Hibernate OGM 5.1.0.Final

Reference Guide

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Preface

Hibernate OGM is a persistence engine providing Java Persistence (JPA) support for NoSQL datastores. It reuses Hibernate ORM's object life cycle management and (de)hydration engine but persists entities into a NoSQL store (key/value, document, column-oriented, etc) instead of a relational database.

It allows using the Java Persistence Query Language (JP-QL) as an interface to querying stored data, in addition to using native queries of the specific NoSQL database.

The project is now fairly mature when it comes to the storage strategies, and the feature set is sufficient to be used in your projects. We do have however much bigger ambitions than a simple object mapper. Many things are on the roadmap (more NoSQL, query, denormalization engine, etc). If you feel a feature is missing, report it to us. If you want to contribute, even better!

Hibernate OGM is released under the LGPL open source license.

The future of this project is being shaped by the requests from our users. Please give us feedback on

- what you like
- what you don't like
- what is confusing
- what you are missing as a feature

Check How to contribute on how to contact us.

We worked hard on this documentation but we know it is far from perfect. If you find something confusing or feel that an explanation is missing, please let us know. Getting in touch is easy: see contacting the developer community.

Goals

Hibernate OGM:

- offers a familiar programming paradigm (JPA) to deal with NoSQL stores
- moves model denormalization from a manual imperative work to a declarative approach handled by the engine
- encourages new data usage patterns and NoSQL exploration in more "traditional" enterprises

- helps scale existing applications with a NoSQL front end to a traditional database

NoSQL can be very disconcerting as it is composed of many disparate solutions with different benefits and drawbacks. NoSQL databases can be loosely classified in four families:

- graph oriented databases
- key/value stores: essentially Maps but with different behaviors and ideas behind various products (data grids, persistent with strong or eventual consistency, etc)
- document based datastores: maps which contain semi-structured documents (think JSON)
- column based datastores

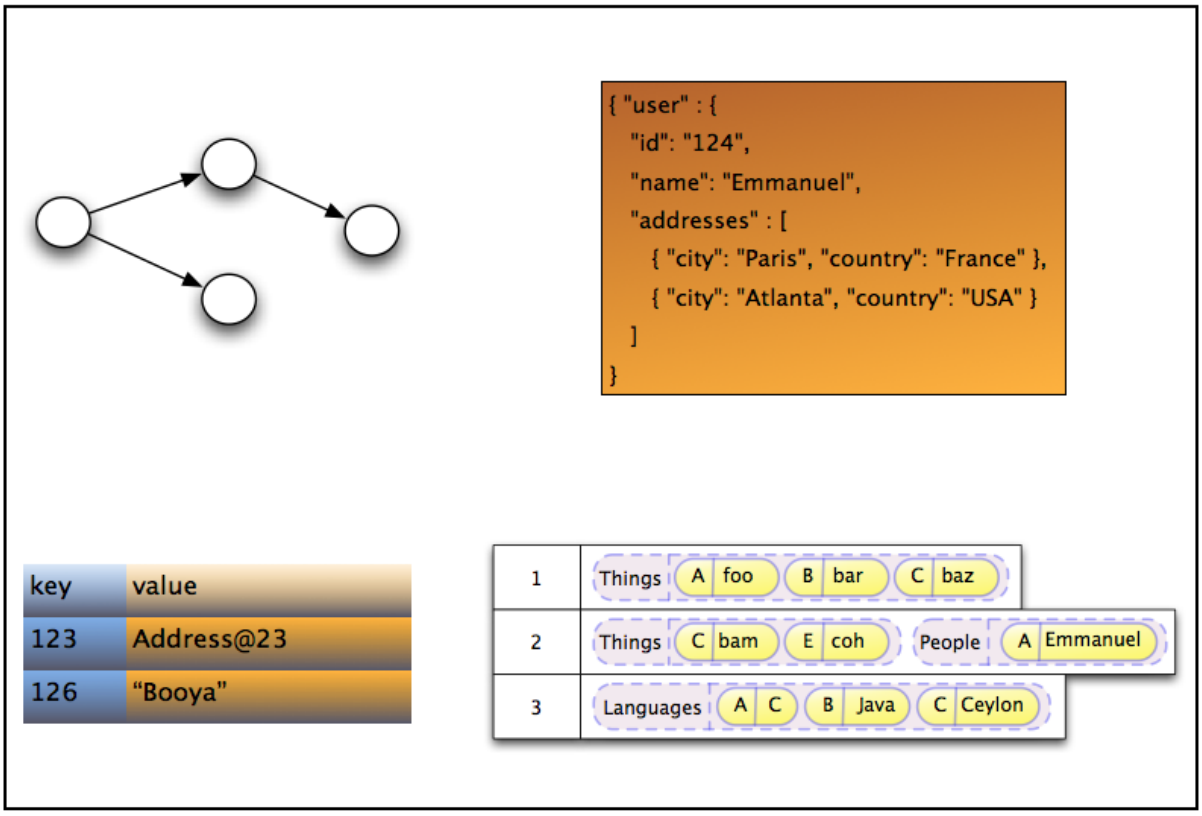


Figure 1. Various NoSQL families

Each have different benefits and drawbacks and one solution might fit a use case better than an other. However access patterns and APIs are different from one product to the other.

Hibernate OGM is not expected to be the Rosetta stone used to interact with *all* NoSQL solution in *all* use cases. But for people modeling their data as a domain model, it provides distinctive advantages over raw APIs and has the benefit of providing an API and semantic known to Java developers. Reusing the same programmatic model and trying different (No)SQL engines will hopefully help people to explore alternative datastores.

Hibernate OGM also aims at helping people scale traditional relational databases by providing a

NoSQL front-end and keeping the same JPA APIs and domain model. It could for example help to migrate a selection of your model from an RDBMS to a particular NoSQL solution which better fits the typical use case.

What we have today

Today, Hibernate OGM does not support all of these goals. Here is a list of what we have:

- store data in key/value stores (Infinispan and Ehcache)
- store data in document stores (MongoDB and CouchDB - the latter in preview)
- store data in graph databases (Neo4J)
- Create, Read, Update and Delete operations (CRUD) for entities
- polymorphic entities (support for superclasses, subclasses etc).
- embeddable objects (aka components)
- support for basic types (numbers, String, URL, Date, enums, etc)
- support for associations
- support for collections (Set, List, Map, etc)
- support for JP-QL queries (not arbitrary joins though)
- support for mapping native queries results to managed entities
- support for Hibernate Search's full-text queries
- and generally, support for JPA and native Hibernate ORM API support

In short, a perfectly capable Object Mapper for multiple popular NoSQL datastores.

Experimental features

As Hibernate OGM is a rather young project, some parts of it may be marked as experimental. This may affect specific APIs or SPIs (e.g. the case for the `SchemaInitializer` SPI contract at the moment), entire dialects (this is the case for the CouchDB dialect at the moment) or deliverables.

Experimental APIs/SPIs are marked via the `@Experimental` annotation. Experimental dialects make that fact apparent through their datastore name (e.g. "COUCHDB_EXPERIMENTAL") and experimental deliverables use the "experimental" artifact classifier.

If a certain part is marked as experimental it may undergo backwards-incompatible changes in future releases. E.g. API/SPI methods may be altered, so that code using them needs to be adapted as well. For experimental dialects the persistent format of data may be changed, so that a future version of such dialect may not be able to read back data written by previous versions.

A manual update of the affected data may be thus required. Experimental deliverables should be used with special care, as they are work in progress. You should use them for testing but not production use cases.

But most of our dialects are mature, so don't worry ;)

Use cases

Here are a few areas where Hibernate OGM can be beneficial:

- need to scale your datastore up and down rapidly (via the underlying NoSQL datastore capability)
- keep your domain model independent of the underlying datastore technology (RDBMS, Infinispan, NoSQL)
- explore the best tool for the use case
- use a familiar JPA front end to your datastore
- use Hibernate Search full-text search / text analysis capabilities and store the data set in an scalable datastore

These are a few ideas and the list will grow as we add more capabilities to Hibernate OGM.

Chapter 1. How to get help and contribute on Hibernate OGM

Hibernate OGM is a young project. Join and help us shape it!

1.1. How to get help

First of all, make sure to read this reference documentation. This is the most comprehensive formal source of information. Of course, it is not perfect: feel free to come and ask for help, comment or propose improvements in our Hibernate OGM forum.

You can also:

- open bug reports in JIRA
- propose improvements on the development mailing list
- join us on IRC to discuss developments and improvements (`#hibernate-dev` on `freenode.net`; you need to be registered on freenode: the room does not accept "anonymous" users).

1.2. How to contribute

Welcome!

There are many ways to contribute:

- report bugs in JIRA
- give feedback in the forum, IRC or the development mailing list
- improve the documentation
- fix bugs or contribute new features
- propose and code a datastore dialect for your favorite NoSQL engine

Hibernate OGM's code is available on GitHub at https://github.com/hibernate/hibernate-ogm.

1.2.1. How to build Hibernate OGM

Hibernate OGM uses Git and Maven 3, make sure to have both installed on your system.

Clone the git repository from GitHub:

```
#get the sources
git clone https://github.com/hibernate/hibernate-ogm
cd hibernate-ogm
```

Run maven

```
#build project
mvn clean install -s settings-example.xml
```

Note that Hibernate OGM uses artifacts from the Maven repository hosted by JBoss. Make sure to either use the `-s settings-example.xml` option or adjust your `~/.m2/settings.xml` according to the descriptions available on this jboss.org wiki page.

These settings are required for development of Hibernate OGM but should not be needed to use it.

To skip building the documentation, set the `skipDocs` property to true:

```
mvn clean install -DskipDocs=true -s settings-example.xml
```

If you just want to build the documentation only, run it from the `hibernate-ogm-documentation/manual` subdirectory.

1.2.2. How to contribute code effectively

The best way to share code is to fork the Hibernate OGM repository on GitHub, create a branch and open a pull request when you are ready. Make sure to rebase your pull request on the latest version of the master branch before offering it.

Here are a couple of approaches the team follows:

- We do small independent commits for each code change. In particular, we do not mix stylistic code changes (import, typos, etc) and new features in the same commit.
- Commit messages follow this convention: the JIRA issue number, a short commit summary, an empty line, a longer description if needed. Make sure to limit line length to 80 characters, even at this day and age it makes for more readable commit comments.

```
OGM-123 Summary of commit operation

Optional details on the commit
and a longer description can be
added here.
```

- A pull request can contain several commits but should be self contained: include the implementation, its unit tests, its documentation and javadoc changes if needed.
- All commits are proposed via pull requests and reviewed by another member of the team before being pushed to the reference repository. That's right, we never commit directly upstream without code review.

1.3. How to build support for a data store

Advanced section

This is an advanced subject, feel free to skip this section if you are not building a data store.

Hibernate OGM supports various data stores by abstracting them with `DatastoreProvider` and `GridDialect`. The supported features vary between data stores, and dialects do not have to implement all features. Hibernate OGM implements a TCK (Technology Compatibility Kit) to verify interoperability and features of the dialect. Hibernate OGM supports a variety of document- and key-value-stores and ships with some abstraction and utility classes for document- and key-value-stores (like `KeyValueStoreProperties` and `DocumentStoreProperties`).

1.3.1. DataStore providers

Supporting a data store usually begins with a `DatastoreProvider`. Providers can implement a lifecycle (`start`, `stop`) to initialize, configure and shutdown resources. Taking a look at existing data store support such as MongoDB (see `org.hibernate.ogm.datastore.mongodb.impl.MongoDBDatastoreProvider`) is a good idea to get an impression of how to boot the data store support. Providers are seen as services, they can implement various service interfaces to activate certain features (see the `org.hibernate.service.spi` package for details).

A common issue to face then implementing new data stores is transactionality. Some data stores provide transactional support that can be used in the context of Hibernate OGM wrapped by JTA. If your data store does not support transactions, you can enable transaction emulation within the `DatastoreProvider`.

Features of a `DatastoreProvider`:

- Resource lifecycle
- Managing connection resources
- Configuration
- Access to query parsers
- Define/Validate a schema

1.3.2. Dialects

A data store can have one or more dialects. Dialects describe the style how data is mapped to a particular data store. NoSQL data stores imply a certain nature, how to map data. Document-oriented data stores encourage an entity-as-document pattern where embedded data structures could be stored within the document itself. Key-value data stores allow different approaches, e.g. storing an entity as JSON document or event storing individual key-value pairs that map the entity within a hash table data structure. Hibernate OGM allows multiple dialects per data store and users may choose the most appropriate one.

The most basic support is provided by implementing the `GridDialect` interface. Implementing that interface is mandatory to support a specific data store.

A `GridDialect` usually supports:

- Create/Read/Update/Delete for entities
- Create/Read/Update/Delete for associations
- Id/Sequence generator
- Provides locking strategies

A dialect *may* optionally implement one or more additional facet interfaces to provide a broader support for certain features:

- `QueryableGridDialect`
- `BatchableGridDialect`
- `IdentityColumnAwareGridDialect`
- `OptimisticLockingAwareGridDialect`
- `MultigetGridDialect`

Features of a `QueryableGridDialect`

- Query execution
- Support for native queries

Features of a `BatchableGridDialect`

- Operation queueing
- Execution of queued Create/Update/Delete as a batch

Features of a `IdentityColumnAwareGridDialect`

- Supports the generation of identity values upon data insertion

Features of an `OptimisticLockingAwareGridDialect`

- Finding and altering versioned records in an atomic fashion

Features of a `MultigetGridDialect`

- Retrieve multiple tuples within one operation

Before starting make a clear plan of how you think entities, relations and nested structures are best represented in the NoSQL store you plan to implement. It helps to have a clear picture about that, and this will require some experience with the NoSQL database you plan to support.

Start with a small feature set to get a feeling for Hibernate OGM, for example aim at implementing CRUD operations only and ignore relations and queries. You can always extend the features as you proceed.

Starting from or studying existing dialects is also an interesting strategy. It can be intimidating with complex dialects though.

Hibernate OGM is not opinionated by which means data is stored/loaded for a particular data store, but the particular dialect is. Hibernate OGM strives for the most natural mapping style. The idea is to facilitate integration with other applications of that database by sticking to established patterns and idioms of that store.

1.3.3. Entities

Entities are seen by a dialect as `Tuple`. A `Tuple` contains:

- a snapshot (that's the view of the data as loaded from your database),
- a set of key-value pairs that carry the actual data,
- and a list of operations to apply onto the original snapshot. Tuple keys use dot-path property identifiers to indicate nesting. That comes handy when working with document stores because you can build a document structure based on that details.

1.3.4. Associations

Most NoSQL data stores have no built-in support for associations between entities (unless you're using a graph database).

Hibernate OGM simulates associations for datastore with no support by storing the navigational information to go from a given entity to its (list of) associated entity. This of it as query materialisation. This navigational information data can be stored within the entity itself or externally (as own documents or relation items).

1.3.5. Configuration

Hibernate OGM can read its configuration properties from various sources. Most common configuration sources are:

- `hibernate.properties` file
- `persistence.xml` file
- environment variables override or integrate properties set in the above configuration files
- annotation configuration (entity classes)
- programmatic configuration

The `org.hibernate.ogm.options` package provides the configuration infrastructure.

You might want to look at `MongoDBConfiguration` or `InfinispanConfiguration` to get an idea how configuration works. Configuration is usually read when starting a data store provider or while operating. A good example of accessing configuration during runtime is the association storage option, where users can define, how to store a particular association (within the entity or as a separate collection/key/document/node).

The configuration and options context infrastructure allows to support data store-specific options such as `ReadPreference` for MongoDB or `TTL` for Redis.

Programmatic configuration

Data store support can implement programmatic configuration. The configuration splits into three parts:

- Global configuration
- Entity configuration
- Property configuration

Programmatic configuration consists of two parts: configuration interfaces (see `org.hibernate.ogm.options.navigation`) and partial (abstract) implementation classes.

These parts are merged at runtime using ASM class generation.

1.3.6. Types

Every data store supports a unique set of data types. Some stores support floating point types and date types, others just strings. Hibernate OGM allows users to utility a variety of data types (see JPA spec) for their data models. On the other hand, that data needs to be stored within the data store and mapped back.

A dialect can provide a `GridType` to describe the handling of a particular data type, meaning you can specify how dates, floating point types or even byte arrays are handled. Whether they are mapped to other data types (e. g. use `double` for `float` or use base64-encoded strings for byte arrays) or wrapped within strings.

Data store-specific types can be handled the same way, check out `StringAsObjectIdType` for the String-mapping of MongoDB's `ObjectId` type.

Type-mapping can be an exhausting task. The whole type handling is in flux and is subject to change as Hibernate OGM progresses. Ask, if you're not sure about it.

1.3.7. Tests

Hibernate OGM brings a well suited infrastructure for tests. The test infrastructure consists of generic base classes (`OgmTestCase` for OGM and `JpaTestCase` for JPA) for tests and a test helper (see `GridDialectTestHelper`). That classes are used to get a different view on data than the frontend-view by the `Session` and the `EntityManager`.

It is always helpful to create a set of own test cases for different scenarios to validate the data is mapped in the way it's intended or to verify data store-specific options such as `TTL`.

Another bunch of tests is called the backend TCK. That test classes test nearly all aspects of Hibernate OGM viewed from a users' perspective. Tests contain cases for simple/complex entities, associations, list- and map data types, queries using Hibernate Search, and tests for data type support.

The backend TCK is included using classpath filters, just check one of the current implementations (like `RedisBackendTckHelper`). When you're developing a core module, that is included in the distribution, you will have to add your dialect to the `@SkipByGridDialect` annotation of some tests.

Running even 20% of the tests successfully is a great achievement. Proceed step-by-step. Large numbers of tests can fail just because of one thing that is handled differently. Don’t hesitate to ask for help.

Chapter 2. Getting started with Hibernate OGM

If you are familiar with JPA, you are almost good to go. We will nevertheless walk you through the first few steps of persisting and retrieving an entity using Hibernate OGM.

