id":10642,"type":"airline"}
# update airline_10642
# read airline_10642
{"country":"United Kingdom","iata":null,"callsign":null,"name":"JC
ROYAL.BRITANNICA","icao":"JRB","id":10642,"type":"airline"}
```

Lab

Lab 7: Delete Object

- Implement method: delete(String[] words)
- Parameter for key is read from command line
- Delete the document:

```
bucket.remove(key);
```

- Rebuild the JAR and run the application
- To test, use create, then delete the same msg key:

```
# create 1001 Brian Doug
Document created with key: msg::1001
# read msg::1001
{"from":"Brian","to":"Doug","type":"msg","timestamp":1536513089236}
# delete msg::1001
# read msg::1001
java.lang.NullPointerException
        at com.cbworkshop.MainLab.read(MainLab.java:145)
        at com.cbworkshop.MainLab.process(MainLab.java:91)
        at com.cbworkshop.MainLab.main(MainLab.java:55)
#
```

JAVA SDK
WORKING WITH PARTS OF A DOCUMENT

The Plan – Working with Parts of a Document

- Get Parts of a JSON Document
- Update JSON Properties in a Document
- Batch Subdocument Operations Together

Large Documents

```
key: nraboy
```

```
{
    "profile": {
        "firstname": "Nic",
        "lastname": "Raboy"
    },
    "data": [
        // 20MB of data
    ]
}
```

Get Part of a Document

```
// Java
DocumentFragment<Lookup> result = bucket
    .lookupIn("nraboy")
    .get(”profile")
    .execute();
```

Update Part of a Document

```
// Java
DocumentFragment<Mutation> result = bucket
    .mutateIn(”nraboy")
    .replace(”profile.firstname", "Nicolas")
    .execute();
```

Chain Subdocument Operations

```
DocumentFragment<Mutation> result = bucket
    .mutateIn(”nraboy")
    .replace(”profile.firstname", ”Nic")
    .insert(”profile.gender", ”Male")
    .remove(”data")
    .withDurability(PersistTo.MASTER, ReplicateTo.NONE)
    .execute();
```

```
DocumentFragment<Lookup> result = bucket
    .lookupIn("myKey")
    .get("sub.value")
    .exists("fruits")
    .execute();

String subValue = result.content("sub.value", String.class);
boolean fruitsExist = result.content("fruits", Boolean.class);
```

Lab 8: SubDocument API example

- Implement method: subdoc(String[] words)
- Parameter for key is read from command line
- Using SubDocument API:
  - Change the existing value of the “from” attribute to “Administrator”
  - Add a new attribute: “reviewed”, with value CurrentTimeMillis

```
DocumentFragment<Mutation> result = bucket
        .mutateIn(key)
        .replace("from", "Administrator")
        .insert("reviewed", System.currentTimeMillis())
        .execute();
```

Lab

Lab 8: SubDocument API example

- Rebuild the JAR and run the application
- To test, use create, then update the same msg key:

```
# create 1001 Brian Colin
Document created with key: msg::1001
# read msg::1001
{"from":"Brian","to":"Colin","type":"msg","timestamp":1536593956715}
# subdoc msg::1001
# read msg::1001
{"reviewed":1536593971600,"from":"Administrator","to":"Colin","type":"msg","timestamp":1
536593956715}
#
```

Lab

INTRODUCTION TO N1QL: SQL FOR JSON

The Plan – Querying for Documents with N1QL

- Understand the Power of N1QL
- Use Query Workbench and the Couchbase CLI
- Create Indexes for N1QL Queries
- Query for Data with N1QL
- Create Data with N1QL
- Remove Data with N1QL

What is N1QL?

- **Non-first (N1)** Normal Form **Query Language (QL)**
  - It is based on ANSI 92 SQL
  - Its query engine is optimized for modern, highly parallel multi-core execution
- SQL-like Query Language
  - Expressive, familiar, and feature-rich language for querying, transforming, and manipulating JSON data
- N1QL extends SQL to handle data that is:
  - **Nested:** Contains nested objects, arrays
  - **Heterogeneous:** Schema-optional, non-uniform
  - **Distributed:** Partitioned across a cluster

Power of SQL

Flexibility of JSON

N1QL (EXPRESSIVE)

- Access to every part of JSON document
- Scalar & Aggregate functions
- Subqueries in the FROM clause
- Aggregation on arrays

Expressive, familiar, and feature-rich language for querying, transforming, and manipulating JSON data

N1QL (FAMILIAR)

- SELECT * FROM bucket WHERE …
- INSERT single & multiple documents
- UPDATE any part of JSON document & use complex filter
- DELETE
- MERGE two sets of documents using traditional MERGE statement
- EXPLAIN to understand the query plan
  - EXPLAIN SELECT * FROM bucket WHERE …

Expressive, familiar, and feature-rich language for querying, transforming, and manipulating JSON data

N1QL (FEATURE-RICH)

- Access to every part of JSON document
- Functions (Date, Pattern, Array, Conditional, etc)
  - https://docs.couchbase.com/server/6.0/n1ql/n1ql-language-reference/functions.html
- ANSI JOINS (new in 5.5)
- Covering Index
- Prepared Statements
- USE KEYS
- LIKE

Expressive, familiar, and feature-rich language for querying, transforming, and manipulating JSON data

N1QL – Example 1

The first example uses a JOIN clause to find the distinct airline details which have routes that start from SFO.

```
SELECT DISTINCT airline.name, airline.callsign, route.destinationairport,
route.stops, route.airline
FROM `travel-sample` route
  JOIN `travel-sample` airline ON KEYS route.airlineid
WHERE route.type = "route"
  AND airline.type = "airline"
  AND route.sourceairport = "SFO";
```

```
[
  {
    "airline": "UA",
    "callsign": "UNITED",
    "destinationairport": "ACV",
    "name": "United Airlines",
    "stops": 0
  },
```

N1QL – Example 2

Which airlines fly from each airport? - ARRAY_AGG function

```
SELECT route.sourceairport, ARRAY_AGG(DISTINCT airline.name) as airlines
FROM `travel-sample` route
  JOIN `travel-sample` airline ON KEYS route.airlineid
WHERE route.type="route"
  AND airline.type="airline"
GROUP BY route.sourceairport
ORDER BY route.sourceairport;
```

```
[
 {
    "airlines": [
      "American Airlines",
      "US Airways"
    ],
    "sourceairport": "ABI"
 },
```

N1QL – Example 3

Which airports can I reach by flying from San Francisco? - ANSI Join

Required index:
CREATE INDEX route_airports ON `travel-sample`(sourceairport, destinationairport) WHERE type = "route";

```
SELECT DISTINCT route.destinationairport
FROM `travel-sample` airport JOIN `travel-sample` route
     ON airport.faa = route.sourceairport
WHERE airport.type = "airport"
  AND route.type = "route"
  AND airport.city = "San Francisco"
  AND airport.country = "United States";
```

```
[
  {
    "destinationairport": "ABQ"
  },
  {
    "destinationairport": "ACV"
  },
```

Query Workbench and the Couchbase CLI

- Query Workbench
  - http://localhost:8091/ui/index.html#!/query/workbench
- Couchbase CLI (Mac)
  - /Applications/Couchbase Server.app/Contents/Resources/couchbase-core/bin/cbq
- Couchbase CLI (Windows)
  - C:\Program Files\CouchbaseServer\bin\cbq.exe
- Couchbase CLI (Linux)
  - /opt/couchbase/bin/cbq

CRUD IN N1QL

C

```
INSERT INTO `default`
(KEY, VALUE)
VALUES (“person-1”, {
    “firstname”: “Nic”,
    “lastname”: “Raboy”
})
```

R