Before we can start, make sure you have the following tools configured:

- Java JDK 8
- Maven 3.2.3 or above

Hibernate OGM can be used with JDK 7 too, but in this example we'll be using Infinispan 8, which requires JDK 8.

Hibernate OGM is published in the Maven central repository.

Add `org.hibernate.ogm:hibernate-ogm-bom:5.1.0.Final` to your dependency management block and `org.hibernate.ogm:hibernate-ogm-infinispan:5.1.0.Final` to your project dependencies:

```
<dependencyManagement>
    <dependencies>
        <dependency>
            <groupId>org.hibernate.ogm</groupId>
            <artifactId>hibernate-ogm-bom</artifactId>
            <version>5.1.0.Final</version>
            <type>pom</type>
            <scope>import</scope>
        </dependency>
    </dependencies>
<dependencyManagement>

<dependencies>
    <dependency>
        <groupId>org.hibernate.ogm</groupId>
        <artifactId>hibernate-ogm-infinispan</artifactId>
    </dependency>
</dependencies>
```

The former is a so-called "bill of materials" POM which specifies a matching set of versions for Hibernate OGM and its dependencies. That way you never need to specify a version explicitly within your dependencies block, you will rather get the versions from the BOM automatically.

If you're deploying your application onto WildFly 10, you don't need to add the Hibernate OGM modules to your deployment unit but you can rather add them as modules to the application server. Refer to How to package Hibernate OGM applications for WildFly 10 to learn more.

We will use the JPA APIs in this tutorial. While Hibernate OGM depends on JPA 2.1, it is marked as provided in the Maven POM file. If you run outside a Java EE container, make sure to explicitly add the dependency:

```
<dependency>
    <groupId>org.hibernate.javax.persistence</groupId>
    <artifactId>hibernate-jpa-2.1-api</artifactId>
</dependency>
```

Let's now map our first Hibernate OGM entity.

```
@Entity
public class Dog {
   @Id @GeneratedValue(strategy = GenerationType.TABLE, generator = "dog")
   @TableGenerator(
      name = "dog",
      table = "sequences",
      pkColumnName = "key",
      pkColumnValue = "dog",
      valueColumnName = "seed"
   )
   public Long getId() { return id; }
   public void setId(Long id) { this.id = id; }
   private Long id;

   public String getName() { return name; }
   public void setName(String name) { this.name = name; }
   private String name;

   @ManyToOne
   public Breed getBreed() { return breed; }
   public void setBreed(Breed breed) { this.breed = breed; }
   private Breed breed;
}

@Entity
public class Breed {

   @Id @GeneratedValue(generator = "uuid")
   @GenericGenerator(name="uuid", strategy="uuid2")
   public String getId() { return id; }
   public void setId(String id) { this.id = id; }
   private String id;

   public String getName() { return name; }
   public void setName(String name) { this.name = name; }
   private String name;
}
```

I lied to you, we have already mapped two entities!

If you are familiar with JPA, you can see that there is nothing specific to Hibernate OGM in our mapping.

In this tutorial, we will use JBoss Transactions for our JTA transaction manager. So let's add the JTA API and JBoss Transactions to our POM as well.

We will also add Hibernate Search because the Infinispan dialect needs it to run JPQL queries, but we will leave the details for another time (Using Hibernate Search).

The final list of dependencies should look like this:

```
<dependencies>
    <!-- Hibernate OGM Infinispan module; pulls in the OGM core module -->
    <dependency>
        <groupId>org.hibernate.ogm</groupId>
        <artifactId>hibernate-ogm-infinispan</artifactId>
    </dependency>

    <1-- Optional, needed to run JPQL queries on some datastores -->
    <dependency>
        <groupId>org.hibernate.search</groupId>
        <artifactId>hibernate-search-orm</artifactId>
    </dependency>

    <!-- Standard APIs dependencies - provided in a Java EE container -->
    <dependency>
        <groupId>org.hibernate.javax.persistence</groupId>
        <artifactId>hibernate-jpa-2.1-api</artifactId>
    </dependency>
    <dependency>
        <groupId>org.jboss.spec.javax.transaction</groupId>
        <artifactId>jboss-transaction-api_1.2_spec</artifactId>
    </dependency>

    <!-- Add the Narayana Transactions Manager
         an implementation would be provided in a Java EE container,
         but this works nicely in Java SE as well -->
    <dependency>
        <groupId>org.jboss.narayana.jta</groupId>
        <artifactId>narayana-jta</artifactId>
    </dependency>
    <dependency>
        <groupId>org.jboss</groupId>
        <artifactId>jboss-transaction-spi</artifactId>
    </dependency>
</dependencies>
```

Next we need to define the persistence unit. Create a `META-INF/persistence.xml` file.

```
<?xml version="1.0"?>
<persistence xmlns="http://java.sun.com/xml/ns/persistence"
             xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
             xsi:schemaLocation="http://java.sun.com/xml/ns/persistence
http://java.sun.com/xml/ns/persistence/persistence_2_0.xsd"
             version="2.0">

    <persistence-unit name="ogm-jpa-tutorial" transaction-type="JTA">
        <!-- Use the Hibernate OGM provider: configuration will be transparent
-->
        <provider>org.hibernate.ogm.jpa.HibernateOgmPersistence</provider>
        <properties>
            <!-- Here you will pick which NoSQL technology to use, and
configure it;
                 in this example we start a local in-memory Infinispan node.
-->
            <property name="hibernate.ogm.datastore.provider" value=
"infinispan_embedded"/>
        </properties>
    </persistence-unit>
</persistence>
```

Let's now persist a set of entities and retrieve them.

```
//accessing JBoss's Transaction can be done differently but this one works
nicely
TransactionManager tm = com.arjuna.ats.jta.TransactionManager
.transactionManager();

//build the EntityManagerFactory as you would build in in Hibernate ORM
EntityManagerFactory emf = Persistence.createEntityManagerFactory(
    "ogm-jpa-tutorial");

final Logger logger = LoggerFactory.getLogger(DogBreedRunner.class);

[..]

//Persist entities the way you are used to in plain JPA
tm.begin();
logger.infof("About to store dog and breed");
EntityManager em = emf.createEntityManager();
Breed collie = new Breed();
collie.setName("Collie");
em.persist(collie);
Dog dina = new Dog();
dina.setName("Dina");
dina.setBreed(collie);
em.persist(dina);
Long dinaId = dina.getId();
em.flush();
em.close();
tm.commit();

[..]

//Retrieve your entities the way you are used to in plain JPA
tm.begin();
logger.infof("About to retrieve dog and breed");
em = emf.createEntityManager();
dina = em.find(Dog.class, dinaId);
logger.infof("Found dog %s of breed %s", dina.getName(), dina.getBreed()
.getName());
em.flush();
em.close();
tm.commit();

[..]

emf.close();
```

A working example can be found in Hibernate OGM's distribution under `hibernate-ogm-documentation/examples/gettingstarted`.

What have we seen?

- Hibernate OGM is a JPA implementation and is used as such both for mapping and in API usage
- It is configured as a specific JPA provider: `org.hibernate.ogm.jpa.HibernateOgmPersistence`

Let’s explore more in the next chapters.

Chapter 3. Architecture

Hibernate OGM defines an abstraction layer represented by `DatastoreProvider` and `GridDialect` to separate the OGM engine from the datastores interaction. It has successfully abstracted various key/value stores, document stores and graph databases. We are working on testing it on other NoSQL families.

In this chapter we will explore:

- the general architecture
- how the data is persisted in the NoSQL datastore
- how we support JP-QL queries

Let's start with the general architecture.

3.1. General architecture

Hibernate OGM is made possible by the reuse of a few key components:

- Hibernate ORM for JPA support
- the NoSQL drivers to interact with the underlying datastore
- optionally Hibernate Search for indexing and query purposes
- optionally Infinispan's Lucene Directory to store indexes in Infinispan itself, or in many other NoSQL using Infinispan's write-through cachestores
- Hibernate OGM itself

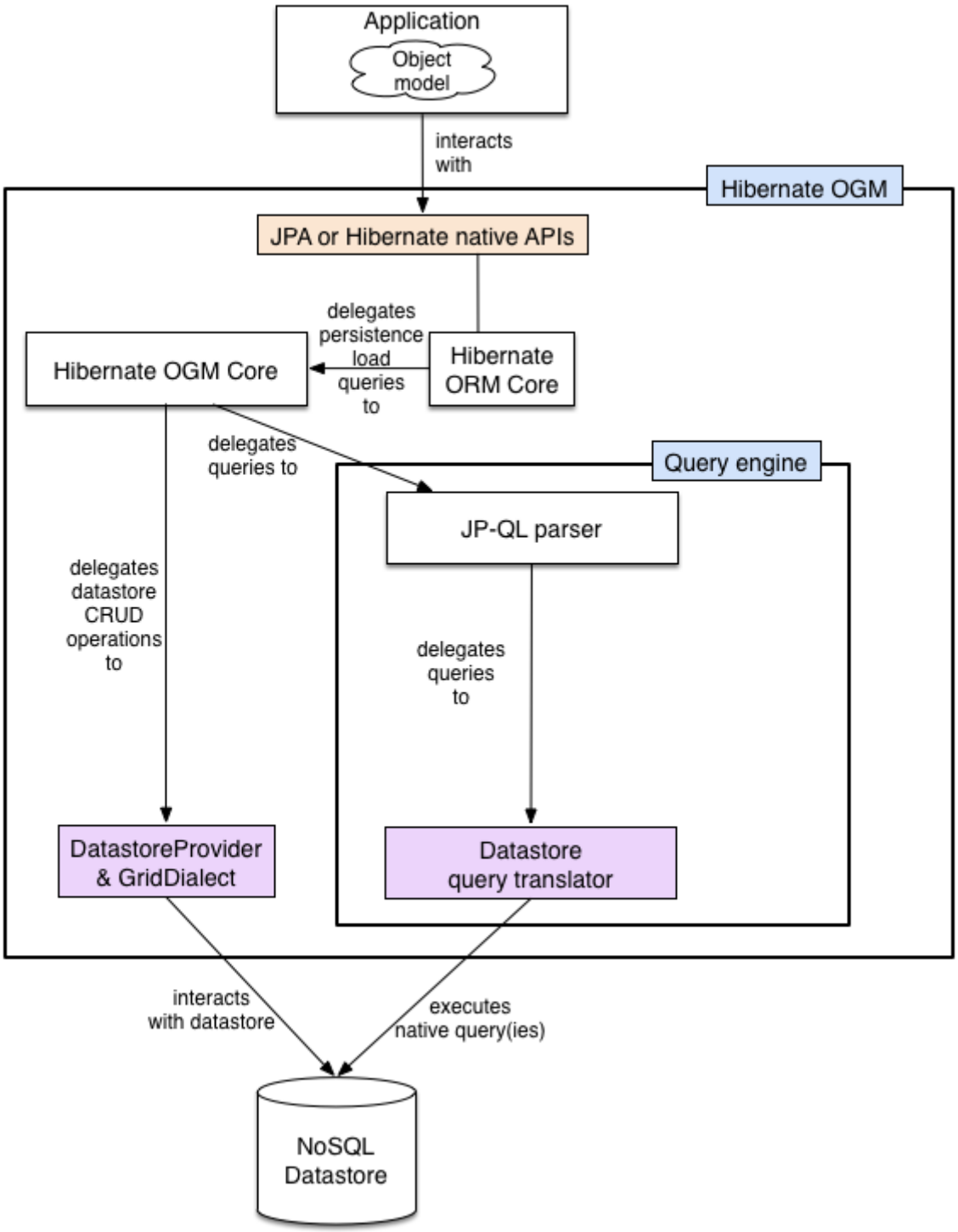


Figure 2. General architecture

Hibernate OGM reuses as much as possible from the Hibernate ORM infrastructure. There is no need to rewrite a new JPA engine. The `Persister`s and the `Loader`s (two interfaces used by Hibernate ORM) have been rewritten to persist data in the NoSQL store. These implementations are the core of Hibernate OGM. We will see in How is data persisted how the data is structured.

The particularities between NoSQL stores are abstracted by the notion of a `DatastoreProvider` and a `GridDialect`.

- `DatastoreProvider` abstracts how to start and maintain a connection between Hibernate OGM and the datastore.
- `GridDialect` abstracts how data itself including associations are persisted.

Think of them as the JDBC layer for our NoSQL stores.

Other than these, all the Create/Read/Update/Delete (CRUD) operations are implemented by the Hibernate ORM engine (object hydration and dehydration, cascading, lifecycle etc).

As of today, we have implemented the following datastore providers:

- a HashMap based datastore provider (for testing)
- an Infinispan Embedded datastore provider to persist your entities in an Infinispan instance running within the same JVM
- an Infinispan Remote datastore provider to persist your entities in Infinispan over a remote Hot Rod client
- an Ehcache based datastore provider to persist your entities in Ehcache
- a MongoDB based datastore provider to persist data in a MongoDB database
- a Neo4j based datastore provider to persist data in the Neo4j graph database
- a CouchDB based datastore provider to persist data in the CouchDB document store (experimental)
- a Cassandra based datastore provider to persist data in Apache Cassandra (experimental)
- a Redis based datastore provider to persist data in the Redis key/value store (experimental)

To implement JP-QL queries, Hibernate OGM parses the JP-QL string and calls the appropriate translator functions to build a native query. Since not all NoSQL technologies support querying, when lacking we can use Hibernate Search as an external query engine.

We will discuss the subject of querying in more details in How is data queried.

Hibernate OGM best works in a JTA environment. The easiest solution is to deploy it on a Java EE container. Alternatively, you can use a standalone JTA `TransactionManager`. We explain how to in In a standalone JTA environment.

Let's now see how and in which structure data is persisted in the NoSQL data store.

3.2. How is data persisted

Hibernate OGM tries to reuse as much as possible the relational model concepts, at least when they are practical and make sense in OGM's case. For very good reasons, the relational model brought peace in the database landscape over 30 years ago. In particular, Hibernate OGM

inherits the following traits:

- abstraction between the application object model and the persistent data model
- persist data as basic types
- keep the notion of primary key to address an entity
- keep the notion of foreign key to link two entities (not enforced)

If the application data model is too tightly coupled with your persistent data model, a few issues arise:

- any change in the application object hierarchy / composition must be reflected in the persistent data
- any change in the application object model will require a migration at the data level
- any access to the data by another application ties both applications losing flexibility
- any access to the data from another platform become somewhat more challenging
- serializing entities leads to many additional problems (see note below)

Why aren't entities serialized in the key/value entry

There are a couple of reasons why serializing the entity directly in the datastore - key/value in particular - can lead to problems:

- When entities are pointing to other entities are you storing the whole graph? Hint: this can be quite big!
- If doing so, how do you guarantee object identity or even consistency amongst duplicated objects? It might make sense to store the same object graph from different root objects.
- What happens in case of class schema change? If you add or remove a property or include a superclass, you must migrate all entities in your datastore to avoid deserialization issues.

Entities are stored as tuples of values by Hibernate OGM. More specifically, each entity is conceptually represented by a `Map<String,Object>` where the key represents the column name (often the property name but not always) and the value represents the column value as a basic type. We favor basic types over complex ones to increase portability (across platforms and across type / class schema evolution over time). For example a `URL` object is stored as its String representation.

The key identifying a given entity instance is composed of:

- the table name

- the primary key column name(s)
- the primary key column value(s)

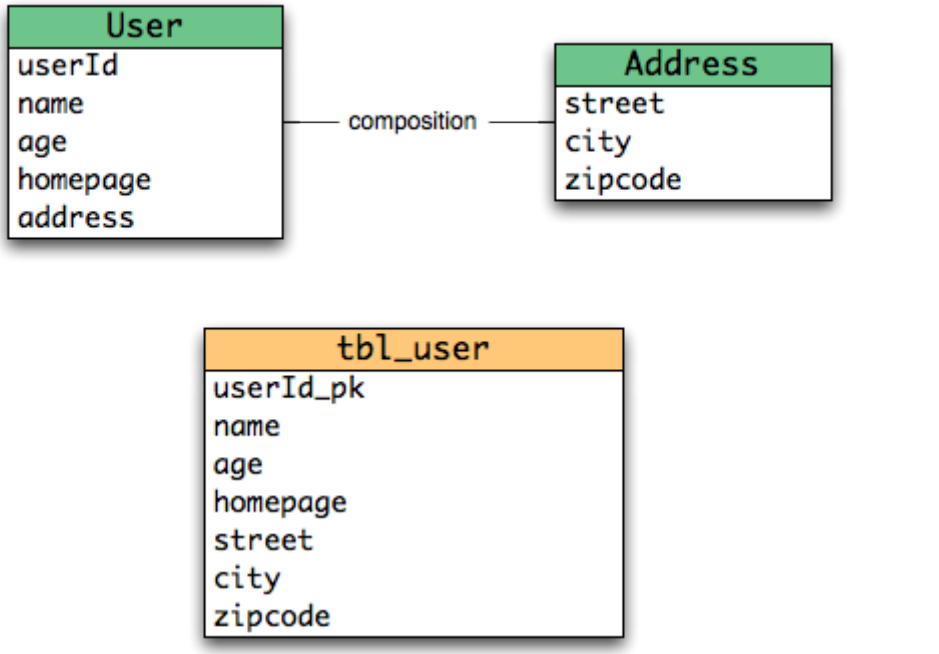


Figure 3. Storing entities

The `GridDialect` specific to the NoSQL datastore you target is then responsible to convert this map into the most natural model:

- for a key/value store or a data grid, we use the logical key as the key in the grid and we store the map as the value. Note that it's an approximation and some key/value providers will use more tailored approaches.
- for a document oriented store, the map is represented by a document and each entry in the map corresponds to a property in a document.