```
SELECT name FROM `travel-sample` WHERE type="airline" AND icao="JRB"
```

U

```
UPDATE `travel-sample` USE KEYS ["hotel_10138"]
SET pets_ok=true, free_internet=true
```

D

```
DELETE FROM `default`
WHERE META().id = ‘person-1’
```

Why do we need indexes?

Indexes are used to

efficiently look up objects

meeting ***user specified criteria***

without having to

search ***every*** object

in the collection

Primary Index

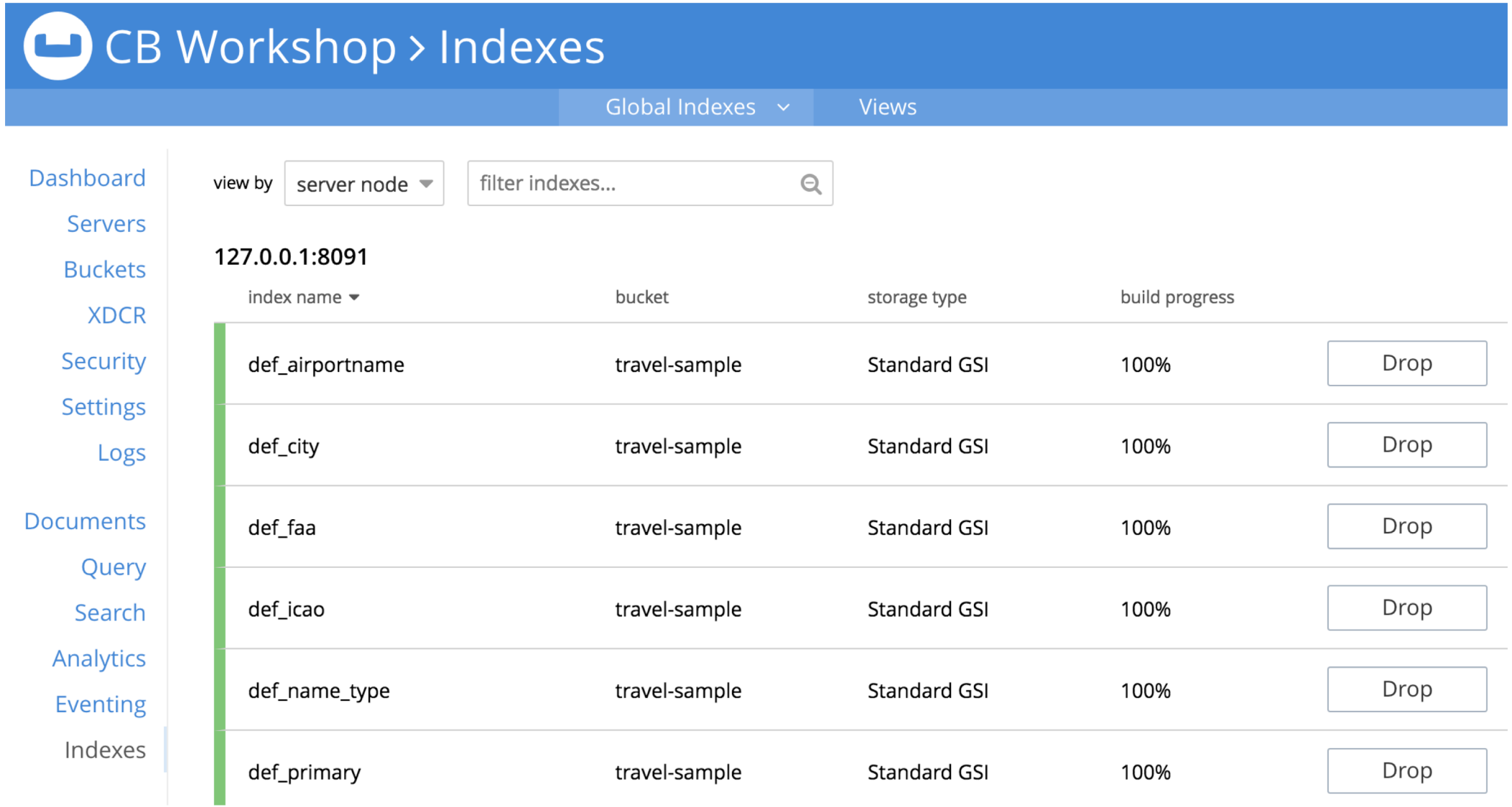
- The primary index is the index on the document key on every document in a keyspace
- The primary index is used for:
  - Complete keyspace scan – equivalent of table scan
  - Query does not have any predicates (filters)
  - Query has predicate on document key
  - No other index or access path can be used
- Primary index is optional

```
CREATE PRIMARY INDEX ON `travel-sample`;


SELECT *
FROM `travel-sample`;

SELECT *
FROM `travel-sample`
WHERE META().id LIKE "user::%”;
```

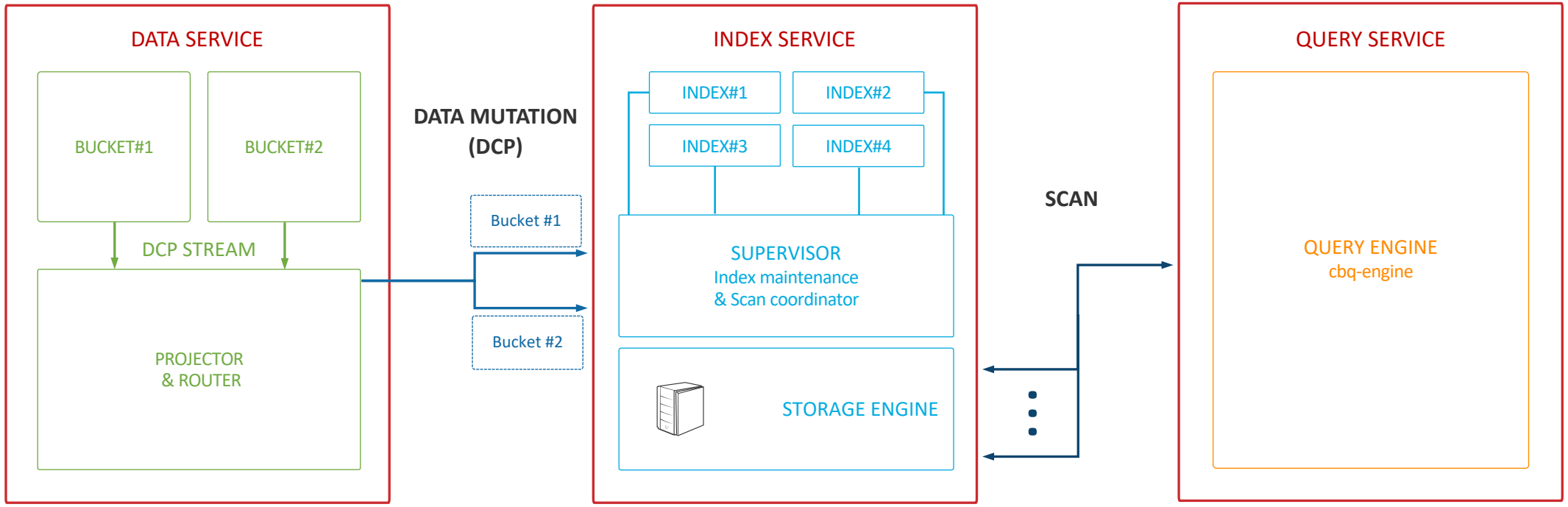
Secondary Index

- Simple Index
- Composite Index
- Functional Index
- Partial Index
- Replica Index
- Covering Index

Indexes



Couchbase Services



JAVA SDK
N1QL QUERIES

Raw Query String vs. DSL

Raw query string