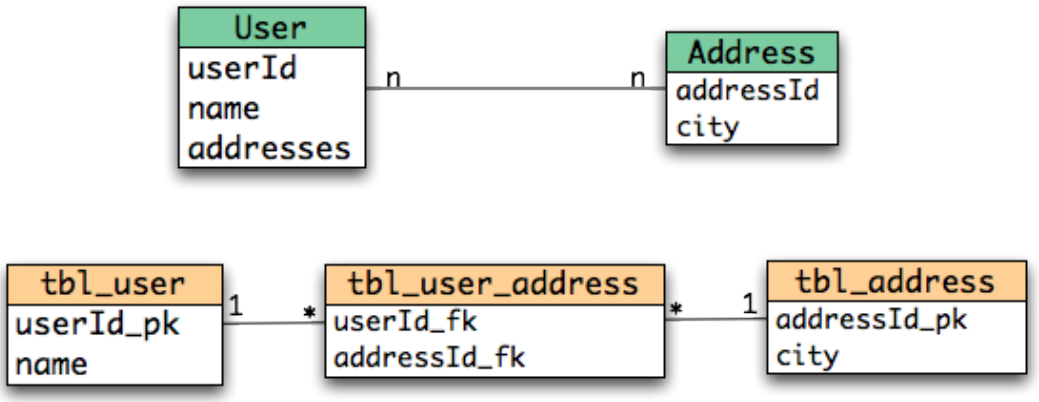
Associations are also stored as tuples. Hibernate OGM stores the information necessary to navigate from an entity to its associations. This is a departure from the pure relational model but it ensures that association data is reachable via key lookups based on the information contained in the entity tuple we want to navigate from. Note that this leads to some level of duplication as

information has to be stored for both sides of the association.

The key in which association data are stored is composed of:

- the table name
- the column name(s) representing the foreign key to the entity we come from
- the column value(s) representing the foreign key to the entity we come from

Using this approach, we favor fast read and (slightly) slower writes.



key	value
tbl_user,userId_pk,1	{userId_pk=1,name="Emmanuel"}
tbl_user,userId_pk,2	{userId_pk=2,name="Caroline"}
tbl_address,addressId_pk,3	{addressId_pk=3,city="Paris"}
tbl_address,addressId_pk,5	{addressId_pk=5,city="Atlanta"}
tbl_user_address,userId_fk,1	{ {userId_fk=1, addressId_fk=3}, {userId_fk=1, addressId_fk=5} }
tbl_user_address,userId_fk,2	{ {userId_fk=2, addressId_fk=3} }
tbl_user_address,addressId_fk,5	{ {userId_fk=1, addressId_fk=5} }
tbl_user_address,addressId_fk,3	{ {userId_fk=1, addressId_fk=3}, {userId_fk=2, addressId_fk=3} }

Figure 4. Storing associations

Note that this approach has benefits and drawbacks:

- it ensures that all CRUD operations are doable via key lookups
- it favors reads over writes (for associations)
- but it duplicates data

Again, there are specificities in how data is inherently stored in the specific NoSQL store. For example, in document oriented stores, the association information including the identifier to the associated entities can be stored in the entity owning the association. This is a more natural model for documents.

key	value
tbl_user,userId_pk,1	{userId_pk=1, name="Emmanuel", addresses=[3, 5]}
tbl_user,userId_pk,2	{userId_pk=2, name="Caroline", addresses=[3]}
tbl_address,addressId_pk,3	{addressId_pk=3, city="Paris", users=[1, 2]}
tbl_address,addressId_pk,5	{addressId_pk=5, city="Atlanta", users=[1]}

Figure 5. Storing associations in a document store

Some identifiers require to store a seed in the datastore (like sequences for examples). The seed is stored in the value whose key is composed of:

- the table name
- the column name representing the segment
- the column value representing the segment

This description is how conceptually Hibernate OGM asks the datastore provider to store data. Depending on the family and even the specific datastore, the storage is optimized to be as natural as possible. In other words as you would have stored the specific structure naturally. Make sure to check the chapter dedicated to the NoSQL store you target to find the specificities.

Many NoSQL stores have no notion of schema. Likewise, the tuple stored by Hibernate OGM is not tied to a particular schema: the tuple is represented by a `Map`, not a typed `Map` specific to a given entity type. Nevertheless, JPA does describe a schema thanks to:

- the class schema
- the JPA physical annotations like `@Table` and `@Column`.

While tied to the application, it offers some robustness and explicit understanding when the

schema is changed as the schema is right in front of the developers' eyes. This is an intermediary model between the strictly typed relational model and the totally schema-less approach pushed by some NoSQL families.

3.3. Id generation using sequences

You can use sequences with the following annotations:

- `@SequenceGenerator`: it will use native sequences if available
- `@TableGenerator`: it will emulate sequences storing the value in the most appropriate data structure; for example a document in MongoDB or a node in Neo4j.

Here's some things to keep in mind when dealing with sequence generation:

- `@TableGenerator` is the fallback approach used when the underlying datastore does not support native sequences generation.
- If the datastore does not support atomic operations and does not support native sequences, Hibernate OGM will throw an exception at bootstrap and suggest alternatives.
- The mapping of the sequence might change based on the annotation used, you should check the mapping paragraph in the documentation related to the dialect you are using.
- The value saved in the the datastore might not be the next value in the sequence.

3.4. How is data queried

Since Hibernate OGM wants to offer all of JPA, it needs to support JP-QL queries. Hibernate OGM parses the JP-QL query string and extracts its meaning. From there, several options are available depending of the capabilities of the NoSQL store you target:

- it directly delegates the native query generation to the datastore specific query translator implementation
- it uses Hibernate Search as a query engine to execute the query

If the NoSQL datastore has some query capabilities and if the JP-QL query is simple enough to be executed by the datastore, then the JP-QL parser directly pushes the query generation to the NoSQL specific query translator. The query returns the list of matching entity columns or projections and Hibernate OGM returns managed entities.

Some NoSQL stores have poor query support, or none at all. In this case Hibernate OGM can use Hibernate Search as its indexing and query engine. Hibernate Search is able to index and query objects - entities - and run full-text queries. It uses the well known Apache Lucene to do this but adds a few interesting characteristics like clustering support and an object oriented abstraction including an object oriented query DSL. Let's have a look at the architecture of Hibernate OGM

when using Hibernate Search:

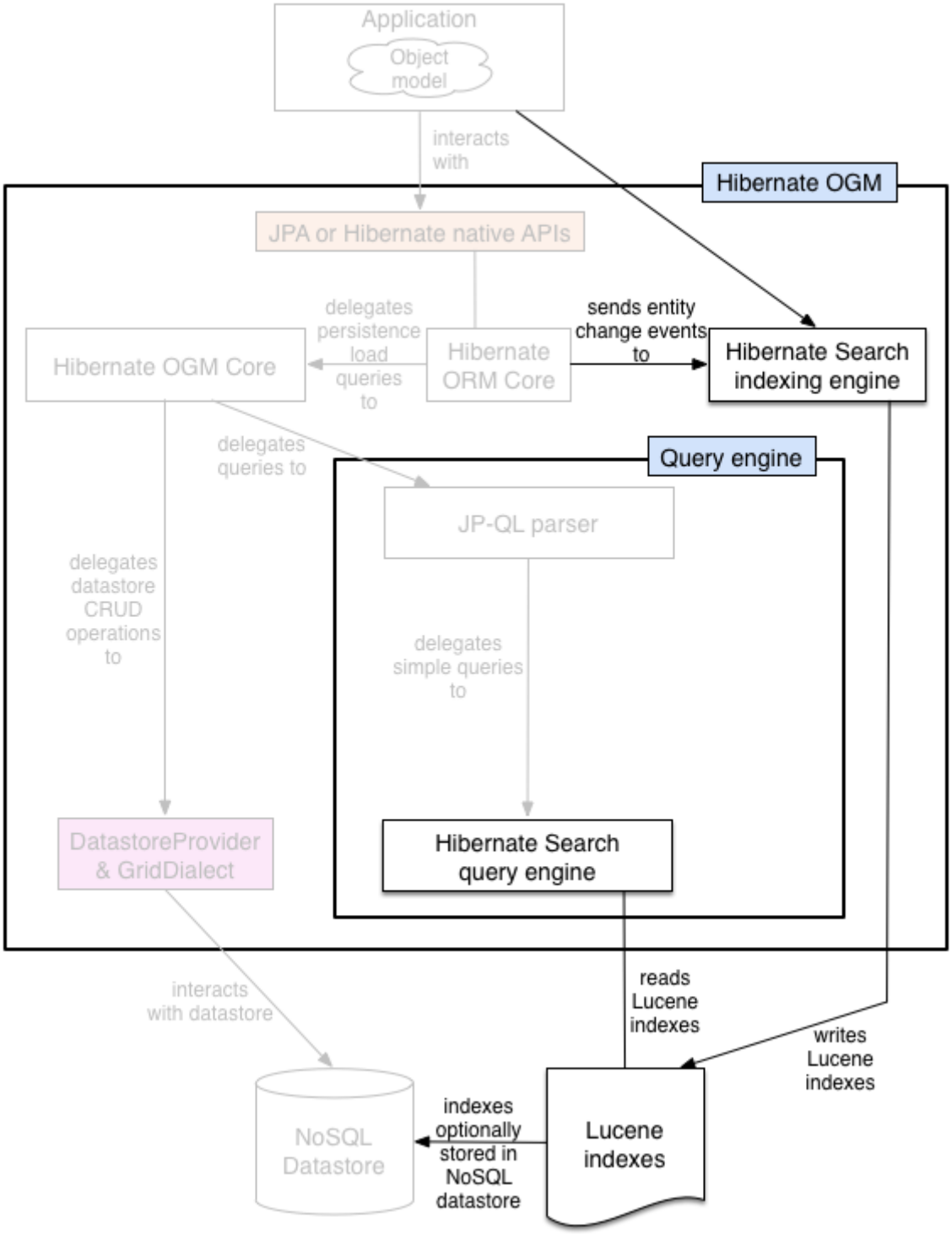


Figure 6. Using Hibernate Search as query engine - greyed areas are blocks already present in Hibernate OGM's architecture

In this situation, Hibernate ORM Core pushes change events to Hibernate Search which will index entities accordingly and keep the index and the datastore in sync. The JP-QL query parser delegates the query translation to the Hibernate Search query translator and executes the query on top of the Lucene indexes. Indexes can be stored in various fashions:

- on a file system (the default in Lucene)
- in Infinispan via the Infinispan Lucene directory implementation: the index is then distributed across several servers transparently
- in NoSQL stores that can natively store Lucene indexes
- in NoSQL stores that can be used as overflow to Infinispan: in this case Infinispan is used as an intermediary layer to serve the index efficiently but persists the index in another NoSQL store.

You can use Hibernate Search even if you do plan to use the NoSQL datastore query capabilities. Hibernate Search offers a few interesting options:

- clusterability
- full-text queries - ie Google for your entities
- geospatial queries
- query faceting (ie dynamic categorization of the query results by price, brand etc)

Chapter 4. Configure and start Hibernate OGM

Hibernate OGM favors ease of use and convention over configuration. This makes its configuration quite simple by default.

4.1. Bootstrapping Hibernate OGM

Hibernate OGM can be used via the Hibernate native APIs (`Session`) or via the JPA APIs (`EntityManager`). Depending on your choice, the bootstrapping strategy is slightly different.

4.1.1. Using JPA

If you use JPA as your primary API, the configuration is extremely simple. Hibernate OGM is seen as a persistence provider which you need to configure in your `persistence.xml`. That's it! The provider name is `org.hibernate.ogm.jpa.HibernateOgmPersistence`.

Example 1. persistence.xml file

```
<?xml version="1.0"?>
<persistence xmlns="http://java.sun.com/xml/ns/persistence"
             xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
             xsi:schemaLocation="http://java.sun.com/xml/ns/persistence
http://java.sun.com/xml/ns/persistence/persistence_2_0.xsd"
             version="2.0">

    <persistence-unit name="org.hibernate.ogm.tutorial.jpa" transaction-
type="JTA">
        <!-- Use Hibernate OGM provider: configuration will be
transparent -->
        <provider>
org.hibernate.ogm.jpa.HibernateOgmPersistence</provider>
        <properties>
            <property name="hibernate.transaction.jta.platform"
                      value="JBossTS" />
            <property name="hibernate.ogm.datastore.provider"
                      value="infinispan_embedded" />
        </properties>
    </persistence-unit>
</persistence>
```

There are a couple of things to notice:

- there is no JDBC dialect setting
- there is no JDBC setting except sometimes a `jta-data-source` (check In a Java EE

container for more info)

- most NoSQL databases do not require a schema, in which case schema generation options (`hbm2ddl`) do not apply
- if you use JTA (which we recommend), you will need to set the JTA platform

You also need to configure which NoSQL datastore you want to use and how to connect to it. We will detail how to do that later in NoSQL datastores.

In this case, we have used the default settings for Infinispan: this will start a local, in-memory Infinispan instance which is useful for testing but the stored data will be lost on shutdown. You might think of this configuration as similar to storing your data in an hashmap, but you could of course change the Infinispan configuration to enable clustering (for both scalability and failover) and to enable permanent persistence strategies.

From there, simply bootstrap JPA the way you are used to with Hibernate ORM:

- via `Persistence.createEntityManagerFactory`
- by injecting the `EntityManager` / `EntityManagerFactory` in a Java EE container
- by using your favorite injection framework (CDI - Weld, Spring, Guice)

Note that what you're starting is not an exotic new JPA implementation but is in all effects an instance of Hibernate ORM, although using some alternative internal components to deal with the NoSQL stores. This means that any framework and tool integrating with Hibernate ORM can integrate with Hibernate OGM - of course as long as it's not making assumptions such as that a JDBC datasource will be used.

4.1.2. Using Hibernate ORM native APIs

If you want to bootstrap Hibernate OGM using the native Hibernate APIs, use the new bootstrap API from Hibernate ORM 5. By setting `OgmProperties.ENABLED` to true, the Hibernate OGM components will be activated. Note that unwrapping into `OgmSessionFactoryBuilder` is not strictly needed, but it will allow you to set Hibernate OGM specific options in the future and also gives you a reference to `OgmSessionFactory` instead of `SessionFactory`.

Example 2. Bootstrap Hibernate OGM with Hibernate ORM native APIs

```
StandardServiceRegistry registry = new StandardServiceRegistryBuilder()
    .applySetting( OgmProperties.ENABLED, true )
    //assuming you are using JTA in a non container environment
    .applySetting( AvailableSettings.TRANSACTION_COORDINATOR_STRATEGY,
"jta" )
    //assuming JBoss TransactionManager in standalone mode
    .applySetting( AvailableSettings.JTA_PLATFORM, "JBossTS" )
    //assuming Infinispan as the backend, using the default settings
    .applySetting( OgmProperties.DATASTORE_PROVIDER, InfinispanEmbedded
.DATASTORE_PROVIDER_NAME );
    .build();

//build the SessionFactory
OgmSessionFactory sessionFactory = new MetadataSources( registry )
    .addAnnotatedClass( Order.class )
    .addAnnotatedClass( Item.class )
    .buildMetadata()
    .getSessionFactoryBuilder()
    .unwrap( OgmSessionFactoryBuilder.class )
    .build();
```

There are a couple of things to notice:

- there is no DDL schema generation options (`hbm2ddl`) as Infinispan does not require schemas when running in embedded mode
- you need to set the right transaction strategy and the right transaction manager lookup strategy if you use a JTA based transaction strategy (see Environments)

You also need to configure which NoSQL datastore you want to use and how to connect to it. We will detail how to do that later in NoSQL datastores. In this case, we have used the defaults settings for Infinispan.

4.2. Environments

Hibernate OGM runs in various environments: it should work pretty much in all environments in which Hibernate ORM runs. There are however some selected environments in which it was tested more thoroughly than others. The current version is being tested regularly in Java SE (without a container) and within the WildFly 10 application server; at time of writing this there's no known reason for it to not work in different containers as long as you remember that it requires a specific version of Hibernate ORM: some containers might package a conflicting version.

4.2.1. In a Java EE container

You don't have to do much in this case. You need three specific settings:

- the transaction coordinator type
- the JTA platform
- a JTA datasource

If you use JPA, simply set the `transaction-type` to `JTA` and the transaction factory will be set for you.

If you use Hibernate ORM native APIs only, then set `hibernate.transaction.coordinator_class` to "jta".

Set the JTA platform to the right Java EE container. The property is `hibernate.transaction.jta.platform` and must contain the fully qualified class name of the lookup implementation. The list of available values are listed in Hibernate ORM's configuration section. For example in WildFly 10 you would pick `JBossAS`, although in WildFly these settings are automatically injected so you could skip this.

In your `persistence.xml` you usually need to define an existing datasource. This is not needed by Hibernate OGM: it will ignore the datasource, but JPA specification mandates the setting.

Example 3. persistence.xml file

```
<?xml version="1.0"?>
<persistence xmlns="http://java.sun.com/xml/ns/persistence"
             xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
             xsi:schemaLocation="http://java.sun.com/xml/ns/persistence
http://java.sun.com/xml/ns/persistence/persistence_2_0.xsd"
             version="2.0">

    <persistence-unit name="org.hibernate.ogm.tutorial.jpa" transaction-
type="JTA">
        <!-- Use Hibernate OGM provider: configuration will be
transparent -->
        <provider>
org.hibernate.ogm.jpa.HibernateOgmPersistence</provider>
        <jta-data-source>java:/DefaultDS</jta-data-source>
        <properties>
            <property name="hibernate.transaction.jta.platform" value=
"JBossAS" />
            <property name="hibernate.ogm.datastore.provider" value=
"infinispan_embedded" />
        </properties>
    </persistence-unit>
</persistence>
```

`java:DefaultDS` will work for out of the box WildFly deployments.

4.2.2. In a standalone JTA environment

There is a set of common misconceptions in the Java community about JTA:

- JTA is hard to use
- JTA is only needed when you need transactions spanning several databases
- JTA works in Java EE only
- JTA is slower than "simple" transactions

None of these are true: let me show you how to use the Narayana Transactions Manager in a standalone environment with Hibernate OGM.

In Hibernate OGM, make sure to set the following properties:

- `transaction-type` to `JTA` in your persistence.xml if you use JPA
- or `hibernate.transaction.coordinator_class` to "jta" if you use `StandardServiceRegistryBuilder`/`OgmConfiguration` to bootstrap Hibernate OGM.
- `hibernate.transaction.jta.platform` to `JBossTS` in both cases.

Add the Narayana Transactions Manager to your classpath. If you use maven, it should look like this:

Example 4. Narayana Transactions Manager dependency declaration

```
<dependency>
    <groupId>org.jboss.narayana.jta</groupId>
    <artifactId>narayana-jta</artifactId>
    <version>5.4.0.Final</version>
</dependency>
```

The next step is you get access to the transaction manager. The easiest solution is to do as the following example:

```
TransactionManager transactionManager =
   com.arjuna.ats.jta.TransactionManager.transactionmanager();
```

Then use the standard JTA APIs to demarcate your transaction and you are done!

Example 5. Demarcate your transaction with standalone JTA

```
//note that you must start the transaction before creating the
EntityManager
//or else call entityManager.joinTransaction()
transactionManager.begin();

final EntityManager em = emf.createEntityManager();

Poem poem = new Poem();
poem.setName("L'albatros");
em.persist(poem);

transactionManager.commit();

em.clear();

transactionManager.begin();

poem = em.find(Poem.class, poem.getId());
assertThat(poem).isNotNull();
assertThat(poem.getName()).isEqualTo("L'albatros");
em.remove(poem );

transactionManager.commit();

em.close();
```

That was not too hard, was it? Note that application frameworks like the Spring Framework should be able to initialize the transaction manager and call it to demarcate transactions for you. Check their respective documentation.

4.2.3. Without JTA

While this approach works today, it does not ensure that operations are done transactionally and hence won't be able to rollback your work. This will change in the future but in the mean time, such an environment is not recommended.

For NoSQL datastores not supporting transactions, this is less of a concern.

4.3. Configuration options

The most important options when configuring Hibernate OGM are related to the datastore. They are explained in NoSQL datastores.

Otherwise, most options from Hibernate ORM and Hibernate Search are applicable when using Hibernate OGM. You can pass them as you are used to do either in your `persistence.xml` file, your `hibernate.cfg.xml` file or programmatically.

More interesting is a list of options that do *not* apply to Hibernate OGM and that should not be set:

- `hibernate.dialect`
- `hibernate.connection.*` and in particular `hibernate.connection.provider_class`
- `hibernate.show_sql` and `hibernate.format_sql`
- `hibernate.default_schema` and `hibernate.default_catalog`
- `hibernate.use_sql_comments`
- `hibernate.jdbc.*`
- `hibernate.hbm2ddl.auto` and `hibernate.hbm2ddl.import_file`

4.4. Configuring Hibernate Search

Hibernate Search integrates with Hibernate OGM just like it does with Hibernate ORM. The Hibernate Search version tested is 5.6.1.Final. Add the dependency to your project - the group id is `org.hibernate` and artifact id `hibernate-search-orm`.

Then configure where you want to store your indexes, map your entities with the relevant index annotations and you are good to go. For more information, simply check the Hibernate Search reference documentation.

In Storing a Lucene index in Infinispan we'll discuss how to store your Lucene indexes in Infinispan. This is useful even if you don't plan to use Infinispan as your primary data store.

Hibernate OGM requires Hibernate Search on the classpath only when you need to run JPQL or HQL queries with some datastores. This is because some datastores don't have a query language or we don't support it yet. In this situation you need to index the entities that you want to query and Hibernate OGM will convert the queries in Lucene queries. Check the paragraph related to the datastore of your choice to see if it requires Hibernate Search or not.

4.5. How to package Hibernate OGM applications for WildFly 10

Provided you're deploying on WildFly, there is an additional way to add the OGM dependencies to your application.

In WildFly, class loading is based on modules; this system defines explicit, non-transitive dependencies on other modules.

Modules allow to share the same artifacts across multiple applications, making deployments smaller and quicker, and also making it possible to deploy multiple different versions of any library.

More details about modules are described in Class Loading in WildFly.

When deploying a JPA application on WildFly, you should be aware that there are some additional useful configuration properties defined by the WildFly JPA subsystem. These are documented in WildFly JPA Reference Guide.

If you apply the following instructions you can create small and efficient deployments which do not include any dependency, as you can include your favourite version of Hibernate OGM directly to the collection of container provided libraries.

4.5.1. Packaging Hibernate OGM applications for WildFly 10

You can download the pre-packaged module ZIP for this version of Hibernate OGM from:

- Sourceforge
- The Maven Central repository

Hibernate OGM 5.1.0.Final requires Hibernate ORM 5.1.4.Final that is not included with WildFly 10.

For this reason, you also need the pre-packaged module ZIP for Hibernate ORM, you can download it from Maven Central

Unpack the archives into the `modules` folder of your WildFly 10 installation. The modules included are:

- *org.hibernate.ogm*, the core Hibernate OGM library.
- *org.hibernate.ogm.<%DATASTORE%>*, one module for each datastore, with *<%DATASTORE%>* being one of *infinispan*, *mongodb* etc.
- *org.hibernate.orm*, the Hibernate ORM libraries.
- Several shared dependencies such as *org.hibernate.hql:<%VERSION%>* (containing the query parser) and others

The module slot to use for Hibernate OGM 5.1.0.Final is `5.1` as the format of the slot name does not include the "micro" part of the project version.

To upgrade the Hibernate ORM version you will need to add the following property to your `persistence.xml`:

Example 6. Property to set a different Hibernate ORM version

```
<property name="jboss.as.jpa.providerModule" value="org.hibernate:5.1"/>
```

You will find more details in the Using latest Hibernate ORM within WildFly paragraph of the Hibernate ORM documentation.

If you are using Maven, you can download and set up your wildfly with the following snippet:

Example 7. Maven example to prepare a WildFly installation for integration tests

```
<plugin>
    <artifactId>maven-dependency-plugin</artifactId>
    <executions>
        <execution>
            <id>unpack</id>
            <phase>pre-integration-test</phase>
            <goals>
                <goal>unpack</goal>
            </goals>
            <configuration>
                <artifactItems>
                    <!-- Download and unpack WildFly -->
                    <artifactItem>
                        <groupId>org.wildfly</groupId>
                        <artifactId>wildfly-dist</artifactId>
                        <version>10.1.0.Final</version>
                        <type>zip</type>
                        <overWrite>false</overWrite>
                        <outputDirectory>
${project.build.directory}</outputDirectory>
                    </artifactItem>

                    <!-- Download and unpack Hibernate ORM modules -->
                    <artifactItem>
                        <groupId>org.hibernate</groupId>
                        <artifactId>hibernate-orm-modules</artifactId>
                        <version>5.1.4.Final</version>
                        <classifier>wildfly-10-dist</classifier>
                        <type>zip</type>
                        <overWrite>false</overWrite>
                        <outputDirectory>
                            ${project.build.directory}/wildfly-
10.1.0.Final/modules
                        </outputDirectory>
                    </artifactItem>

                    <!-- Download and unpack Hibernate OGM modules -->
                    <artifactItem>
                        <groupId>org.hibernate.ogm</groupId>
                        <artifactId>hibernate-ogm-modules</artifactId>
                        <classifier>wildfly-10-dist</classifier>
                        <version>5.1.0.Final</version>
                        <type>zip</type>
                        <overWrite>false</overWrite>
                        <outputDirectory>
                            ${project.build.directory}/wildfly-
10.1.0.Final/modules
                        </outputDirectory>
                    </artifactItem>
                </artifactItems>
            </configuration>
        </execution>
    </executions>
</plugin>
```

There are two ways to include the dependencies in your project:

Using the manifest

Add this entry to the MANIFEST.MF in your archive (replace *<%DATASTORE%>* with the right value for your chosen datastore):

```
Dependencies: org.hibernate.ogm:5.1 services,
org.hibernate.ogm.<%DATASTORE%>:5.1 services
```

Using jboss-deployment-structure.xml

This is a JBoss-specific descriptor. Add a `WEB-INF/jboss-deployment-structure.xml` in your archive with the following content (replace *<%DATASTORE%>* with the right value for your chosen datastore):

```
<jboss-deployment-structure>
    <deployment>
        <dependencies>
            <module name="org.hibernate.ogm" slot="5.1" services="export" />
            <module name="org.hibernate.ogm.<%DATASTORE%>" slot="5.1"
services="export" />
        </dependencies>
    </deployment>
</jboss-deployment-structure>
```

More information about the descriptor can be found in the WildFly documentation.

4.5.2. Configure your persistence.xml to use your choice of persistence provider

WildFly will by default attempt to guess which Persistence Provider you need by having a look at the `provider` section of the `persistence.xml`.

4.5.3. Enabling both the Hibernate Search and Hibernate OGM modules

A compatible Hibernate Search module is included in WildFly 10, and Hibernate Search is activated automatically if you're indexing any entity.

When using WildFly several of the technologies it includes are automatically enabled. For example Hibernate ORM is made available to your applications if your `persistence.xml` defines a persistence unit using Hibernate as persistence provider (or is not specifying any provider, as Hibernate is the default one).

Similarly, Hibernate Search is automatically activated and made available on the user's application classpath if and when the application server detects the need for it. This is the default behaviour, but you are in control and can override this all; see the WildFly JPA Reference

Guide for a full list of properties you can explicitly set. Among these you fill find properties to control and override which modules are activated.

Hibernate OGM however is currently not included in WildFly, so you have to enable it explicitly.

Optionally you could download a different version of the Hibernate Search modules, provided it is compatible with the Hibernate OGM version you plan to use. For example you might want to download a more recent micro version of what is included in WildFly 10 at the time of publishing this documentation.

The Hibernate Search documentation explains the details of downloading and deploying a custom version: Update and activate latest Hibernate Search version in WildFly.

This approach might require you to make changes to the XML definitions of the Hibernate OGM modules to change the references to the Hibernate Search slot to the slot version that you plan to use.

4.5.4. Using the Hibernate OGM modules with Infinispan

The Infinispan project also provides custom modules for WildFly 10. Hibernate OGM modules require these modules if you're planning to use the Hibernate OGM / Infinispan combination on WildFly.

This release of Hibernate OGM was tested exclusively with Infinispan version 8.2.5.Final; the Infinispan project generally attempts to maintain the same API and integration points within the same major.minor version, so a micro version update should be safe but is untested.

In case you want to experiment with a more significant version upgrade, you will need to edit the modules of Hibernate OGM: the module identifiers are hardcoded in the XML files representing the module.

Download the Infinispan modules pack for WildFly 10 from here:

- Infinispan WildFly modules version 8.2.5.Final from the Maven repository

Then similarly to what you did with the Hibernate OGM modules zip, unpack this one too in your `modules` directory within the application server.

Chapter 5. Map your entities

This section mainly describes the specificities of Hibernate OGM mappings. It's not meant to be a comprehensive guide to entity mappings, the complete guide is Hibernate ORM's documentation: after all Hibernate OGM *is* Hibernate ORM.

5.1. Supported entity mapping

Pretty much all entity related constructs should work out of the box in Hibernate OGM. `@Entity`, `@Table`, `@Column`, `@Enumerated`, `@Temporal`, `@Cacheable` and the like will work as expected. If you want an example, check out Getting started with Hibernate OGM or the documentation of Hibernate ORM. Let's concentrate of the features that differ or are simply not supported by Hibernate OGM.

Hibernate OGM supports the following inheritance strategies: * `InheritanceType.TABLE_PER_CLASS` * `InheritanceType.SINGLE_TABLE`

If you feel the need to support other strategies, let us know (see How to contribute).

JPA annotations refer to tables but the kind of abstraction the database will use depends on the nature of the NoSQL datastore you are dealing with. For example, in MongoDB a table is mapped as a document.

You can find more details about the way entities are stored in the corresponding mapping section of the datastore you are using.

Secondary tables are not supported by Hibernate OGM at the moment. If you have needs for this feature, let us know (see How to contribute).

Queries are partially supported, you will find more information in the query chapter.

All standard JPA id generators are supported: IDENTITY, SEQUENCE, TABLE and AUTO. If you need support for additional generators, let us know (see How to contribute).

Some NoSQL databases can not provide an efficient implementation for IDENTITY or SEQUENCE, for these cases we recommend you use a UUID based generator. For example on Infinispan (in embedded mode) using IDENTITY is possible but it will require using cluster wide coordination to maintain the counters, which is not going to perform very well.

```
@Entity
public class Breed {

    @Id @GeneratedValue(generator = "uuid")
    @GenericGenerator(name="uuid", strategy="uuid2")
    public String getId() { return id; }
    public void setId(String id) { this.id = id; }
    private String id;

    public String getName() { return name; }
    public void setName(String name) { this.name = name; }
    private String name;
}
```

5.2. Supported Types

Most Java built-in types are supported at this stage. However, custom types (`@Type`) are not supported.

Here is a list of supported Java types:

- Boolean
- Byte
- Byte Array
- Calendar
- Class
- Date
- Double
- Integer
- Long
- Short
- Float
- Character
- String

- BigDecimal (mapped as scientific notation)
- BigInteger
- Url (as described by RFC 1738 and returned by toString of the Java URL type)
- UUID stored as described by RFC 4122
- Enums

Let us know if you need more type support How to contribute

5.3. Supported association mapping

All association types are supported (`@OneToOne`, `@OneToMany`, `@ManyToOne`, `@ManyToMany`). Likewise, all collection types are supported (`Set`, `Map`, `List`). The way Hibernate OGM stores association information is however quite different than the traditional RDBMS representation. Each chapter dedicated to a datastore describes how associations are persisted, make sure to check them out.

Not all types of associations can be mapped efficiently on all datastores: this will depend on the specific capabilities of the NoSQL technology being used. For example the key/value stores will have all of the association navigation for a given entity stored in a single key. If your collection is made of 1 million elements, Hibernate OGM will have to store 1 million tuples in the association key. For example the Infinispan Embedded dialect suffers from this limitation as it's treated as a pure key/value store, while the Infinispan Remote dialect does not as it is more similar to a document store.

Chapter 6. Hibernate OGM APIs

Hibernate OGM has very few specific APIs. For the most part, you will interact with it via either:

- the JPA APIs
- the native Hibernate ORM APIs

This chapter will only discuss the Hibernate OGM specific behaviors regarding these APIs. If you need to learn JPA or the native Hibernate APIs, check out the Hibernate ORM documentation.

6.1. Bootstrap Hibernate OGM

We already discussed this subject earlier, have a look at Configure and start Hibernate OGM for all the details.

As a reminder, it basically boils down to either:

- set the right persistence provider in your `persistence.xml` file and create an `EntityManagerFactory` the usual way
- start via the Hibernate ORM native APIs using `StandardServiceRegistryBuilder` and `MetadataSources` to boot a `SessionFactory`

6.2. JPA and native Hibernate ORM APIs

You know of the Java Persistence and Hibernate ORM native APIs? You are pretty much good to go. If you need a refresher, make sure you read the Hibernate ORM documentation.

A few things are a bit different though, let's discuss them.

Most of the `EntityManager` and `Session` contracts are supported. Here are the few exceptions:

- `Session.createCriteria`: criteria queries are not yet supported in Hibernate OGM
- `Session.createFilter`: queries on collections are not supported yet
- `Session` 's `enableFilter`, `disableFilter` etc: query filters are not supported at the moment
- `doWork` and `doReturningWork` are not implemented as they rely on JDBC connections - see OGM-694
- `Session` 's stored procedure APIs are not supported
- `Session` 's natural id APIs are not yet supported

- `Session.lock` is not fully supported at this time
- `EntityManager` 's criteria query APIs are not supported
- `EntityManager` 's stored procedure APIs are not supported - see OGM-695
- `EntityManager.lock` is not fully supported at this time
- see Query your entities to know what is supported for JP-QL and native queries

6.2.1. Accessing the `OgmSession` API

To execute NoSQL native queries, one approach is to use `OgmSession#createNativeQuery`. You can read more about it in Using the native query language of your NoSQL. But let's see how to access an `OgmSession` instance.

From JPA, use the `unwrap` method of `EntityManager`

Example 8. Get to an `OgmSession` from an `EntityManager`

```
EntityManager entityManager = ...
OgmSession ogmSession = entityManager.unwrap(OgmSession.class);
NoSQLQuery query = ogmSession.createNativeQuery(...);
```

In the Hibernate native API case, you should already have access to an `OgmSession`. The `OgmConfiguration` you used returns an `OgmSessionFactory`. This factory in turns produces `OgmSession`.

Example 9. Get to an `OgmSession` with Hibernate ORM native APIs

```
StandardServiceRegistry registry = new StandardServiceRegistryBuilder()
    .applySetting( OgmProperties.ENABLED, true )
    .build();

OgmSessionFactory ogmSessionFactory = new MetadataSources( registry )
    .buildMetadata()
    .getSessionFactoryBuilder()
    .unwrap( OgmSessionFactoryBuilder.class )
    .build();
OgmSession ogmSession = ogmSessionFactory.openSession();
NoSQLQuery query = ogmSession.createNativeQuery(...);
```

6.3. On flush and transactions

Even though some underlying NoSQL datastores do not support transaction, it is important to demarcate transaction via the Hibernate OGM APIs. Let's see why.

Hibernate does pile up changes for as long as it can before pushing them down to the datastore. This opens up the doors to huge optimizations (avoiding duplication, batching operations etc). You can force changes to be sent to the datastore by calling `Session.flush` or `EntityManager.flush`. In some situations - for example before some queries are executed -, Hibernate will flush automatically. It will also flush when the transaction demarcation happens (whether there is a real transaction or not).

The best approach is to always demarcate the transaction as shown below. This avoids the needs to manually call flush and will offer future opportunities for Hibernate OGM.