```
N1qlQueryResult queryResult =
bucket.query(N1qlQuery.simple("SELECT * FROM `travel-sample` LIMIT 10"));
```

Using the DSL

```
import static com.couchbase.client.java.query.Select.select;
import static com.couchbase.client.java.query.dsl.Expression.*;
...
N1qlQueryResult queryResult =
bucket.query(select("*").from("`travel-sample`").limit(10));
```

Iterate result

```
for(N1qlQueryRow row : queryResult){
      System.out.println(row.value().toString());
}
```

Lab 9: Simple Query

- Implement method: query ()
- Execute the query: “SELECT * FROM `travel-sample` LIMIT 10”
- Print the results to STDOUT
- Use both implementations, first raw and then DSL

```
N1qlQueryResult queryResult;
// Raw
queryResult = bucket.query(N1qlQuery.simple("SELECT * FROM `travel-sample` LIMIT 10"));
for(N1qlQueryRow row : queryResult){
    System.out.println("Raw " + row.value().toString());
}
// DSL
queryResult = bucket.query(select("*").from("`travel-sample`").limit(10));
for(N1qlQueryRow row : queryResult){
    System.out.println("DSL " + row.value().toString());
}
```

Lab

Lab 9: Simple Query

- Rebuild the JAR and run the application
- Test using the query command

```
# query
{"travel-sample":{"country":"United States","iata":"Q5","callsign":"MILE-AIR","name":"40-Mile Air","icao":"MLA","id":10,"type":"airline"}}
{"travel-sample":{"country":"United States","iata":"TQ","callsign":"TXW","name":"Texas Wings","icao":"TXW","id":10123,"type":"airline"}}
{"travel-sample":{"country":"United States","iata":"A1","callsign":"atifly","name":"Atifly","icao":"A1F","id":10226,"type":"airline"}}
{"travel-sample":{"country":"United Kingdom","iata":null,"callsign":null,"name":"JC ROYAL.BRITANNICA","icao":"JRB","id":10642,"type":"airline"}}
{"travel-sample":{"country":"United States","iata":"ZQ","callsign":"LOCAIR","name":"Locair","icao":"LOC","id":10748,"type":"airline"}}
{"travel-sample":{"country":"United States","iata":"K5","callsign":"SASQUATCH","name":"SeaPort Airlines","icao":"SQH","id":10765,"type":"airline"}}
{"travel-sample":{"country":"United States","iata":"KO","callsign":"ACE AIR","name":"Alaska Central Express","icao":"AER","id":109,"type":"airline"}}
{"travel-sample":{"country":"United Kingdom","iata":"5W","callsign":"FLYSTAR","name":"Astraeus","icao":"AEU","id":112,"type":"airline"}}
{"travel-sample":{"country":"France","iata":"UU","callsign":"REUNION","name":"Air Austral","icao":"REU","id":1191,"type":"airline"}}
{"travel-sample":{"country":"France","iata":"A5","callsign":"AIRLINAIR","name":"Airlinair","icao":"RLA","id":1203,"type":"airline"}}
#
```

Query with parameters

Create a new query with named parameters from a JsonObject.
Named parameters have the form of $name, where the name represents the unique name.

```
JsonObject params = JsonObject.create()
       .put("src", “JFK”)
       .put("dst", “LHR”);

String queryStr = "SELECT a.name FROM `travel-sample` r JOIN `travel-sample` a ON
KEYS r.airlineid WHERE r.type=‘route’ AND r.sourceairport=$src AND
r.destinationairport=$dst";

N1qlQuery query = N1qlQuery.parameterized(queryStr, params);
```

Lab 10: Query with parameters

- Implement method: queryAirports(String[] words)
- Parameters (sourceairport, destinationairport) are read from command line and added to the params JsonObject
- Write a parameterized query with a join to find airlines flying from sourceairport to destinationairport and print the results to STDOUT

```
String queryStr = "SELECT a.name FROM `travel-sample` r JOIN `travel-sample` a " +
   "ON KEYS r.airlineid WHERE r.type='route' AND " +
   "r.sourceairport=$src AND r.destinationairport=$dst";

N1qlQuery query = N1qlQuery.parameterized(queryStr, params);

N1qlQueryResult queryResult = bucket.query(query);
for(N1qlQueryRow row : queryResult) {
    System.out.println(row.value().toString());
}
```

Lab

Lab 10: Query with parameters

- Rebuild the JAR and run the application
- Test using the queryairports command and two airport codes
  - **TIP**: Highest traffic airport codes are ATL, ORD, LHR, CDG, LAX, DFW, JFK

```
# queryairports JFK LHR
{"name":"British Airways"}
{"name":"Delta Air Lines"}
{"name":"American Airlines"}
{"name":"US Airways"}
{"name":"Virgin Atlantic Airways"}
{"name":"Air France"}
#
```

Query Consistency

- not_bounded
  - Fastest
  - Returns data that is currently indexed and accessible by the index or the view.
- at_plus
  - Fast
  - A query submitted with at_plus consistency level requires all mutations, up to the moment of the scan_vector (the logical timestamp passed in with at_plus), to be processed before the query execution can start.
- request_plus
  - Slowest, but still fast
  - Requires all mutations, up to the moment of the query request, to be processed before the query execution can start.

Query Consistency

Sample code