Example 10. Explicitly demarcating transactions

Here is how you do outside of a JTA environment.

```
Session session = ...

Transaction transaction = session.beginTransaction();
try {
    // do your work
    transaction.commit(); // will flush changes to the datastore
catch (Exception e) {
    transaction.rollback();
}

// or in JPA
EntityManager entityManager = ...
EntityTransaction transaction = entityManager.getTransaction();
try {
    // do your work
    transaction.commit(); // will flush changes to the datastore
}
catch (Exception e) {
    transaction.rollback();
}
```

Inside a JTA environment, either the container demarcates the transaction for you and Hibernate OGM will transparently join that transaction and flush at commit time. Or you need to manually demarcate the transaction. In the latter case, it is best to start / stop the transaction before retrieving the `Session` or `EntityManager` as shown below. The alternative is to call the `EntityManager.joinTransaction()` once the transaction has started.

```
transactionManager.begin();
Session session = sessionFactory.openSession();
// do your work
transactionManager.commit(); // will flush changes to the datastore

// or in JPA
transactionManager.begin();
EntityManager entityManager = entityManagerFactory.createEntityManager();
// do your work
transactionManager.commit(); // will flush changes to the datastore
```

6.3.1. Acting upon errors during application of changes

The error compensation API described in the following section is an experimental feature. It will be enriched with additional features over time. This might require changes to existing method signatures and thus may break code using a previous version of the API.

Please let us know about your usage of the API and your wishes regarding futher capabilities!

If an error occurs during flushing a set of changes, some data changes may already have been applied in the datastore. If the store is non-transactional, there is no way to rollback (undo) these changes if they were already flushed. In this case it is desirable to know which changes have been applied and which ones failed in order to take appropriate action.

Hibernate OGM provides an error compensation API for this purpose. By implementing the `org.hibernate.ogm.failure.ErrorHandler` interface, you will be notified if

- an interaction between the Hibernate OGM engine and the grid dialect failed
- a rollback of the current transaction was triggered

Use cases for the error compensation API include:

- Logging all applied operations
- Retrying a failed operation e.g. after timeouts
- Making an attempt to compensate (apply an inverse operation) applied changes

In its current form the API lays the ground for manually performing these and similar tasks, but we envision a more automated approach in future versions, e.g. for automatic retries of failed operations or the automatic application of compensating operations.

Let's take a look at an example:

Example 11. Custom `ErrorHandler` implementation

```
public class ExampleErrorHandler extends BaseErrorHandler {

    @Override
    public void onRollback(RollbackContext context) {
        // write all applied operations to a log file
        for ( GridDialectOperation appliedOperation : context
.getAppliedGridDialectOperations() ) {
            switch ( appliedOperation.getType() ) {
                case INSERT_TUPLE:
                    EntityKeyMetadata entityKeyMetadata =
appliedOperation.as( InsertTuple.class ).getEntityKeyMetadata();
                    Tuple tuple = appliedOperation.as( InsertTuple.class
).getTuple();

                    // write EKM and tuple to log file...
                    break;
                case REMOVE_TUPLE:
                    // ...
                    break;
                case ...
                    // ...
                    break;
            }
        }
    }

    @Override
    public ErrorHandlingStrategy onFailedGridDialectOperation
(FailedGridDialectOperationContext context) {
        // Ignore this exception and continue
        if ( context.getException() instanceof
TupleAlreadyExistsException ) {
            GridDialectOperation failedOperation = context
.getFailedOperation();
            // write to log ...

            return ErrorHandlingStrategy.CONTINUE;
        }
        // But abort on all others
        else {
            return ErrorHandlingStrategy.ABORT;
        }
    }
}
```

The `onRollback()` method - which is called when the transaction is rolled back (either by the user or by the container) - shows how to iterate over all methods applied prior to the rollback, examine their specific type and e.g. write them to a log file.

The `onFailedGridDialectOperation()` method is called for each specific datastore operation failing. It lets you decide whether to continue ignoring the failure, retry or abort the operation. If `ABORT` is returned, the causing exception will be re-thrown, eventually causing the

current transaction to be rolled back. If `CONTINUE` is returned, that exception will be ignored, causing the current transaction to continue.

The decision whether to abort or continue can be based on the specific exception type or on the grid dialect operation which caused the failure. In the example all exceptions of type `TupleAlreadyExistsException` are ignored, whereas all other exceptions cause the current flush cycle to be aborted. You also could react to datastore-specific exceptions such as MongoDB's `MongoTimeoutException`, if needed.

Note that by extending the provided base class `BaseErrorHandler` rather than implementing the interface directly, you only need to implement those callback methods you are actually interested in. The implementation will also not break if further callback methods are added to the `ErrorHandler` interface in future releases.

Having implemented the error handler, it needs to be registered with Hibernate OGM. To do so, specify it using the property `hibernate.ogm.error_handler`, e.g. as a persistence unit property in `META-INF/persistence.xml`:

```
<property name="hibernate.ogm.error_handler" value=
"com.example.ExampleErrorHandler"/>
```

6.4. SPIs

Some of the Hibernate OGM public contracts are geared towards either integrators or implementors of datastore providers. They should not be used by a regular application. These contracts are named SPIs and are in a `.spi` package.

To keep improving Hibernate OGM, we might break these SPIs between versions. If you plan on writing a datastore, come and talk to us.

Non public contracts are stored within a `.impl` package. If you see yourself using one of these classes, beware that we can break these without notice.

Chapter 7. Query your entities

Once your data is in the datastore, it's time for some query fun! With Hibernate OGM, you have a few alternatives that should get you covered:

- Use JP-QL - only for simple queries for now
- Use the NoSQL native query mapping the result as managed entities
- Use Hibernate Search queries - primarily full-text queries

7.1. Using JP-QL

For Hibernate OGM, we developed a brand new JP-QL parser which is already able to convert simple queries into the native underlying datastore query language (e.g. MongoQL for MongoDB, CypherQL for Neo4J, etc). This parser can also generate Hibernate Search queries for datastores that do not support a query language.

For datastores like Infinispan that require Hibernate Search to execute JP-QL queries, the following preconditions must be met:

- no join, aggregation, or other relational operations are implied
- the entity involved in the query must be indexed
- the properties involved in the predicates must be indexed

Here is an example:

```
@Entity @Indexed
public class Hypothesis {

    @Id
    public String getId() { return id; }
    public void setId(String id) { this.id = id; }
    private String id;

    @Field(analyze=Analyze.NO)
    public String getDescription() { return description; }
    public void setDescription(String description) { this
.description = description; }
    private String description;
}

Query query = session
    .createQuery("from Hypothesis h where h.description =
:desc")
    .setString("desc", "tomorrow it's going to rain");
```

Note that the `description` field is marked as not analysed. This is necessary to support field equality and comparison as defined by JP-QL.

You can make use of the following JP-QL constructs:

- simple comparisons using "<", "<=", "=", ">=" and ">"
- `IS NULL` and `IS NOT NULL`
- the boolean operators `AND`, `OR`, `NOT`
- `LIKE`, `IN` and `BETWEEN`
- `ORDER BY`

In particular and of notice, what is not supported is:

- cross entity joins
- JP-QL functions in particular aggregation functions like `count`
- JP-QL update and delete queries

That may sound rather limiting for your use cases so bear with us. This is a hot area we want to improve, please tell us what feature you miss by opening a JIRA or via email. Also read the next section, you will see other alternatives to implement your queries.

Let's look at some of the queries you can express in JP-QL:

Example 12. Some JP-QL queries

```
// query returning an entity based on a simple predicate
select h from Hypothesis h where id = 16

// projection of the entity property
select id, description from Hypothesis h where id = 16

// projection of the embedded properties
select h.author.address.street from Hypothesis h where h.id = 16

// predicate comparing a property value and a literal
from Hypothesis h where h.position = '2'

// negation
from Hypothesis h where not h.id = '13'
from Hypothesis h where h.position <> 4

// conjunction
from Hypothesis h where h.position = 2 and not h.id = '13'

// named parameters
from Hypothesis h where h.description = :myParam

// range query
from Hypothesis h where h.description BETWEEN :start and :end"

// comparisons
from Hypothesis h where h.position < 3

// in
from Hypothesis h where h.position IN (2, 3, 4)

// like
from Hypothesis h where h.description LIKE '%dimensions%'

// comparison with null
from Hypothesis h where h.description IS null

// order by
from Hypothesis h where h.description IS NOT null ORDER BY id
from Helicopter h order by h.make desc, h.name
```

There are also features that are partially supported:

- Inner `JOIN` on an embedded association: works as expected with Neo4j and MongoDB; doesn't work if your datastore provider implements JP-QL queries using Hibernate Search.

- Projections or filters on properties of an embedded identifier: works as expected with Neo4j and MongoDB; doesn't work if your datastore provider implements JP-QL queries using Hibernate Search.

These are better illustrated by the following example:

Example 13. Entity with embedded collection and supported JP-QL queries

```
@Indexed
@Entity
public class StoryGame {

    @DocumentId
    @EmbeddedId
    @FieldBridge(impl = NewsIdFieldBridge.class)
    private StoryID storyId;

    @ElementCollection
    @IndexedEmbedded
    private List<OptionalStoryBranch> optionalEndings;

    ...

}

@Embeddable
public class StoryID implements Serializable {

    private String title;
    private String author;

    ...
}

@Embeddable
public class OptionalStoryBranch {

    // Analyze.NO for filtering in query
    // Store.YES for projection in query
    @Field(store = Store.YES, analyze = Analyze.NO)
    private String text;

    ...

}
```

Filter the results using the supported operators will work for all the datastores:

```
String query =
    "SELECT sg" +
    "FROM StoryGame sg JOIN sg.optionalEndings ending WHERE ending.text =
'Happy ending'"
List<StoryGame> stories = session.createQuery( query ).list();
```

Projection of properties of an embedded association works with Neo4j and MongoDB, but the other datastores will only return one element from the association. This is due to the fact that Hibernate Search is currently not supporting projection of associations. Here's an example of a query affected by this:

```
String query =
     "SELECT ending.text " +
     "FROM StoryGame sg JOIN sg.optionalEndings ending WHERE ending.text
LIKE 'Happy%'";
List<String> endings = session.createQuery( query ).list();
```

Projecting and filtering on embedded id properties works with Neo4j and MongoDB but throws an exception with the other datastores:

```
String query =
     "SELECT sg.storyId.title FROM StoryGame sg WHERE sg.storyId.title =
'Best Story Ever'";
List<String> title = session.createQuery( query ).list();
```

It will cause the following exception if the datastore uses Hibernate Search to execute JP-QL queries:

```
org.hibernate.hql.ParsingException: HQL100002: The type [storyId] has no
indexed property named title.
```

In order to reflect changes performed in the current session, all entities affected by a given query are flushed to the datastore prior to query execution (that's the case for Hibernate ORM as well as Hibernate OGM).

For not fully transactional stores, this can cause changes to be written as a side-effect of running queries which cannot be reverted by a possible later rollback.

Depending on your specific use cases and requirements you may prefer to disable auto-flushing, e.g. by invoking `query.setFlushMode(FlushMode.MANUAL)`. Bear in mind though that query results will then not reflect changes applied within the current session.

7.2. Using the native query language of your NoSQL

Often you want the raw power of the underlying NoSQL query engine. Even if that costs you portability.

Hibernate OGM addresses that problem by letting you express native queries (e.g. in MongoQL or CypherQL) and map the result of these queries as mapped entities.

In JPA, use `EntityManager.createNativeQuery`. The first form accepts a result class if your result set maps the mapping definition of the entity. The second form accepts the name of a resultSetMapping and lets you customize how properties are mapped to columns by the query. You can also used a predefined named query which defines its result set mapping.

Let's take a look at how it is done for Neo4J:

Example 14. Various ways to create a native query in JPA

```
@Entity
@NamedNativeQuery(
   name = "AthanasiaPoem",
   query = "{ $and: [ { name : 'Athanasia' }, { author : 'Oscar Wilde' }
] }",
   resultClass = Poem.class )
public class Poem {

    @Id
    private Long id;

    private String name;

    private String author;

   // getters, setters ...

}

...

javax.persistence.EntityManager em = ...

// a single result query
String query1 = "MATCH ( n:Poem { name:'Portia', author:'Oscar Wilde' } )
RETURN n";
Poem poem = (Poem) em.createNativeQuery( query1, Poem.class )
.getSingleResult();

// query with order by
String query2 = "MATCH ( n:Poem { name:'Portia', author:'Oscar Wilde' } )
" +
                "RETURN n ORDER BY n.name";
List<Poem> poems = em.createNativeQuery( query2, Poem.class )
.getResultList();

// query with projections
String query3 = MATCH ( n:Poem ) RETURN n.name, n.author ORDER BY n.name
";
List<Object[]> poemNames = (List<Object[]>)em.createNativeQuery( query3 )
                                .getResultList();

// named query
Poem poem = (Poem) em.createNamedQuery( "AthanasiaPoem"
).getSingleResult();
```

In the native Hibernate API, use `OgmSession.createNativeQuery` or `Session.getNamedQuery`. The former form lets you define the result set mapping programmatically. The latter is receiving the name of a predefined query already describing its result set mapping.

Example 15. Hibernate API defining a result set mapping

```
OgmSession session = ...
String query1 = "{ $and: [ { name : 'Portia' }, { author : 'Oscar Wilde'
} ] }";
Poem poem = session.createNativeQuery( query1 )
                       .addEntity( "Poem", Poem.class )
                       .uniqueResult();
```

Check out each individual datastore chapter for more info on the specifics of the native query language mapping. In particular Neo4J and MongoDB.

7.3. Using Hibernate Search

Hibernate Search offers a way to index Java objects into Lucene indexes and to execute full-text queries on them. The indexes do live outside your datastore. This offers a few interesting properties in terms of feature set and scalability.

Apache Lucene is a full-text indexing and query engine with excellent query performance. Feature wise, *full-text* means you can do much more than a simple equality match.

Hibernate Search natively integrates with Hibernate ORM. And Hibernate OGM of course!

Example 16. Adding Hibernate Search artifact to your project via Maven

```
<dependency>
    <groupId>org.hibernate</groupId>
    <artifactId>hibernate-search-orm</artifactId>
</dependency>
```

Example 17. Using Hibernate Search for full-text matching

```
@Entity @Indexed
public class Hypothesis {

    @Id
    public String getId() { return id; }
    public void setId(String id) { this.id = id; }
    private String id;

    @Field(analyze=Analyze.YES)
    public String getDescription() { return description; }
    public void setDescription(String description) { this.description =
description; }
    private String description;
}
```

```
EntityManager entityManager = ...
//Add full-text superpowers to any EntityManager:
FullTextEntityManager ftem = Search.getFullTextEntityManager
(entityManager);

//Optionally use the QueryBuilder to simplify Query definition:
QueryBuilder b = ftem.getSearchFactory()
   .buildQueryBuilder()
   .forEntity(Hypothesis.class)
   .get();

//Create a Lucene Query:
Query lq = b.keyword().onField("description").matching("tomorrow")
.createQuery();

//Transform the Lucene Query in a JPA Query:
FullTextQuery ftQuery = ftem.createFullTextQuery(lq, Hypothesis.class);

//List all matching Hypothesis:
List<Hypothesis> resultList = ftQuery.getResultList();
```

Assuming our database contains an `Hypothesis` instance having description "Sometimes tomorrow we release", that instance will be returned by our full-text query.

Text similarity can be very powerful as it can be configured for specific languages or domain specific terminology; it can deal with typos and synonyms, and above all it can return results by *relevance*.

Worth noting the Lucene index is a vectorial space of term occurrence statistics: so extracting tags from text, frequencies of strings and correlate this data makes it very easy to build efficient data analysis applications.

While the potential of Lucene queries is very high, it's not suited for all use cases Let's see some of the limitations of Lucene Queries as our main query engine:

- Lucene doesn't support Joins. Any `to-One` relations can be mapped fine, and the Lucene community is making progress on other forms, but restrictions on `OneToMany` or `ManyToMany` can't be implemented today.
- Since we apply changes to the index at commit time, your updates won't affect queries until you commit (we might improve on this).
- While queries are extremely fast, write operations are not as fast (but we can make it scale).

For a complete understanding of what Hibernate Search can do for you and how to use it, go check the Hibernate Search reference documentation.

7.4. Using the Criteria API

At this time, we have not implemented support for the Criteria APIs (neither Hibernate native nor JPA).

Chapter 8. NoSQL datastores

Currently Hibernate OGM supports the following NoSQL datastores:

- Map: stores data in an in-memory Java map to store data. Use it only for unit tests.
- Infinispan Embedded: stores data into Infinispan (data grid) participating directly in the cluster
- Infinispan Remote: (also called Hot Rod, the name of the Infinispan client) stores data into Infinispan by connecting as an Hot Rod client
    - at this stage, this datastore is experimental
- Ehcache: stores data into Ehcache (cache)
- MongoDB: stores data into MongoDB (document store)
- Neo4j: stores data into Neo4j (graph database)
- CouchDB: stores data into CouchDB (document store)
    - at this stage, this datastore is experimental
- Redis: stores data into Redis (key-value store)
    - at this stage, this datastore is experimental

More are planned, if you are interested, come talk to us (see How to get help and contribute on Hibernate OGM).

For each datastore, Hibernate OGM has specific integration code called a datastore provider. All are in a dedicated maven module, you simply need to depend on the one you use.

Hibernate OGM interacts with NoSQL datastores via two contracts:

- a `DatastoreProvider` which is responsible for starting and stopping the connection(s) with the datastore and prop up the datastore if needed
- a `GridDialect` which is responsible for converting an Hibernate OGM operation into a datastore specific operation

8.1. Using a specific NoSQL datastore

Only a few steps are necessary:

- add the datastore provider module to your classpath
- ask Hibernate OGM to use that datastore provider

- configure the URL or configuration to reach the datastore

Adding the relevant Hibernate OGM module in your classpath looks like this in Maven:

```
<dependency>
    <groupId>org.hibernate.ogm</groupId>
    <artifactId>hibernate-ogm-infinispan</artifactId>
    <version>5.1.0.Final</version>
</dependency>
```

The module names are `hibernate-ogm-infinispan`, `hibernate-ogm-infinispan-remote`, `hibernate-ogm-ehcache`, `hibernate-ogm-mongodb`, `hibernate-ogm-neo4j`, `hibernate-ogm-couchdb`, `hibernate-ogm-redis` and `hibernate-ogm-cassandra`. The map datastore is included in the Hibernate OGM engine module.

Next, configure which datastore provider you want to use. This is done via the `hibernate.ogm.datastore.provider` option. Possible values are:

- specific shortcuts (preferable): `map` (only to be used for unit tests), `infinispan_embedded`, `infinispan_remote`, `ehcache`, `mongodb`, `neo4j_embedded`, `neo4j_http`, `neo4j_bolt`, `couchdb_experimental` or `redis_experimental`
- the fully qualified class name of a `DatastoreProvider` implementation

When bootstrapping a session factory or entity manager factory programmatically, you should use the constants declared on `org.hibernate.ogm.cfg.OgmProperties` to specify configuration properties such as `hibernate.ogm.datastore.provider`.

In this case you also can specify the provider in form of a class object of a datastore provider type or pass an instance of a datastore provider type:

```
Map<String, Object> properties = new HashMap<String, Object>
();

// pass the type
properties.put( OgmProperties.DATASTORE_PROVIDER,
MongoDBDatastoreProvider.class );

EntityManagerFactory emf = Persistence
.createEntityManagerFactory( "my-pu", properties );
```

By default, a datastore provider chooses the grid dialect transparently but you can override this setting with the `hibernate.ogm.datastore.grid_dialect` option. Use the fully qualified class name of the `GridDialect` implementation. Most users should ignore this setting entirely.

Let's now look at the specifics of each datastore provider. How to configure it further, what

mapping structure is used and more.

Chapter 9. Infinispan

Infinispan is an open source in-memory data grid focusing on high performance. As a data grid, you can deploy it on multiple servers - referred to as nodes - and connect to it as if it were a single storage engine: it will cleverly distribute both the computation effort and the data storage.

It is trivial to setup on a single node and Hibernate OGM knows how to boot one, so you can easily try it out. But Infinispan really shines in multiple node deployments: you will need to configure some networking details but nothing changes in terms of application behaviour, while performance and data size can scale linearly.

From all its features we will only describe those relevant to Hibernate OGM; for a complete description of all its capabilities and configuration options, refer to the Infinispan project documentation at infinispan.org.

9.1. Infinispan: Choosing between Embedded Mode and Hot Rod

Java applications can use Infinispan in two fundamentally different ways:

- Run Infinispan in *Embedded Mode*.
- Connect to an *Infinispan Server* using an *Hot Rod client*.

Hibernate OGM supports connecting in either mode, but since the APIs and capabilities are different in the two modes, it provides two different modules each having its own set of configuration options and features.

Running Infinispan in *Embedded Mode* implies that the Infinispan node is running in the same JVM as the code using it. The benefit is that some data (or all data) will be stored on the same JVM, making reads of this data extremely fast and efficient as there won't be RPCs to other systems. Write operations will still need to issue some coordination RPCs but they also benefit from a reduction of necessary operations.

However the very fact that some data is stored in the same JVM is also the drawback of this choice: this typically implies having to configure your JVM for larger heap sizes, which are harder to tune for optimal performance. Other system parameters might also need to be configured as this JVM node is now to be treated as a "data holding node" rather than a stateless app node. Some architects and system administrators will not like that.

When connecting to an *Infinispan Server* over the *Hot Rod client*, the architecture is similar to having Hibernate connect to traditional database: the data is stored on the *Infinispan Server* nodes, and Hibernate OGM uses a client with a pool of TCP connections to talk to the server.

Another important difference, is that when connecting to *Infinispan Server* via *Hot Rod* the data is encoded using *Google Protobuf*, which requires a schema. This schema is auto-generated by Hibernate OGM.

Having a *Protobuf Schema* makes it possible to evolve the schema in non-destructive ways, and makes it possible for other clients to access the data - even clients written in other programming languages.

Most introductory tutorials of Hibernate OGM focus on Infinispan in *Embedded Mode* because in this mode OGM can start its own embedded Infinispan node, using a simple, local only Infinispan configuration.

When using *Infinispan Server* instead, you'll need to download the server distribution, unpack and start it, then set the Hibernate OGM configuration properties so that the integrated Hot Rod client knows how to connect to it.

Advanced performance options & interaction with Hibernate 2nd level caching

When using Infinispan in Embedded Mode, and it's caches are configured in `REPLICATION` Mode, all nodes will contain a full replica of the database: write performance won't scale but your reads will be very fast and scale up linearly with the size of the cluster, making usage of Hibernate's 2nd level cache redundant.

When configuring Infinispan in `DISTRIBUTED` cache mode, each of your nodes will have a local copy of a slice of your data; remember you can tune how large the section should be with various Infinispan configuration options (such as *numOwners*), and you could combine this with Hibernate's 2nd level caching and/or enable Infinispan's 1st level caching.

You can even combine Infinispan with having it passivate to other storage systems such as a RDBMs or another NoSQL engine; such storage can be configured to be asynchronous. This option is available to both Infinispan Embedded and Infinispan Server; it's even possible to use a light layer of Infinispan Embedded - containing a small data set - and have it backed by an Infinispan Server cluster to expand its storage capabilities without having to enlarge heap size too much on the embedded, application nodes.

Finally, remember that options such as replication vs distribution (`CacheMode`) and passivation to additional storage (`CacheStores`) can be configured differently for each of Infinispan caches.

9.2. Hibernate OGM & Infinispan Embedded

Let's see how to configure and use Hibernate OGM with Infinispan in Embedded Mode.

For usage of Infinispan Server over Hot Rod, skip to Hibernate OGM & Infinispan Server over Hot Rod.

9.2.1. Configure Hibernate OGM for Infinispan Embedded

You configure Hibernate OGM and Infinispan in two steps basically:

- Add the dependencies to your classpath
- And then choose one of:
  - Use the default Infinispan configuration (no action needed)
  - Point to your own configuration resource file
  - Point to a `JNDI` name of an existing instance of an Infinispan `CacheManager`
- If you need to run JPQL or HQL queries, add Hibernate Search on the classpath (Using Hibernate Search)

Note that, except when using `JNDI`, Hibernate OGM will bootstrap and Infinispan Embedded node in your same JVM, and terminate it on shutdown of the Hibernate instance.

If you have Hibernate OGM boot Infinispan using a clustered configuration, this might automatically join the cluster of other Infinispan nodes running in your network: the default is automatic discovery!

9.2.2. Adding Infinispan dependencies

To add the dependencies for the Hibernate OGM extensions for Infinispan Embedded via Maven, add the following module:

```
<dependency>
    <groupId>org.hibernate.ogm</groupId>
    <artifactId>hibernate-ogm-infinispan</artifactId>
    <version>5.1.0.Final</version>
</dependency>
```

If you're not using a dependency management tool, copy all the dependencies from the distribution in the directories:

- `/lib/required`

- `/lib/infinispan`
- Optionally - depending on your container - you might need some of the jars from `/lib/provided`

9.2.3. Infinispan specific configuration properties

The advanced configuration details of an Infinispan Cache are defined in an Infinispan specific XML configuration file; the Hibernate OGM properties are simple and usually just point to this external resource.

To use the default configuration provided by Hibernate OGM - which is a good starting point for new users - you don't have to set any property.

Hibernate OGM properties for Infinispan

`hibernate.ogm.datastore.provider`

Set it to `infinispan_embedded` to use Infinispan as the datastore provider in embedded mode.

`hibernate.ogm.infinispan.cachemanager_jndi_name`

If you have an Infinispan `EmbeddedCacheManager` registered in JNDI, provide the JNDI name and Hibernate OGM will use this instance instead of starting a new `CacheManager`. This will ignore any further configuration properties as Infinispan is assumed being already configured. Infinispan can typically be pushed to JNDI via WildFly, Spring or Seam.

`hibernate.ogm.infinispan.configuration_resource_name`

Should point to the resource name of an Infinispan configuration file. This is ignored in case `JNDI` lookup is set. Defaults to `org/hibernate/ogm/datastore/infinispan/default-config.xml`.

`hibernate.ogm.datastore.keyvalue.cache_storage`

The strategy for persisting data in Infinispan. The following two strategies exist (values of the `org.hibernate.ogm.datastore.keyvalue.options.CacheMappingType` enum):

- `CACHE_PER_TABLE`: A dedicated cache will be used for each entity type, association type and id source table.
- `CACHE_PER_KIND`: Three caches will be used: one cache for all entities, one cache for all associations and one cache for all id sources.

Defaults to `CACHE_PER_TABLE`. It is the recommended strategy as it makes it easier to target a specific cache for a given entity.

When bootstrapping a session factory or entity manager factory programmatically, you should use the constants accessible via `org.hibernate.ogm.datastore.infinispan.InfinispanProperties` when specifying the configuration properties listed above.

Common properties shared between stores are declared on `OgmProperties` (a super interface of `InfinispanProperties`).

For maximum portability between stores, use the most generic interface possible.

9.2.4. Cache names used by Hibernate OGM

Depending on the cache mapping approach, Hibernate OGM will either:

- store each entity type, association type and id source table in a dedicated cache very much like what Hibernate ORM would do. This is the `CACHE_PER_TABLE` approach.
- store data in three different caches when using the `CACHE_PER_KIND` approach:
  - `ENTITIES`: is going to be used to store the main attributes of all your entities.
  - `ASSOCIATIONS`: stores the association information representing the links between entities.
  - `IDENTIFIER_STORE`: contains internal metadata that Hibernate OGM needs to provide sequences and auto-incremental numbers for primary key generation.

The preferred strategy is `CACHE_PER_TABLE` as it offers both more fine grained configuration options and the ability to work on specific entities in a more simple fashion.

In the following paragraphs, we will explain which aspects of Infinispan you're likely to want to reconfigure from their defaults. All attributes and elements from Infinispan which we don't mention are safe to ignore. Refer to the Infinispan User Guide for the guru level performance tuning and customizations.

An Infinispan configuration file is an XML file complying with the Infinispan schema; the basic structure is shown in the following example:

Example 18. Simple structure of an infinispan xml configuration file

```
<?xml version="1.0" encoding="UTF-8"?>
<infinispan
    xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
    xsi:schemaLocation="urn:infinispan:config:7.0
http://www.infinispan.org/schemas/infinispan-config-7.0.xsd"
    xmlns="urn:infinispan:config:7.0">

    <cache-container name="HibernateOGM" default-cache="DEFAULT">

        <!-- ************************** -->
        <!--   Default cache settings   -->
        <!-- ************************** -->
        <local-cache name="DEFAULT">
            <transaction mode="NON_DURABLE_XA"
                         transaction-manager-lookup=
"org.infinispan.transaction.lookup.JBossStandaloneJTAManagerLookup"/>
        </local-cache>

        <local-cache name="User"/>

        <local-cache name="Order"/>

        <local-cache name="associations_User_Order"/>

    </cache-container>
</infinispan>
```

There are global settings that can be set before the `cache_container` section. These settings will affect the whole instance; mainly of interest for Hibernate OGM users is the `jgroups` element in which we will set JGroups configuration overrides.

Inside the `cache-container` section are defined explicit named caches and their configurations as well as the default cache (named `DEFAULT` here) if we want to affect all named caches. This is where we will likely want to configure clustering modes, eviction policies and `CacheStore`s.

9.2.5. Manage data size

In its default configuration Infinispan stores all data in the heap of the JVM; in this barebone mode it is conceptually not very different than using a HashMap: the size of the data should fit in the heap of your VM, and stopping/killing/crashing your application will get all data lost with no way to recover it.

To store data permanently (out of the JVM memory) a `CacheStore` should be enabled. The Infinispan project provides many `CacheStore` implementations; a simple one is the "single file store" which is able to store data in simple binary files, on any read/write mounted filesystem; You can find many more implementations to store your data in anything from JDBC connected relational databases, other NoSQL engines such as MongoDB and Cassandra, or even delegate

to other Infinispan clusters. Finally, implementing a custom `CacheStore` is quite easy.

To limit the memory consumption of the precious heap space, you can activate a `passivation` or an `eviction` policy; again there are several strategies to play with, for now let's just consider you'll likely need one to avoid running out of memory when storing too many entries in the bounded JVM memory space; of course you don't need to choose one while experimenting with limited data sizes: enabling such a strategy doesn't have any other impact in the functionality of your Hibernate OGM application (other than performance: entries stored in the Infinispan in-memory space is accessed much quicker than from any CacheStore).

A `CacheStore` can be configured as write-through, committing all changes to the `CacheStore` before returning (and in the same transaction) or as write-behind. A write-behind configuration is normally not encouraged in storage engines, as a failure of the node implies some data might be lost without receiving any notification about it, but this problem is mitigated in Infinispan because of its capability to combine CacheStore write-behind with a synchronous replication to other Infinispan nodes.

Example 19. Enabling a FileCacheStore and eviction

```
<local-cache name="User">
    <transaction mode="NON_DURABLE_XA"
                 transaction-manager-lookup=
"org.infinispan.transaction.lookup.JBossStandaloneJTAManagerLookup"/>
    <eviction strategy="LIRS" max-entries="2000"/>
    <persistence passivation="true">
        <file-store
           shared="false"
           path="/var/infinispan/myapp/users">
            <write-behind flush-lock-timeout="15000" thread-pool-size="5"
/>
        </file-store>
    </persistence>
</local-cache>
```

In this example we enabled both `eviction` and a `CacheStore` (the `persistence` element). `LIRS` is one of the choices we have for eviction strategies. Here it is configured to keep (approximately) 2000 entries in live memory and evict the remaining as a memory usage control strategy.

The `CacheStore` is enabling `passivation`, which means that the entries which are evicted are stored on the filesystem.

You could configure an eviction strategy while not configuring a passivating CacheStore! That is a valid configuration for Infinispan but will have the evictor permanently remove entries. Hibernate OGM will break in such a configuration.

9.2.6. Clustering: store data on multiple Infinispan nodes

The best thing about Infinispan is that all nodes are treated equally and it requires almost no beforehand capacity planning: to add more nodes to the cluster you just have to start new JVMs, on the same or different physical servers, having your same Infinispan configuration and your same application.

Infinispan supports several clustering *cache modes*; each mode provides the same API and functionality but with different performance, scalability and availability options:

Infinispan cache modes

local

Useful for a single VM: networking stack is disabled

replication

All data is replicated to each node; each node contains a full copy of all entries. Consequentially reads are faster but writes don't scale as well. Not suited for very large datasets.

distribution

Each entry is distributed on multiple nodes for redundancy and failure recovery, but not to all the nodes. Provides linear scalability for both write and read operations. distribution is the default mode.

To use the `replication` or `distribution` cache modes Infinispan will use JGroups to discover and connect to the other nodes.

In the default configuration, JGroups will attempt to autodetect peer nodes using a multicast socket; this works out of the box in the most network environments but will require some extra configuration in cloud environments (which often block multicast packets) or in case of strict firewalls. See the JGroups reference documentation, specifically look for *Discovery Protocols* to customize the detection of peer nodes.

Nowadays, the `JVM` defaults to use `IPv6` network stack; this will work fine with JGroups, but only if you configured `IPv6` correctly. It is often useful to force the `JVM` to use `IPv4`.

It is also important to let JGroups know which networking interface you want to use; it will bind to one interface by default, but if you have multiple network interfaces that might not be the one you expect.

Example 20. JVM properties to set for clustering

```
#192.168.122.1 is an example IPv4 address
-Djava.net.preferIPv4Stack=true -Djgroups.bind_addr=192.168.122.1
```

You don't need to use `IPv4`: JGroups is compatible with `IPv6` provided you have routing properly configured and valid addresses assigned.

The `jgroups.bind_addr` needs to match a placeholder name in your JGroups configuration in case you don't use the default one.

The default configuration uses `distribution` as cache mode and uses the `jgroups-tcp.xml` configuration for JGroups, which is contained in the Infinispan jar as the default configuration for Infinispan users. Let's see how to reconfigure this:

Example 21. Reconfiguring cache mode and override JGroups configuration

```
<?xml version="1.0" encoding="UTF-8"?>
<infinispan
    xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
    xsi:schemaLocation="urn:infinispan:config:7.0
http://www.infinispan.org/schemas/infinispan-config-7.0.xsd"
    xmlns="urn:infinispan:config:7.0">

    <jgroups>
        <stack-file name="custom-stack" path="my-jgroups-conf.xml" />
    </jgroups>

    <cache-container name="HibernateOGM" default-cache="DEFAULT">
        <transport stack="custom-stack" />

        <!-- ************************************** -->
        <!--     Default cache used as template     -->
        <!-- ************************************** -->
        <distrubuted-cache name="DEFAULT" mode="SYNC">
            <locking striping="false" acquire-timeout="10000"
                concurrency-level="500" write-skew="false" />
            <transaction mode="NON_DURABLE_XA"
                transaction-manager-lookup=
"org.infinispan.transaction.lookup.JBossStandaloneJTAManagerLookup" />
            <state-transfer enabled="true" timeout="480000"
                await-initial-transfer="true" />
        </distributed-cache>

        <!-- Override the cache mode: -->
        <replicated-cache name="User" mode="SYNC">
            <locking striping="false" acquire-timeout="10000"
                concurrency-level="500" write-skew="false" />
            <transaction mode="NON_DURABLE_XA"
                transaction-manager-lookup=
"org.infinispan.transaction.lookup.JBossStandaloneJTAManagerLookup" />
```

```
            <state-transfer enabled="true" timeout="480000"
                await-initial-transfer="true" />
        </replicated-cache>

        <distributed-cache name="Order" mode="SYNC">
            <locking striping="false" acquire-timeout="10000"
                concurrency-level="500" write-skew="false" />
            <transaction mode="NON_DURABLE_XA"
                transaction-manager-lookup=
"org.infinispan.transaction.lookup.JBossStandaloneJTAManagerLookup" />
            <state-transfer enabled="true" timeout="480000"
                await-initial-transfer="true" />
        </distributed-cache>

        <distributed-cache name="associations_User_Order" mode="SYNC">
            <locking striping="false" acquire-timeout="10000"
                concurrency-level="500" write-skew="false" />
            <transaction mode="NON_DURABLE_XA"
                transaction-manager-lookup=
"org.infinispan.transaction.lookup.JBossStandaloneJTAManagerLookup" />
            <state-transfer enabled="true" timeout="480000"
                await-initial-transfer="true" />
        </distributed-cache>

    </cache-container>

</infinispan>
```

In the example above we specify a custom JGroups configuration file and set the cache mode for the default cache to `distribution`; this is going to be inherited by the `Order` and the `associations_User_Order` caches. But for `User` we have chosen (for the sake of this example) to use `replication`.