```
// Java
N1qlQueryResult result =
  bucket.query(
    N1qlQuery.simple(
      statement,
      N1qlParams.build().consistency(ScanConsistency.REQUEST_PLUS)
    )
  );
```

JAVA SDK
FULL TEXT SEARCH

Full Text Search vs N1QL

- Wildcard Queries are Slow
- What happens to variations of the wildcard term in N1QL / SQL?
  - ‘%golang%’, does ‘Golang’ or ‘GoLang’ pop up?
  - ‘%golang%’, do spelling errors like ‘goang’ pop up?
- FTS is for Natural Language Querying

Full Text Search – Query Types

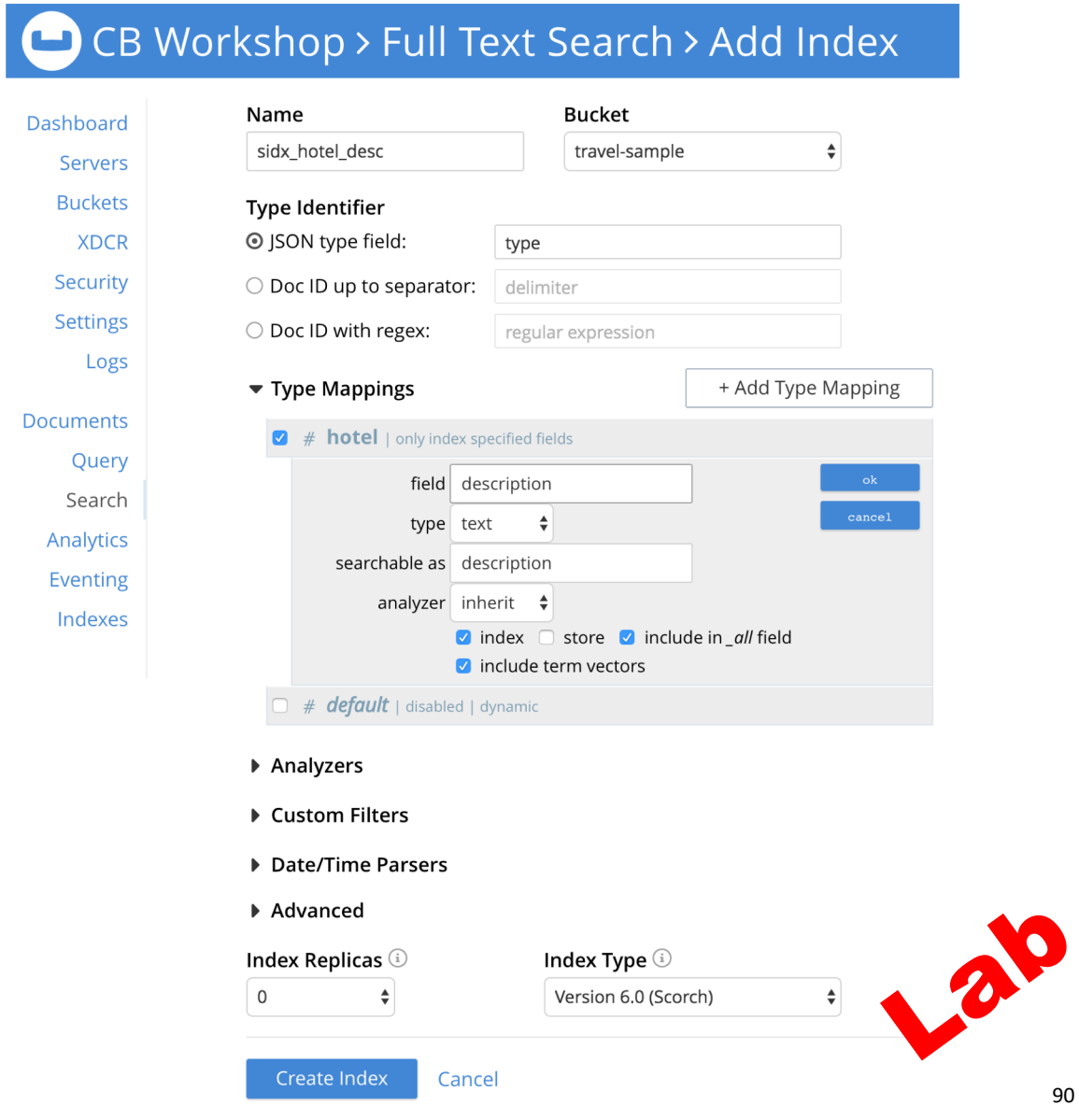
Couchbase Full Text Search supports multiple types of search queries:

- Simple Queries
  - Match
  - Match Phrase
  - Fuzzy
  - Prefix
  - Regexp
  - Wildcard Query
  - Boolean Field
- Compound, Range, Query String, Geospatial, Non-analytic, Special

Full list: https://docs.couchbase.com/server/6.0/fts/fts-query-types.html

Lab 11: FTS – Create index

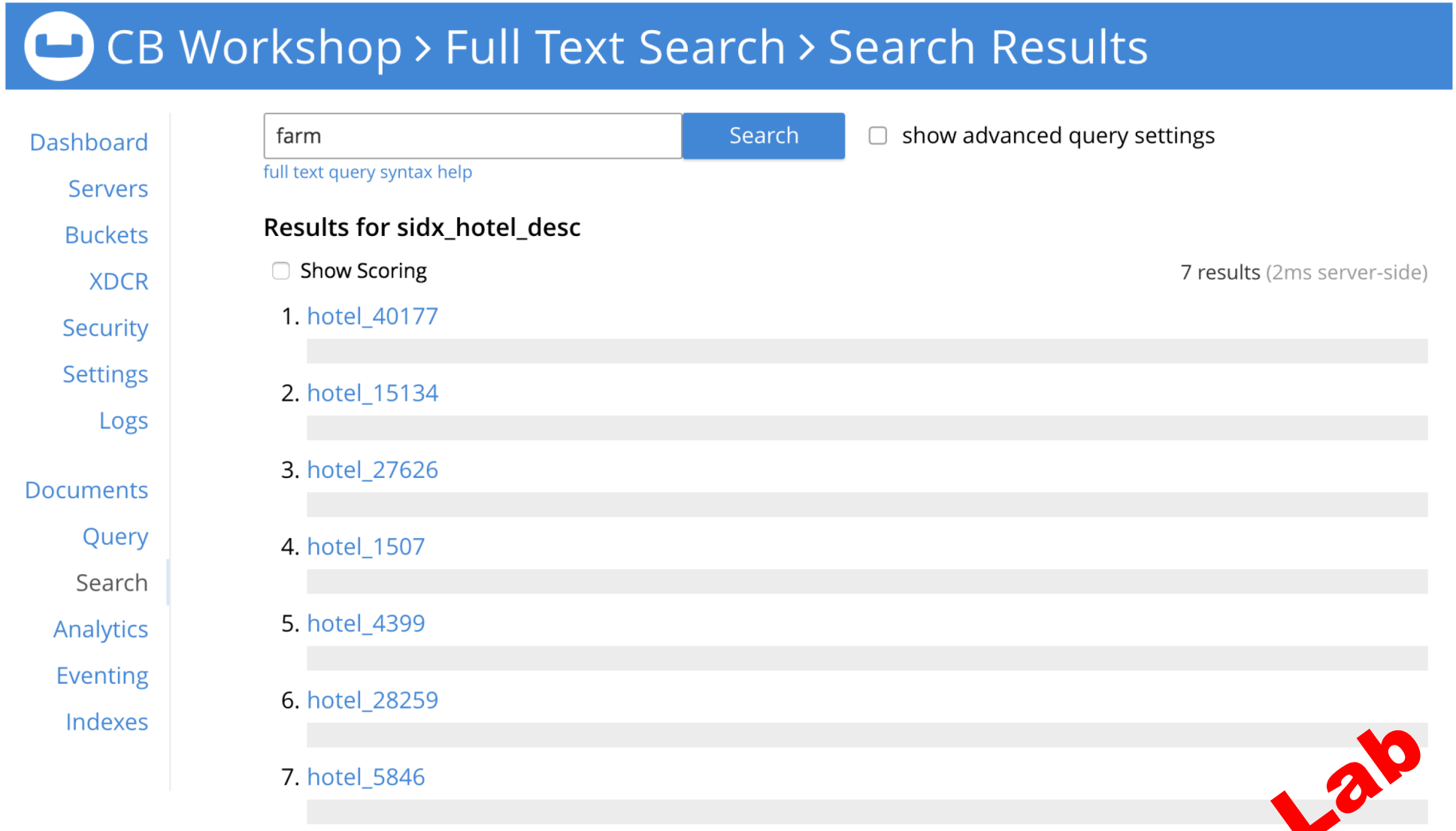
- Build an FTS index on travel-sample for hotels (type="hotel") on the attribute "description":
- Index name: sidx_hotel_desc
- Bucket: travel-sample
- Type Mappings: uncheck default
- Add Type Mapping:
  - type name: hotel
  - Check "only index specified fields"
  - Click "ok"
- + to insert child field: description; click "ok"
- Click "Create Index"



Lab 11: FTS – Create index

- Search for “farm”

- Edit the index: Advanced, Default Analyzer: select ”en”, Update Index
- Test:
  - ”farms”
  - “farming”



Lab

Full Text Search: Java example

```
String term = ... ;

MatchQuery fts = SearchQuery.match(term);
SearchQueryResult result = bucket.query(new SearchQuery("sidx_hotel_desc", fts));
for (SearchQueryRow row : result) {
    System.out.println(row);
}
```

Lab 12: FTS – Java example

- Implement method: search(String[] words)
- Parameter for the search term is read from command line
- Write code to search using the index sidx_hotel_desc for the search term and print results to STDOUT

```
MatchQuery fts = SearchQuery.match(term);
SearchQueryResult result = bucket.query(new SearchQuery("sidx_hotel_desc", fts));
for (SearchQueryRow row : result) {
    System.out.println(row);
}
```

Lab

Lab 12: FTS – Java example

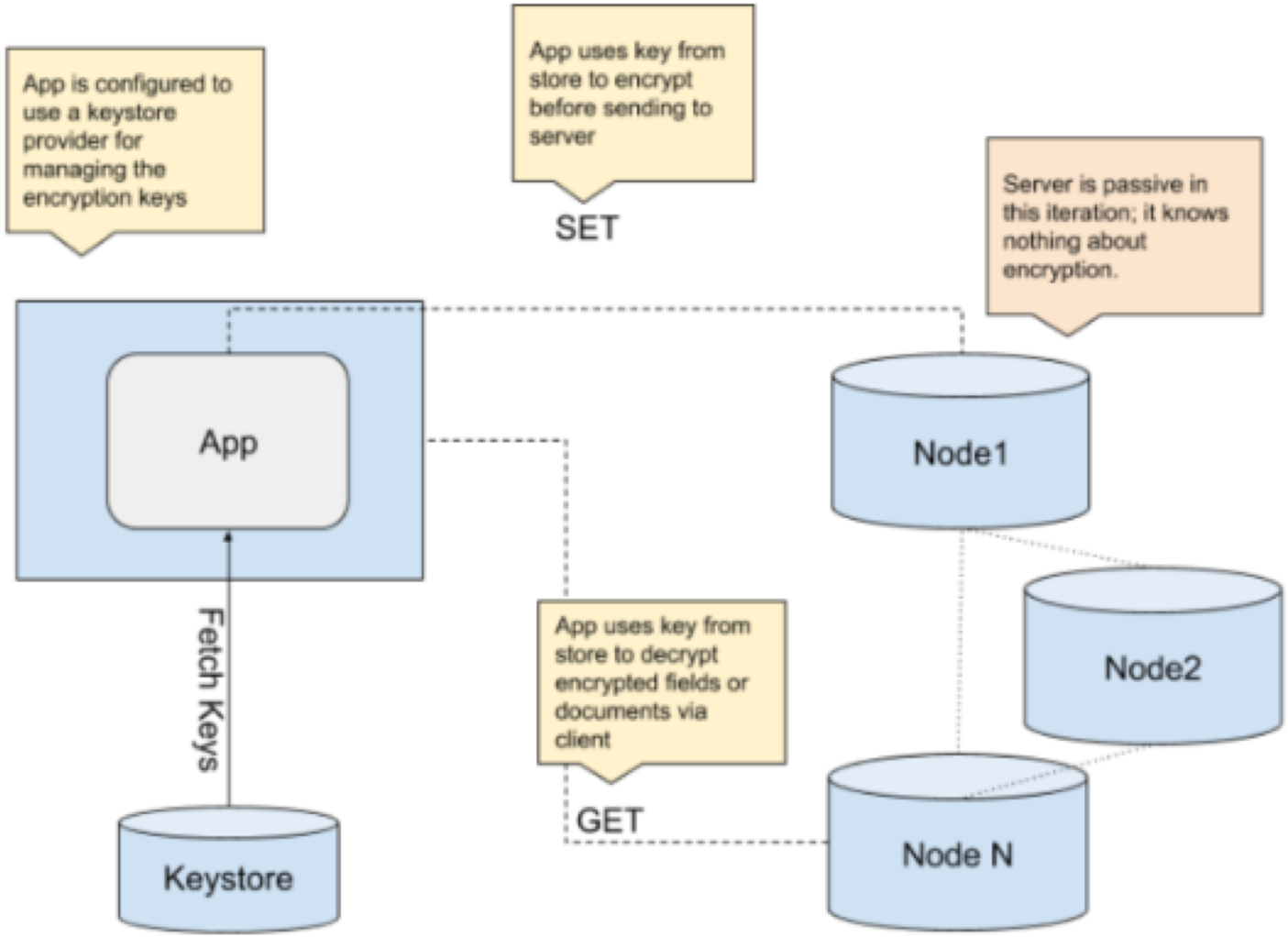
- Rebuild the JAR and run the application
- Test using the search command with a search term, e.g. “farm”

```
# search farm
DefaultSearchQueryRow{index='sidx_hotel_desc_66ab355a2a9392b8_13aa53f3', id='hotel_40177', score=2.961906336277922,
explanation={}, locations=DefaultHitLocations{size=0, locations=[]}, fragments={}, fields={}}
DefaultSearchQueryRow{index='sidx_hotel_desc_66ab355a2a9392b8_aa574717', id='hotel_15134', score=2.31408575442229,
explanation={}, locations=DefaultHitLocations{size=0, locations=[]}, fragments={}, fields={}}
DefaultSearchQueryRow{index='sidx_hotel_desc_66ab355a2a9392b8_54820232', id='hotel_27626', score=1.956240330221747,
explanation={}, locations=DefaultHitLocations{size=0, locations=[]}, fragments={}, fields={}}
DefaultSearchQueryRow{index='sidx_hotel_desc_66ab355a2a9392b8_18572d87', id='hotel_1507', score=1.9547615867497852,
explanation={}, locations=DefaultHitLocations{size=0, locations=[]}, fragments={}, fields={}}
DefaultSearchQueryRow{index='sidx_hotel_desc_66ab355a2a9392b8_54820232', id='hotel_4397', score=1.6941537614950384,
explanation={}, locations=DefaultHitLocations{size=0, locations=[]}, fragments={}, fields={}}
DefaultSearchQueryRow{index='sidx_hotel_desc_66ab355a2a9392b8_aa574717', id='hotel_4399', score=1.5968708706127248,
explanation={}, locations=DefaultHitLocations{size=0, locations=[]}, fragments={}, fields={}}
DefaultSearchQueryRow{index='sidx_hotel_desc_66ab355a2a9392b8_f4e0a48a', id='hotel_28259', score=1.4280208176277713,
explanation={}, locations=DefaultHitLocations{size=0, locations=[]}, fragments={}, fields={}}
DefaultSearchQueryRow{index='sidx_hotel_desc_66ab355a2a9392b8_6ddbfb54', id='hotel_5846', score=1.002838035409521,
explanation={}, locations=DefaultHitLocations{size=0, locations=[]}, fragments={}, fields={}}
```

JAVA SDK
FIELD LEVEL ENCRYPTION

Field Level Encryption

- We support field-level encryption in our SDKs to protect sensitive user data.
- Fields within a document can be securely encrypted by the SDK, to support FIPS-140-2 compliance.
- This is a client-side implementation, with key management and initialization of data encryption done during configuration of the SDK, which then exposes the API during runtime, for normal read/write operations.
- In Couchbase Data Platform, AES-256, AES-128, and RSA are all supported. Native Keystores (including Java Key Store and Windows Certificate Store) are supported, as well as an in-memory keystore for development and testing.



Field Level Encryption

- Behind the API, the format displayed here is used internally to encompass both the temporary field name used to hold the encrypted value, plus the additional metadata associated with the algorithm used and the public key:
- This is how Couchbase stores the JSON internally, but it is exposed to the developer as a public API.