Now that you have clustering configured, start the service on multiple nodes. Each node will need the same configuration and jars.

We have just shown how to override the clustering mode and the networking stack for the sake of completeness, but you don't have to!

Start with the default configuration and see if that fits you. You can fine tune these setting when you are closer to going in production.

9.2.7. Storage principles

To describe things simply, each entity is stored under a single key. The value itself is a map containing the columns / values pair.

Each association from one entity instance to (a set of) another is stored under a single key. The value contains the navigational information to the (set of) entity.

Properties and built-in types

Each entity is represented by a map. Each property or more precisely column is represented by an entry in this map, the key being the column name.

Hibernate OGM support by default the following property types:

- `java.lang.String`
- `java.lang.Character` (or char primitive)
- `java.lang.Boolean` (or boolean primitive); Optionally the annotations `@Type(type = "true_false")`, `@Type(type = "yes_no")` and `@Type(type = "numeric_boolean")` can be used to map boolean properties to the characters 'T'/'F', 'Y'/'N' or the int values 0/1, respectively.
- `java.lang.Byte` (or byte primitive)
- `java.lang.Short` (or short primitive)
- `java.lang.Integer` (or integer primitive)
- `java.lang.Long` (or long primitive)
- `java.lang.Integer` (or integer primitive)
- `java.lang.Float` (or float primitive)
- `java.lang.Double` (or double primitive)
- `java.math.BigDecimal`
- `java.math.BigInteger`
- `java.util.Calendar`
- `java.util.Date`
- `java.util.UUID`
- `java.util.URL`

Hibernate OGM doesn't store null values in Infinispan, setting a value to null is the same as removing the corresponding entry from Infinispan.

This can have consequences when it comes to queries on null value.

Identifiers

Entity identifiers are used to build the key in which the entity is stored in the cache.

The key is comprised of the following information:

- the identifier column names
- the identifier column values
- the entity table (for the `CACHE_PER_KIND` strategy)

In `CACHE_PER_TABLE`, the table name is inferred from the cache name. In `CACHE_PER_KIND`, the table name is necessary to identify the entity in the generic cache.

Example 22. Define an identifier as a primitive type

```
@Entity
public class Bookmark {

    @Id
    private Long id;

    private String title;

    // getters, setters ...
}
```

Table 1. Content of the `Bookmark` cache in `CACHE_PER_TABLE`

KEY	MAP ENTRIES	
["id"], [42]	id	42
	title	"Hibernate OGM documentation"

Table 2. Content of the `ENTITIES` cache in `CACHE_PER_KIND`

KEY	MAP ENTRIES	
"Bookmark", ["id"], [42]	id	42
	title	"Hibernate OGM documentation"

Example 23. Define an identifier using @EmbeddedId

```
@Embeddable
public class NewsID implements Serializable {

    private String title;
    private String author;

    // getters, setters ...
}

@Entity
public class News {

    @EmbeddedId
    private NewsID newsId;
    private String content;

    // getters, setters ...
}
```

Table 3. Content of the `News` cache in `CACHE_PER_TABLE`

KEY	MAP ENTRIES	
[newsId.author, newsId.title], ["Guillaume", "How to use Hibernate OGM ?"]	newsId.author	"Guillaume"
	newsId.title	"How to use Hibernate OGM ?"
	content	"Simple, just like ORM but with a NoSQL database"

Table 4. Content of the `ENTITIES` cache in `CACHE_PER_KIND`

KEY	MAP ENTRIES	
"News", [newsId.author, newsId.title], ["Guillaume", "How to use Hibernate OGM ?"]	newsId.author	"Guillaume"
	newsId.title	"How to use Hibernate OGM ?"
	content	"Simple, just like ORM but with a NoSQL database"

Identifier generation strategies

Since Infinispan has not native sequence nor identity column support, these are simulated using the table strategy, however their default values vary. We highly recommend you explicitly use a `TABLE` strategy if you want to generate a monotonic identifier.

But if you can, use a pure in-memory and scalable strategy like a UUID generator.

Example 24. Id generation strategy TABLE using default values

```
@Entity
public class GuitarPlayer {

    @Id
    @GeneratedValue(strategy = GenerationType.TABLE)
    private long id;

    private String name;

    // getters, setters ...
}
```

Table 5. Content of the `hibernate_sequences` cache in `CACHE_PER_TABLE`

KEY	NEXT VALUE
["sequence_name"], ["default"]	2

Table 6. Content of the IDENTIFIERS cache in `CACHE_PER_KIND`

KEY	NEXT VALUE
"hibernate_sequences", ["sequence_name"], ["default"]	2

As you can see, in `CACHE_PER_TABLE`, the key does not contain the id source table name. It is inferred by the cache name hosting that key.

Example 25. Id generation strategy TABLE using a custom table

```
@Entity
public class GuitarPlayer {

    @Id
    @GeneratedValue(strategy = GenerationType.TABLE, generator =
"guitarGen")
    @TableGenerator(
        name = "guitarGen",
        table = "GuitarPlayerSequence",
        pkColumnName = "seq"
        pkColumnValue = "guitarPlayer",
    )
    private long id;

    // getters, setters ...
}
```

Table 7. Content of the `GuitarPlayerSequence` cache in `CACHE_PER_TABLE`

KEY	NEXT VALUE
["seq"], ["guitarPlayer"]	2

Table 8. Content of the IDENTIFIERS cache in `CACHE_PER_KIND`

KEY	NEXT VALUE
"GuitarPlayerSequence", ["seq"], ["guitarPlayer"]	2

Example 26. SEQUENCE id generation strategy

```
@Entity
public class Song {

  @Id
  @GeneratedValue(strategy = GenerationType.SEQUENCE, generator =
"songSequenceGenerator")
  @SequenceGenerator(
       name = "songSequenceGenerator",
       sequenceName = "song_sequence",
       initialValue = 2,
       allocationSize = 20
  )
  private Long id;

  private String title;

  // getters, setters ...
}
```

Table 9. Content of the `hibernate_sequences` cache in `CACHE_PER_TABLE`

KEY	NEXT VALUE
["sequence_name"], ["song_sequence"]	11

Table 10. Content of the `IDENTIFIERS` cache in `CACHE_PER_KIND`

KEY	NEXT VALUE
"hibernate_sequences", "["sequence_name"], ["song_sequence"]	11

Entities

Entities are stored in the cache named after the entity name when using the `CACHE_PER_TABLE` strategy. In the `CACHE_PER_KIND` strategy, entities are stored in a single cache named `ENTITIES`.

The key is comprised of the following information:

- the identifier column names
- the identifier column values
- the entity table (for the `CACHE_PER_KIND` strategy)

In `CACHE_PER_TABLE`, the table name is inferred from the cache name. In `CACHE_PER_KIND`, the table name is necessary to identify the entity in the generic cache.

The entry value is an instance of `org.infinispan.atomic.FineGrainedMap` which contains

all the entity properties - or to be specific columns. Each column name and value is stored as a key / value pair in the map. We use this specialized map as Infinispan is able to transport changes in a much more efficient way.

Example 27. Default JPA mapping for an entity

```
@Entity
public class News {

    @Id
    private String id;
    private String title;

    // getters, setters ...
}
```

Table 11. Content of the `News` cache in `CACHE_PER_TYPE`

KEY	MAP ENTRIES	
["id"], ["1234-5678"]	id	"1234-5678"
	title	"On the merits of NoSQL"

Table 12. Content of the `ENTITIES` cache in `CACHE_PER_KIND`

KEY	MAP ENTRIES	
"News", ["id"], ["1234-5678"]	id	"1234-5678"
	title	"On the merits of NoSQL"

As you can see, the table name is not part of the key for `CACHE_PER_TYPE`. In the rest of this section we will no longer show the `CACHE_PER_KIND` strategy.

Example 28. Rename field and collection using @Table and @Column

```
@Entity
@Table(name = "Article")
public class News {

    @Id
    private String id;

    @Column(name = "headline")
    private String title;

    // getters, setters ...
}
```

Table 13. Content of the `Article` cache

KEY	MAP ENTRIES	
["id"], ["1234-5678"]	id	"1234-5678"
	headline	"On the merits of NoSQL"

Embedded objects and collections

Example 29. Embedded object

```
@Entity
public class News {

    @Id
    private String id;
    private String title;

    @Embedded
    private NewsPaper paper;

    // getters, setters ...
}

@Embeddable
public class NewsPaper {

    private String name;
    private String owner;

    // getters, setters ...
}
```

Table 14. Content of the `News` cache

KEY	MAP ENTRIES	
["id"], ["1234-5678"]	id	"1234-5678"
	title	"On the merits of NoSQL"
	paper.name	"NoSQL journal of prophecies"
	paper.owner	"Delphy"

Example 30. @ElementCollection with one attribute

```
@Entity
public class GrandMother {

    @Id
    private String id;

    @ElementCollection
    private List<GrandChild> grandChildren = new ArrayList<GrandChild>();

    // getters, setters ...
}

@Embeddable
public class GrandChild {

    private String name;

    // getters, setters ...
}
```

Table 15. Content of the `GrandMother` cache

KEY	MAP ENTRIES	
["id"], ["granny"]	id	"granny"

Table 16. Content of the `associations_GrandMother_grandChildren` cache in `CACHE_PER_TYPE`

KEY	ROW KEY	ROW MAP ENTRIES	
["GrandMother_id"], ["granny"]	["GrandMother_id", "name"], ["granny", "Leia"]	GrandMother_id	"granny"
		name	"Leia"
	["GrandMother_id", "name"], ["granny", "Luke"]	GrandMother_id	"granny"
		name	"Luke"

Table 17. Content of the `ASSOCIATIONS` cache in `CACHE_PER_KIND`

KEY	ROW KEY	ROW MAP ENTRIES	
"GrandMother_grandChildren", ["GrandMother_id"], ["granny"]	["GrandMother_id", "name"], ["granny", "Leia"]	GrandMother_id	"granny"
		name	"Leia"
	["GrandMother_id", "name"], ["granny", "Luke"]	GrandMother_id	"granny"
		name	"Luke"

Here, we see that the collection of elements is stored in a separate cache and entry. The association key is made of:

- the foreign key column names pointing to the owner of this association
- the foreign key column values pointing to the owner of this association
- the association table name in the `CACHE_PER_KIND` approach where all associations share the same cache

The association entry is a map containing the representation of each entry in the collection. The keys of that map are made of:

- the names of the columns uniquely identifying that specific collection entry (e.g. for a `Set` this is all of the columns)
- the values of the columns uniquely identifying that specific collection entry

The value attack to that collection entry key is a Map containing the key value pairs column name / column value.

Example 31. @ElementCollection with @OrderColumn

```
@Entity
public class GrandMother {

    @Id
    private String id;

    @ElementCollection
    @OrderColumn( name = "birth_order" )
    private List<GrandChild> grandChildren = new ArrayList<GrandChild>();

    // getters, setters ...
}

@Embeddable
public class GrandChild {

    private String name;

    // getters, setters ...
}
```

Table 18. Content of the `GrandMother` cache

KEY	MAP ENTRIES	
["id"], ["granny"]	id	"granny"

Table 19. Content of the `GrandMother_grandChildren` cache

KEY	ROW KEY	ROW MAP ENTRIES	
["GrandMother_id"], ["granny"]	["GrandMother_id", "birth_order"], ["granny", 0]	GrandMother_id	"granny"
		birth_order	0
		name	"Leia"
	["GrandMother_id", "birth_order"], ["granny", 1]	GrandMother_id	"granny"
		birth_order	1
		name	"Luke"

Here we used an indexed collection and to identify the entry in the collection, only the owning entity id and the index value is enough.

Example 32. @ElementCollection with Map of @Embeddable

```
@Entity
public class ForumUser {

    @Id
    private String name;

    @ElementCollection
    private Map<String, JiraIssue> issues = new HashMap<>();

    // getters, setters ...
}

@Embeddable
public class JiraIssue {

    private Integer number;
    private String project;

    // getters, setters ...
}
```

Table 20. Content of the `ForumUser` cache

KEY	MAP ENTRIES	
["id"], ["Jane Doe"]	id	"Jane Doe"

Table 21. Content of the `ForumUser_issues` cache

KEY	ROW KEY	ROW MAP ENTRIES	
["ForumUser_id"], ["Jane Doe"]	["ForumUser_id", "issues_KEY"], ["Jane Doe", "issueWithNull"]	ForumUser_id	Jane Doe
		issue_KEY	"issueWithNull"
		issues.value.project	<null>
		issues.value.number	<null>
	["ForumUser_id", "issues_KEY"], ["Jane Doe", "issue1"]	ForumUser_id	"Jane Doe"
		issue_KEY	"issue1"
		issues.value.project	"OGM"
		issues.value.number	1253
	["ForumUser_id", "issues_KEY"], ["Jane Doe", "issue2"]	ForumUser_id	"Jane Doe"
		issue_KEY	"issue2"
		issues.value.project	"HSEARCH"
		issues.value.number	2000

Associations

Associations between entities are mapped like (collection of) embeddables except that the

target entity is represented by its identifier(s).

Example 33. Unidirectional one-to-one

```
@Entity
public class Vehicule {

    @Id
    private String id;
    private String brand;

    // getters, setters ...
}

@Entity
public class Wheel {

    @Id
    private String id;
    private double diameter;

    @OneToOne
    private Vehicule vehicule;

    // getters, setters ...
}
```

Table 22. Content of the `Vehicule` cache

KEY	MAP ENTRIES	
["id"], ["V_01"]	id	"V_01"
	brand	"Mercedes"

Table 23. Content of the `Wheel` cache

KEY	MAP ENTRIES	
["id"], ["W001"]	id	"W001"
	diameter	0.0
	vehicule_id	"V_01"

Example 34. Unidirectional one-to-one with @JoinColumn

```
@Entity
public class Vehicule {

    @Id
    private String id;
    private String brand;

    // getters, setters ...
}


@Entity
public class Wheel {

    @Id
    private String id;
    private double diameter;

    @OneToOne
    @JoinColumn( name = "part_of" )
    private Vehicule vehicule;

    // getters, setters ...
}
```

Table 24. Content of the `Vehicle` cache

KEY	MAP ENTRIES	
["id"], ["V_01"]	id	"V_01"
	brand	"Mercedes"

Table 25. Content of the `Wheel` cache

KEY	MAP ENTRIES	
"Wheel", ["id"], ["W001"]	id	"W001"
	diameter	0.0
	part_of	"V_01"

Example 35. Unidirectional one-to-one with @MapsId and @PrimaryKeyJoinColumn

```
@Entity
public class Vehicule {

    @Id
    private String id;
    private String brand;

    // getters, setters ...
}

@Entity
public class Wheel {

    @Id
    private String id;
    private double diameter;

    @OneToOne
    @PrimaryKeyJoinColumn
    @MapsId
    private Vehicule vehicule;

    // getters, setters ...
}
```

Table 26. Content of the `Vehicle` cache

KEY	MAP ENTRIES	
["id"], ["V_01"]	id	"V_01"
	brand	"Mercedes"

Table 27. Content of the `Wheel` cache

KEY	MAP ENTRIES	
["vehicule_id"], ["V_01"]	vehicule_id	"V_01"
	diameter	0.0

Example 36. Bidirectional one-to-one

```
@Entity
public class Husband {

    @Id
    private String id;
    private String name;

    @OneToOne
    private Wife wife;

    // getters, setters ...
}

@Entity
public class Wife {

    @Id
    private String id;
    private String name;

    @OneToOne(mappedBy="wife")
    private Husband husband;

    // getters, setters ...
}
```

Table 28. Content of the `Husband` cache

KEY	MAP ENTRIES	
["id"], ["alex"]	id	"alex"
	name	"Alex"
	wife	"bea"

Table 29. Content of the `Wife` cache

KEY	MAP ENTRIES	
["id"], ["bea"]	id	"bea"
	name	"Bea"

Table 30. Content of the `associations_Husband` cache

KEY	ROW KEY	MAP ENTRIES	
["wife"], ["bea"]	["id", "wife"], ["alex", "bea"]	id	"alex"
		wife	"bea"

Example 37. Unidirectional one-to-many

```
@Entity
public class Basket {

    @Id
    private String id;

    private String owner;

    @OneToMany
    private List<Product> products = new ArrayList<Product>();

    // getters, setters ...
}

@Entity
public class Product {

    @Id
    private String name;

    private String description;

    // getters, setters ...
}
```

Table 31. Content of the `Basket` cache

KEY	MAP ENTRIES	
["id"], ["davide_basket"]	id	"davide_basket"
	owner	"Davide"

Table 32. Content of the `Product` cache

KEY	MAP ENTRIES	
["name"], ["Beer"]	name	"Beer"
	description	"Tactical Nuclear Penguin"
["name"], ["Pretzel"]	name	"Pretzel"
	description	"Glutino Pretzel Sticks"

Table 33. Content of the `associations_Basket_Product` cache

KEY	ROW KEY	MAP ENTRIES	
["Basket_id"], ["davide_basket"]	["Basket_id", "products_name"], ["davide_basket", "Beer"]	Basket_id	"davide_basket"
		products_name	"Beer"
	["Basket_id", "products_name"], ["davide_basket", "Pretzel"]	Basket_id	"davide_basket"
		products_name	"Pretzel"