```
__[PREFIX]_[FIELDNAME]” : {
                “kid” : “[KEY_IDENTIFIER]”,
                “alg”: “[ALGORITHM”],
                “ciphertext”: “[BASE64_ENCRYPTED_DATA]”,
                “sig”: “[BASE64_HMAC_SIGNATURE]”,
                “Iv” : [“INITIALIZATION_VECTOR”]
}
```

- It’s important that encrypted fields be treated as “special” fields and not mutated by APIs other than through the Field Level Encryption (FLE) API. For example, for AES-HMAC-SHA256 the entire temporary field is signed; if any changes are made to any fields (“alg”, “kid”, “ciphertext”, “sig” or “iv”) then the decryption will fail because the signature has changed.
- Field Level Encryption for all SDKs is a separate package from the Couchbase SDK itself; Additional Maven dependency.

Field Level Encryption: Java example

Create a configuration to connect to your Couchbase cluster and configure the crypto manager in the Couchbase environment with the encryption crypto algorithm and key store providers.

To apply encryption to a repository entity, use the EncryptedField annotation with provider name as registered on the crypto manager:

```
@EncryptedField(provider = "AES")
public String password;
```

Encryption can also be applied to JsonObjects:

```
JsonObject.create().putAndEncrypt("foo", "bar", "AES");
```

Encrypted fields in entities are decrypted based on the annotations.
To decrypt use fields in JsonObject, use getAndDecrypt methods:

```
JsonDocument stored = bucket.get("mydoc");
stored.content().getAndDecrypt("foo", "AES")
```

Lab 13: Field Level Encryption

- Modify method: initConnection()
  - Setup key store and encryption configuration manager:

```
JceksKeyStoreProvider kp = new JceksKeyStoreProvider("secret");
kp.storeKey("SecretKey", "aabbccddqqnnmmeerryybbff3322kk99".getBytes());
kp.storeKey("HMACsecret", "myauthsecret".getBytes());
kp.publicKeyName("secretkey");
kp.signingKeyName("hmacsecret");
AES256CryptoProvider aes256CryptoProvider = new AES256CryptoProvider(kp);
CryptoManager cryptomanager = new CryptoManager();
cryptomanager.registerProvider("AES", aes256CryptoProvider);
```

  - Include the tracer in the Environment builder:

```
env = DefaultCouchbaseEnvironment.builder()
    .cryptoManager(cryptomanager)
...
```

Lab

Lab 13: Field Level Encryption

- 13A: Implement method: encryptPut(String[] words)
- Parameters (key, ccNum) are read from command line and added to a JsonObject
- Using Field Level Encryption API:
  - Encrypt the credit card number (ccNum) with the AES encryption provider and add to JsonObject
  - Add a timestamp attribute: “reviewed”, with value of currentTimeMillis
  - Create a JsonDocument from the key and JsonObject, and upsert the doc into the bucket

```
JsonObject jObj = JsonObject.create()
            .putAndEncrypt("ccNum",ccNum, "AES")
            .put("timestamp", System.currentTimeMillis());
JsonDocument doc = JsonDocument.create(key,jObj);

bucket.upsert(doc);
```

Lab 13: Field Level Encryption

- 13B: Implement method: encryptGet(String[] words)
- Parameter for the key is read from command line
- Using Field Level Encryption API:
  - Get the document by key
  - Decrypt the credit card number field (ccNum) with the AES encryption provider
  - Write the value to STDOUT

```
String decryptedString =
      bucket.get(key).content().toDecryptedString("AES");
System.out.println(decryptedString);
```

Lab

Lab 13: Field Level Encryption

- Rebuild the JAR and run the application
- Test using the fleput command to create a doc with an encrypted field, then use the read and fleget commands to see the encrypted and unencrypted field values

```
# fleput myKey 1234-5678-9012-3456
Running encrypt put on field ccNum for key myKey
# read myKey
{"__crypt_ccNum":{"sig":"x7JnVpkj4Y8hydltN3icg+pLi2SJMPA9O9H4dxU+20s=","ciphertext":"nqJeB8hvv1T1oKQtu0KSYwm0EXHXMOCIYeKhFp
x3TDY=","alg":"AES-256-HMAC-SHA256","iv":"qixS8dxQ6Bud/Qe7zDH91w==","kid":"secretkey"},"timestamp":1553664508421}
# fleget myKey
Running encrypt get on doc myKey
{"ccNum":"1234-5678-9012-3456","timestamp":1553664508421}
#
```

JAVA SDK
THRESHOLD LOGGING

Threshold Logging

- Response Time Observability, introduced in Couchbase 5.5, is implemented as Threshold Logging in Java SDK from release 2.6.0.
- Provides telemetry for monitoring how well your Couchbase cluster is meeting your application SLAs.
  - In your application you can set thresholds to allow you to log operations based on performance of your requests.
  - You can correlate timing information from client through to server and back to quickly triage performance issues and help identify the root cause of performance issues.
- The performance of operations are all exposed via methods you are already familiar with in the Couchbase SDK.
- Couchbase SDK team selected OpenTracing as their tracing API:
  - Separate the data that is being collected from the mechanism that collects and does something with that data
  - Couchbase SDKs provide a Tracer implementation out of the box called the ThresholdLoggingTracer
  - Use any OpenTracing compatible tracer implementation: open source (e.g. jaeger), or one from APM vendors

Threshold Logging

Output fields in detail:

```
{
        "server_us" : 23,
        "last_local_id" : "41837B87B9B1C5D1/000000004746B9AA",
        "last_local_address" : "127.0.0.1:55011",
        "last_operation_id" : "get:0x1",
        "decode_us" : 1203,
        "last_dispatch_us" : 947,
        "last_remote_address" : "127.0.0.1:11210",
        "total_us" : 1525
}
```

- total_us: The total time it took to perform the full operation: here around 1.5 milliseconds.
- server_us: The server reported that its work performed took 23 microseconds (this does not include network time or time in the buffer before picked up at the cluster).
- decode_us: Decoding the response took the client 1.2 milliseconds.
- last_dispatch_us: The time when the client sent the request and got the response took around 1 millisecond.
- last_local_address: The local socket used for this operation.
- last_remote_address: The remote socket on the server used for this operation. Useful to figure out which node is affected.
- last_operation_id: A combination of type of operation and id (in this case the opaque value), useful for diagnosing and troubleshooting in combination with the last_local_id.
- last_local_id: With Server 5.5 and later, this id is negotiated with the server and can be used to correlate logging information on both sides in a simpler fashion.

Threshold Logging: Java example

You can customize Tracer settings through the CouchbaseEnvironment.Builder.

Here is an example of how to customize our default tracer to:

- reduce the threshold for KV operations from 500 ms to 100 ms
- reduce the time interval when the information gets logged from 1 minute to 10 seconds

```
Tracer tracer = ThresholdLogTracer.create(ThresholdLogReporter.builder()
  .kvThreshold(100, TimeUnit.MILLISECONDS) // reduce default 500ms threshold
  .logInterval(10, TimeUnit.SECONDS)       // log every 10 seconds
  .build());

CouchbaseEnvironment env = DefaultCouchbaseEnvironment.builder()
  .tracer(tracer)
  .build();

Cluster cluster = CouchbaseCluster.create(env, "127.0.0.1");
cluster.authenticate("username", "password");

Bucket bucket = cluster.openBucket("travel-sample");
```

Lab 14: Threshold Logging

- Modify method: initConnection()
  - Create a create a tracer with a KV threshold of 1 microsecond:

```
Tracer tracer = ThresholdLogTracer.create(ThresholdLogReporter.builder()
    .kvThreshold(1, TimeUnit.MICROSECONDS) // 1 microsecond
    .logInterval(1, TimeUnit.SECONDS) // log every second
    .sampleSize(Integer.MAX_VALUE)
    .pretty(true) // pretty print the json output in the logs
    .build());
```

  - Include the tracer in the Environment builder, and enable tracing:

```
env = DefaultCouchbaseEnvironment.builder()
    .tracer(tracer)
    .operationTracingEnabled(true)
...
```

Lab

Lab 14: Threshold Logging

- Rebuild the JAR and run the application
- Test using the threshold command (or read or update)

```
# threshold
Mar 27, 2019 6:30:59 AM com.couchbase.client.core.tracing.ThresholdLogReporter logOverThreshold
WARNING: Operations over threshold: [ {
  "top" : [ {
    "operation_name" : "get",
    "server_us" : 2320,
    "last_local_id" : "0A2BBE8639B1BCAD/000000007B702834",
    "last_local_address" : "127.0.0.1:61928",
    "last_remote_address" : "127.0.0.1:11210",
    "last_dispatch_us" : 5099,
    "decode_us" : 8144,
    "last_operation_id" : "0x2",
    "total_us" : 18600
  }, {
    "operation_name" : "upsert",
    "server_us" : 108,
    "last_local_id" : "0A2BBE8639B1BCAD/000000007B702834",
    "encode_us" : 3442,
    "last_local_address" : "127.0.0.1:61928",
    "last_remote_address" : "127.0.0.1:11210",
    "last_dispatch_us" : 2647,
    "last_operation_id" : "0x3",
    "total_us" : 10597
  } ],
  "service" : "kv",
  "count" : 2
} ]
```

Lab

JAVA SDK
BATCHING WITH RXJAVA

Batching with RxJava

Implicit batching is performed by utilizing a few operators:

- **Observable.just()** or **Observable.from()** to generate an Observable that contains the data you want to batch on.
- **flatMap()** to send those events against the Couchbase Java SDK and merge the results asynchronously.
- **last()** if you want to wait until the last element of the batch is received.
- **toList()** if you care about the responses and want to aggregate them easily.

Batching with RxJava

- The following example creates an observable stream of 5 keys to load in a batch,
- asynchronously fires off get() requests against the SDK,
- waits until the last result has arrived,
- and then converts the result into a list and blocks at the very end

```
Cluster cluster = CouchbaseCluster.create();
Bucket bucket = cluster.openBucket();

List<JsonDocument> foundDocs = Observable
    .just("key1", "key2", "key3", "key4", "key5")
    .flatMap(new Func1<String, Observable<JsonDocument>>() {
        @Override
        public Observable<JsonDocument> call(String id) {
            return bucket.async().get(id);
        }
    })
    .toList()
    .toBlocking()
    .single();
```

Batching with RxJava - Batching mutations

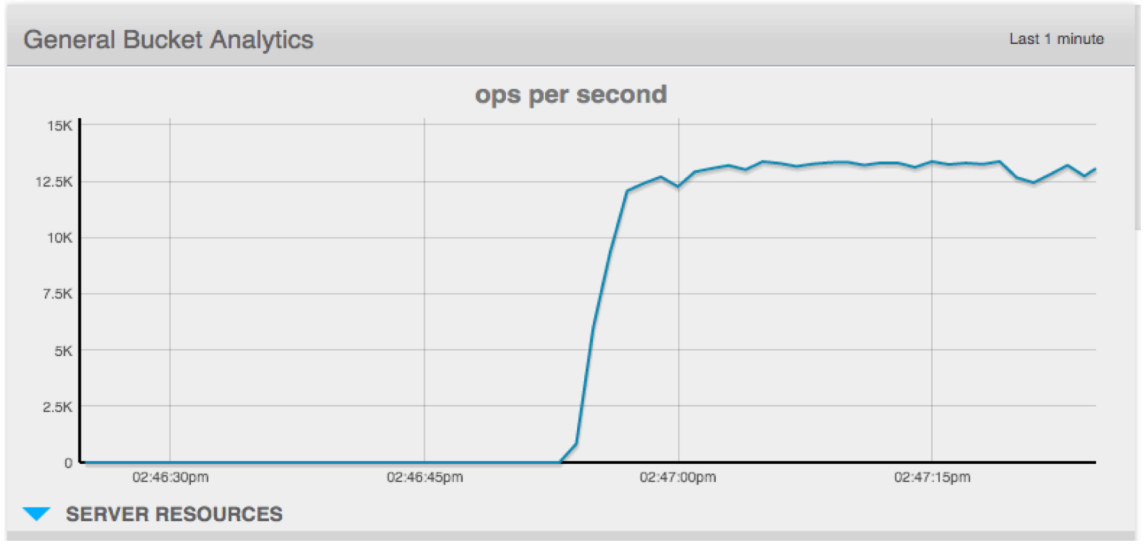
- The following code generates a number of fake documents and inserts them in one batch.
- Note that you can decide to either collect the results with **toList()** as shown in the previous slide or just use **last()** as shown here to wait until the last document is properly inserted.

```
// Generate a number of dummy JSON documents
int docsToCreate = 100;
List<JsonDocument> documents = new ArrayList<JsonDocument>();
for (int i = 0; i < docsToCreate; i++) {
    JsonObject content = JsonObject.create()
        .put("counter", i)
        .put("name", "Foo Bar");
    documents.add(JsonDocument.create("doc-"+i, content));
}

// Insert them in one batch, waiting until the last one is done.
Observable
    .from(documents)
    .flatMap(new Func1<JsonDocument, Observable<JsonDocument>>() {
        @Override
        public Observable<JsonDocument> call(final JsonDocument docToInsert) {
            return bucket.async().insert(docToInsert);
        }
    })
    .last()
    .toBlocking()
    .single();
```

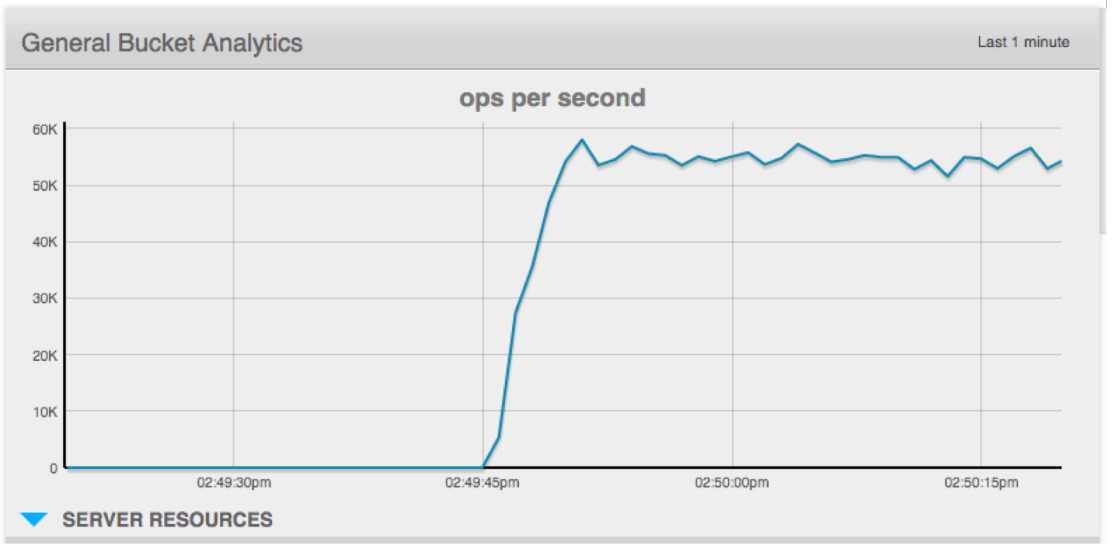
Sync Vs. ASync

✓ Here are two code samples that showcase serialized and batched loading of documents.

```
// Serialized workload of loading documents
while(true) {
    List<JsonDocument> loaded = new ArrayList<JsonDocument>();
    int docsToLoad = 10;
    for (int i = 0; i < docsToLoad; i++) {
        JsonDocument doc = bucket.get("doc-" + i);
        if (doc != null) {
            loaded.add(doc);
        }
    }
}
```




```
// Same workload, utilizing batching effects
while(true) {
    int docsToLoad = 10;
    Observable
        .range(0, docsToLoad)
        .flatMap(new Func1<Integer, Observable<JsonDocument>>() {
            @Override
            public Observable<JsonDocument> call(Integer i) {
                return bucket.async().get("doc-"+i);
            }
        })
        .toList()
        .toBlocking()
        .single();
}
```



Bulk Read Async

```
List<String> priceKeys;
List<JsonObject> res = Observable
    .from(priceKeys)
    .flatMap(k -> bucket.async().get(k))
    .map(doc -> doc.content())
    .toList()
    .toBlocking()
    .single();
```

Bulk Write

Async version:

```
List<JsonDocument> docs = ...;
Observable
    .from(docs)
    .flatMap(doc -> bucket.async().insert(doc))
    .last()
    .toBlocking()
    .single();
```

Sync version:

```
for(JsonDocument doc : docs){
   bucket.insert(doc);
}
```

Lab 15: Bulk Write Performance

- Implement 2 methods:
  - 15A: bulkWrite (String[] words) : Async version
  - 15B: bulkWriteSync (String[] words) : Sync version
- Parameter for the number of messages to insert is read from command line
- Delete all messages in the bucket:

```
DELETE FROM `travel-sample` WHERE type='msg'
```

- An array of JsonDocuments of messages is created (count is number parameter)
- Insert the messages into the bucket…

15A: asynchronously	15B: synchronously

`Observable`
`  .from(docs)`
`  .flatMap(doc -> bucket.async().insert(doc))`
`  .last()`
`  .toBlocking()`
`  .single();`
	`for(JsonDocument doc : docs){`
	`  bucket.insert(doc);`
	`}`

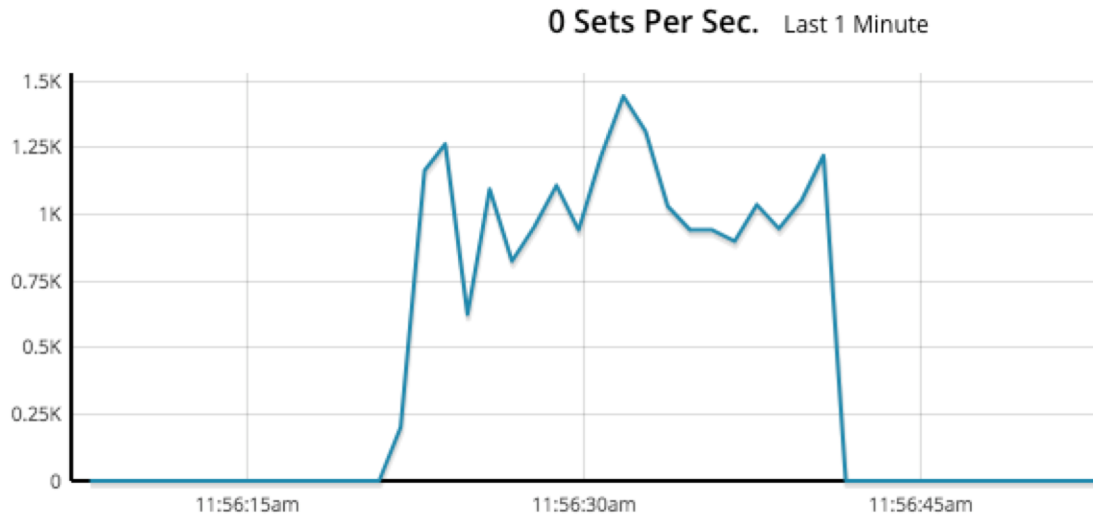
Lab

Lab 15: Bulk Write Performance

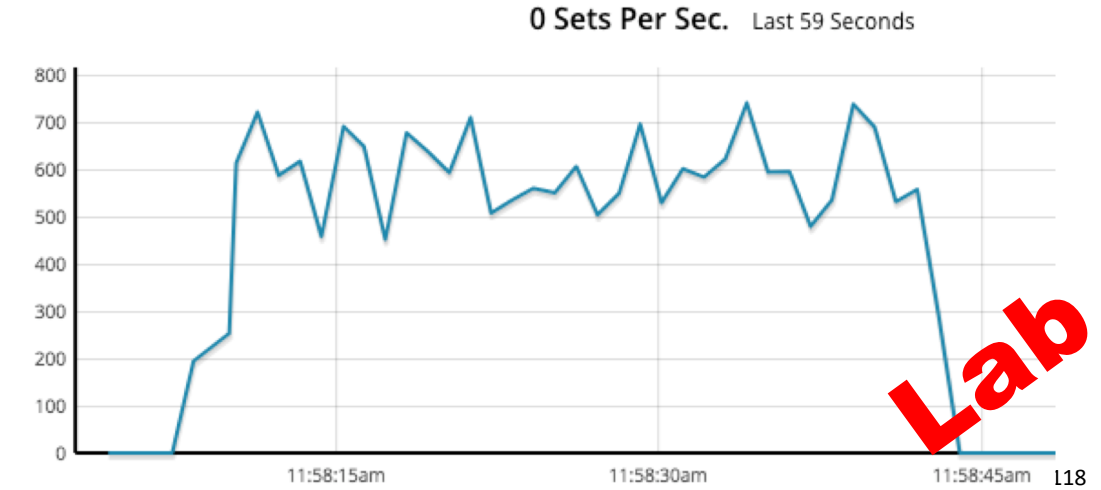
- Print the time elapsed to STDOUT
- Note: in initConnection, set env.keepAliveInterval(60000) to minimize keepAlive warnings
- Rebuild the JAR and run the application
- Test both methods creating 20000 messages
- Compare results sync vs. async: check both time and operations per second in the console

```
# bulkwrite 20000
Deleting messages ...
Writing 20000 messages
Time elapsed 17508 ms
# bulkwritesync 20000
Deleting messages ...
Writing 20000 messages
Time elapsed 64430 ms
#
```

Async



Sync



Query Async mode

```
bucket.async()
   .query(select("*").from("`travel-sample`").limit(5))
   .flatMap(result -> result.errors()
      .flatMap(e -> Observable
         .<AsyncN1qlQueryRow>error(new CouchbaseException("N1QL Error/Warning: " + e)))
      .switchIfEmpty(result.rows())
   )
   .map(AsyncN1qlQueryRow::value)
   .subscribe(
      rowContent -> System.out.println(rowContent),
      runtimeError -> runtimeError.printStackTrace()
   );
```

Lab 16: Simple Query – Async version

- Implement method: queryAsync (String[] words)
- Execute the query: "`SELECT * FROM \`travel-sample\` LIMIT 5`" and print the results to STDOUT using asynchronous implementation

```
bucket.async()
   .query(N1qlQuery.simple(select("*").from("`travel-sample`").limit(5)))
   .subscribe(result -> {
      result.errors()
         .subscribe(
            e -> System.err.println("N1QL Error/Warning: " + e),
            runtimeError -> runtimeError.printStackTrace()
         );
      result.rows()
         .map(row -> row.value())
         .subscribe(
            rowContent -> System.out.println(rowContent),
            runtimeError -> runtimeError.printStackTrace()
         );
   });
```

Lab 16: Simple Query – Async version

- Rebuild the JAR and run the application
- Test using the queryasync command

```
# queryasync
# {"travel-sample":{"country":"United States","iata":"Q5","callsign":"MILE-AIR","name":"40-Mile
Air","icao":"MLA","id":10,"type":"airline"}}
{"travel-sample":{"country":"United States","iata":"TQ","callsign":"TXW","name":"Texas
Wings","icao":"TXW","id":10123,"type":"airline"}}
{"travel-sample":{"country":"United
States","iata":"A1","callsign":"atifly","name":"Atifly","icao":"A1F","id":10226,"type":"airline"}}
{"travel-sample":{"country":"United Kingdom","iata":null,"callsign":null,"name":"JC
ROYAL.BRITANNICA","icao":"JRB","id":10642,"type":"airline"}}
{"travel-sample":{"country":"United
States","iata":"ZQ","callsign":"LOCAIR","name":"Locair","icao":"LOC","id":10748,"type":"airline"}}
```

Lab

SPRING & COUCHBASE

THANK YOU