Example 38. Unidirectional one-to-many with `@JoinTable`

```
@Entity
public class Basket {

    @Id
    private String id;

    private String owner;

    @OneToMany
    @JoinTable( name = "BasketContent" )
    private List<Product> products = new ArrayList<Product>();

    // getters, setters ...
}

@Entity
public class Product {

    @Id
    private String name;

    private String description;

    // getters, setters ...
}
```

Table 34. Content of the `Basket` cache

KEY	MAP ENTRIES	
["id"], ["davide_basket"]	id	"davide_basket"
	owner	"Davide"

Table 35. Content of the `Basket` cache

KEY	MAP ENTRIES	
["name"], ["Beer"]	name	"Beer"
	description	"Tactical Nuclear Penguin"
["name"], ["Pretzel"]	name	"Pretzel"
	description	"Glutino Pretzel Sticks"

Table 36. Content of the `associations_BasketContent` cache

KEY	ROW KEY	MAP ENTRIES	
["Basket_id"], ["davide_basket"]	["Basket_id", "products_name"], ["davide_basket", "Beer"]	Basket_id	"davide_basket"
		products_name	"Beer"
	["Basket_id", "products_name"], ["davide_basket", "Pretzel"]	Basket_id	"davide_basket"
		products_name	"Pretzel"

Example 39. Unidirectional one-to-many using maps with defaults

```
@Entity
public class User {

    @Id
    private String id;

    @OneToMany
    private Map<String, Address> addresses = new HashMap<String, Address
>();

    // getters, setters ...
}

@Entity
public class Address {

    @Id
    private String id;
    private String city;

    // getters, setters ...
}
```

Table 37. Content of the `User` cache

KEY	MAP ENTRIES	
["id"], ["user_001"]	id	"user_001"

Table 38. Content of the `Address` cache

KEY	MAP ENTRIES	
["id"], ["address_001"]	id	"address_001"
	city	"Rome"
["id"], ["address_002"]	id	"address_002"
	city	"Paris"

Table 39. Content of the `associations_User_address` cache

KEY	ROW KEY	MAP ENTRIES	
["User_id"], "user_001"]	["User_id", "addresses_KEY"], ["user_001", "home"]	User_id	"user_001"
		addresses_KEY	"home"
		addresses_id	"address_001"
	["User_id", "addresses_KEY"], ["user_001", "work"]	User_id	"user_002"
		addresses_KEY	"work"
		addresses_id	"address_002"

Example 40. Unidirectional one-to-many using maps with @MapKeyColumn

```
@Entity
public class User {

    @Id
    private String id;

    @OneToMany
    @MapKeyColumn(name = "addressType")
    private Map<String, Address> addresses = new HashMap<String, Address
>();

    // getters, setters ...
}

@Entity
public class Address {

    @Id
    private String id;
    private String city;

    // getters, setters ...
}
```

Table 40. Content of the `User` cache

KEY	MAP ENTRIES	
["id"], ["user_001"]	id	"user_001"

Table 41. Content of the `Address` cache

KEY	MAP ENTRIES	
["id"], ["address_001"]	id	"address_001"
	city	"Rome"
["id"], ["address_002"]	id	"address_002"
	city	"Paris"

Table 42. Content of the `associations_User_address` cache

KEY	ROW KEY	MAP ENTRIES	
["User_id"], "user_001"]	["User_id", "addressType"], ["user_001", "home"]	User_id	"user_001"
		addressesType	"home"
		addresses_id	"address_001"
	["User_id", "addressType"], ["user_001", "work"]	User_id	"user_002"
		addressesType	"work"
		addresses_id	"address_002"

Example 41. Unidirectional many-to-one

```
@Entity
public class JavaUserGroup {

    @Id
    private String jugId;
    private String name;

    // getters, setters ...
}

@Entity
public class Member {

    @Id
    private String id;
    private String name;

    @ManyToOne
    private JavaUserGroup memberOf;

    // getters, setters ...
}
```

Table 43. Content of the `JavaUserGroup` cache

KEY	MAP ENTRIES	
["jugId"], ["summer_camp"]	jugId	"summer_camp"
	name	"JUG Summer Camp"

Table 44. Content of the `Member` cache

KEY	MAP ENTRIES	
["member_id"], ["emmanuel"]	member_id	"emmanuel"
	name	"Emmanuel Bernard"
	memberOf_jug_id	"summer_camp"
["member_id"], ["jerome"]	member_id	"jerome"
	name	"Jerome"
	memberOf_jug_id	"summer_camp"

Example 42. Bidirectional many-to-one

```
@Entity
public class SalesForce {

    @Id
    private String id;
    private String corporation;

    @OneToMany(mappedBy = "salesForce")
    private Set<SalesGuy> salesGuys = new HashSet<SalesGuy>();

    // getters, setters ...
}

@Entity
public class SalesGuy {
    private String id;
    private String name;

    @ManyToOne
    private SalesForce salesForce;

    // getters, setters ...
}
```

Table 45. Content of the `SalesForce` cache

KEY	MAP ENTRIES	
["id"], ["red_hat"]	id	"red_hat"
	corporation	"Red Hat"

Table 46. Content of the `SalesGuy` cache

KEY	MAP ENTRIES	
["id"], ["eric"]	id	"eric"
	name	"Eric"
	salesForce_id	"red_hat"
["id"], ["simon"]	id	"simon"
	name	"Simon"
	salesForce_id	"red_hat"

Table 47. Content of the `associations_SalesGuy` cache

KEY	ROW KEY	MAP ENTRIES	
["salesForce_id"], ["red_hat"]	["salesForce_id", "id"], ["red_hat", "eric"]	salesForce_id	"red_hat"
		id	"eric"
	["salesForce_id", "id"], ["red_hat", "simon"]	salesForce_id	"red_hat"
		id	"simon"

Example 43. Unidirectional many-to-many

```
@Entity
public class Student {

    @Id
    private String id;
    private String name;

    // getters, setters ...
}

@Entity
public class ClassRoom {

    @Id
    private long id;
    private String lesson;

    @ManyToMany
    private List<Student> students = new ArrayList<Student>();

    // getters, setters ...
}
```

The "Math" class has 2 students: John Doe and Mario Rossi

The "English" class has 2 students: Kate Doe and Mario Rossi

Table 48. Content of the `ClassRoom` cache

KEY	MAP ENTRIES	
["id"], [1]	id	1
	name	"Math"
["id"], [2]	id	2
	name	"English"

Table 49. Content of the `Student` cache

KEY	MAP ENTRIES	
["id"], ["john"]	id	"john"
	name	"John Doe"
["id"], ["mario"]	id	"mario"
	name	"Mario Rossi"
["id"], ["kate"]	id	"kate"
	name	"Kate Doe"

Table 50. Content of the `associations_ClassRoom_Student` cache

KEY	ROW KEY	MAP ENTRIES	
["ClassRoom_id"], [1]	["ClassRoom_id", "students_id"], [1, "mario"]	ClassRoom_id	1
		students_id	"mario"
	["ClassRoom_id", "students_id"], [1, "john"]	ClassRoom_id	1
		students_id	"john"
["ClassRoom_id"], [2]	["ClassRoom_id", "students_id"], [2, "kate"]	ClassRoom_id	2
		students_id	"kate"
	["ClassRoom_id", "students_id"], [2, "mario"]	ClassRoom_id	2
		students_id	"mario"

Example 44. Bidirectional many-to-many

```
@Entity
public class AccountOwner {

    @Id
    private String id;

    private String SSN;

    @ManyToMany
    private Set<BankAccount> bankAccounts;

    // getters, setters ...
}

@Entity
public class BankAccount {

    @Id
    private String id;

    private String accountNumber;

    @ManyToMany( mappedBy = "bankAccounts" )
    private Set<AccountOwner> owners = new HashSet<AccountOwner>();

    // getters, setters ...
}
```

David owns 2 accounts: "012345" and "ZZZ-009"

Table 51. Content of the `AccountOwner` cache

KEY	MAP ENTRIES	
["id"], ["David"]	id	"David"
	SSN	"0123456"

Table 52. Content of the `BankAccount` cache

KEY	MAP ENTRIES	
["id"], ["account_1"]	id	"account_1"
	accountNumber	"X2345000"
["id"], ["account_2"]	id	"account_2"
	accountNumber	"ZZZ-009"

Table 53. Content of the `AccountOwner_BankAccount` cache

KEY	ROW KEY	MAP ENTRIES	
["bankAccounts_id"], ["account_1"]	["bankAccounts_id", "owners_id"], ["account_1", "David"]	bankAccounts_id	"account_1"
		owners_id	"David"
["bankAccounts_id"], ["account_2"]	["bankAccounts_id", "owners_id"], ["account_2", "David"]	bankAccounts_id	"account_2"
		owners_id	"David"
["owners_id"], ["David"]	["owners_id", "banksAccounts_id"], ["David", "account_1"]	bankAccounts_id	"account_1"
		owners_id	"David"
	["owners_id", "banksAccounts_id"], ["David", "account_2"]	bankAccounts_id	"account_2"
		owners_id	"David"

9.2.8. Transactions

Infinispan supports transactions and integrates with any standard JTA `TransactionManager`; this is a great advantage for JPA users as it allows to experience a *similar* behaviour to the one we are used to when we work with RDBMS databases.

This capability is only available to Infinispan Embedded users: the transactional integration capabilities are not exposed to the Hot Rod clients.

If you're having Hibernate OGM start and manage Infinispan, you can skip this as it will inject the same `TransactionManager` instance which you already have set up in the Hibernate / JPA configuration.

If you are providing an already started Infinispan CacheManager instance by using the `JNDI` lookup approach, then you have to make sure the CacheManager is using the same `TransactionManager` as Hibernate:

Example 45. Configuring a JBoss Standalone TransactionManager lookup in Infinispan configuration

```
<default>
   <transaction
      transactionMode="TRANSACTIONAL"
      transactionManagerLookupClass=
    "org.infinispan.transaction.lookup.JBossStandaloneJTAManagerLookup"
/>
</default>
```

Infinispan supports different transaction modes like `PESSIMISTIC` and `OPTIMISTIC`, supports `XA` recovery and provides many more configuration options; see the Infinispan User Guide for more advanced configuration options.

9.2.9. Storing a Lucene index in Infinispan

Hibernate Search, which can be used for advanced query capabilities (see Query your entities), needs some place to store the indexes for its embedded `Apache Lucene` engine.

A common place to store these indexes is the filesystem which is the default for Hibernate Search; however if your goal is to scale your NoSQL engine on multiple nodes you need to share this index. Network sharing file systems are a possibility but we don't recommended that. Often the best option is to store the index in whatever NoSQL database you are using (or a different dedicated one).

You might find this section useful even if you don't intend to store your data in Infinispan.

The Infinispan project provides an adaptor to plug into Apache Lucene, so that it writes the indexes in Infinispan and searches data in it. Since Infinispan can be used as an application cache to other NoSQL storage engines by using a CacheStore (see Manage data size) you can use this adaptor to store the Lucene indexes in any NoSQL store supported by Infinispan:

- JDBC databases
- Cassandra
- Filesystem (but locked correctly at the Infinispan level)
- MongoDB
- HBase
- LevelDB
- A secondary (independent) Infinispan grid

How to configure it? Here is a simple cheat sheet to get you started with this type of setup:

- Add `org.infinispan:infinispan-directory-provider:{infinispanVersion}` to your dependencies
- set these configuration properties:
  - `hibernate.search.default.directory_provider = infinispan`
  - `hibernate.search.default.exclusive_index_use = false`
  - `hibernate.search.infinispan.configuration_resourcename = [infinispan configuration filename]`

This configuration is simple and will work fine in most scenarios, but keep in mind that using 'exclusive_index_use' will be neither fast nor scalable. For high performance, high concurrency or production use please refer to the Infinispan documentation for more advanced configuration options and tuning.

The referenced Infinispan configuration should define a `CacheStore` to load/store the index in the NoSQL engine of choice. It should also define three cache names:

Table 54. Infinispan caches used to store indexes

Cache name	Description	Suggested cluster mode
LuceneIndexesLocking	Transfers locking information. Does not need a cache store.	replication
LuceneIndexesData	Contains the bulk of Lucene data. Needs a cache store.	distribution + L1
LuceneIndexesMetadata	Stores metadata on the index segments. Needs a cache store.	replication

This configuration is not going to scale well on write operations: to do that you should read about the master/slave and sharding options in Hibernate Search. The complete explanation and configuration options can be found in the Hibernate Search Reference Guide

Some NoSQL support storage of Lucene indexes directly, in which case you might skip the Infinispan Lucene integration by implementing a custom `DirectoryProvider` for Hibernate Search. You're very welcome to share the code and have it merged in Hibernate Search for others to use, inspect, improve and maintain.

9.3. Hibernate OGM & Infinispan Server over Hot Rod

In this section we'll see how to configure Hibernate OGM to connect to "Infinispan Server using the Hot Rod protocol", which we will call "Infinispan Remote" for brevity and to differentiate it from "Infinispan Embedded".

In this mode Hibernate OGM can not boostrap or otherwise control the lifecycle of Infinispan, so

we will assume that you already have a cluster of Infinispan Server nodes running. For instructions on setting one up, see the Infinispan Server Guide.

The good news is that - since it's a separate service - there won't be much to configure in Hibernate OGM.

The Hibernate OGM support for Infinispan Remote is considered experimental. In particular, the storage format is not set in stone.

9.3.1. Adding Infinispan Remote dependencies

To use Hibernate OGM to connect to an Infinispan Server using the Hot Rod protocol, you will need the following extension and its transitive dependencies (which include, among others, the Hot Rod client):

```
<dependency>
    <groupId>org.hibernate.ogm</groupId>
    <artifactId>hibernate-ogm-infinispan-remote</artifactId>
    <version>5.1.0.Final</version>
</dependency>
```

9.3.2. Configuration properties for Infinispan Remote

First, let Hibernate know that you want to use the OGM Infinispan Remote datastore by setting the `hibernate.ogm.datastore.provider` property to `infinispan_remote`.

The next step is to configure the Hot Rod client. You have two options:

- either provide a resource file containing all Hot Rod client configuration properties
- or include all the Hot Rod client configuration properties with a custom prefix, as explained below.

To use an external configuration resource, set the `hibernate.ogm.infinispan_remote.configuration_resource_name` configuration property to the resource name.

Example 46. Using a separate resource to configure the Hot Rod client

```
<?xml version="1.0"?>
<persistence xmlns="http://java.sun.com/xml/ns/persistence"
    xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
    xsi:schemaLocation="http://java.sun.com/xml/ns/persistence
http://java.sun.com/xml/ns/persistence/persistence_2_0.xsd"
    version="2.0">

    <persistence-unit name="ogm-with-hotrod">
        <provider>
org.hibernate.ogm.jpa.HibernateOgmPersistence</provider> ①
        <properties>
            <property name="hibernate.ogm.datastore.provider"
                value="infinispan_remote" /> ②
            <property name=
"hibernate.ogm.infinispan_remote.configuration_resource_name"
                value="hotrodclient.properties" /> ③
        </properties>
    </persistence-unit>
</persistence>
```

① Choose Hibernate OGM as JPA Provider

② pick `infinispan_remote` as datastore

③ point to the Hot Rod configuration file

```
infinispan.client.hotrod.server_list = 127.0.0.1:11222
infinispan.client.hotrod.tcp_no_delay = true
infinispan.client.hotrod.tcp_keep_alive = false

## below is connection pooling config
maxActive=-1
maxTotal = -1
maxIdle = -1
whenExhaustedAction = 1
timeBetweenEvictionRunsMillis = 120000
minEvictableIdleTimeMillis = 300000
testWhileIdle = true
minIdle = 1
```

Alternatively you can embed the Hot Rod properties in your Hibernate (or JPA) configuration file, but you'll have to replace the `infinispan.client.hotrod.` prefix with the custom prefix `hibernate.ogm.infinispan_remote.client.`.

Some of the Hot Rod client configuration properties don't normally use a prefix - specifically all properties relating to connection pooling as in the previous example - these will also need to use the `hibernate.ogm.infinispan_remote.client.` prefix.

Properties set with the `hibernate.ogm.infinispan_remote.client.` prefix will override the same properties configured using an external reosurce file.

Example 47. Embedding the Hot Rod client configuration properties in the Hibernate configuration

```
<?xml version="1.0"?>
<persistence xmlns="http://java.sun.com/xml/ns/persistence"
    xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
    xsi:schemaLocation="http://java.sun.com/xml/ns/persistence
http://java.sun.com/xml/ns/persistence/persistence_2_0.xsd"
    version="2.0">

    <persistence-unit name="ogm-with-hotrod">
        <provider>
org.hibernate.ogm.jpa.HibernateOgmPersistence</provider> ①
        <properties>
            <property name="hibernate.ogm.datastore.provider"
                value="infinispan_remote" /> ②
            <property name=
"hibernate.ogm.infinispan_remote.client.server_list"
                value="127.0.0.1:11222" /> ③
            <property name=
"hibernate.ogm.infinispan_remote.client.tcp_no_delay"
                value="true" />
            <property name=
"hibernate.ogm.infinispan_remote.client.tcp_keep_alive"
                value="false" />
            <property name=
"hibernate.ogm.infinispan_remote.client.maxActive"
                value="-1" />
            <property name=
"hibernate.ogm.infinispan_remote.client.maxTotal"
                value="-1" />
            <property name=
"hibernate.ogm.infinispan_remote.client.maxIdle"
                value="-1" />
            <property name=
"hibernate.ogm.infinispan_remote.client.whenExhaustedAction"
                value="1" />
            <property name=
"hibernate.ogm.infinispan_remote.client.timeBetweenEvictionRunsMillis"
                value="120000" />
            <property name=
"hibernate.ogm.infinispan_remote.client.minEvictableIdleTimeMillis"
                value="300000" />
            <property name=
"hibernate.ogm.infinispan_remote.client.testWhileIdle"
                value="true" />
            <property name=
"hibernate.ogm.infinispan_remote.client.minIdle"
                value="1" />
        </properties>
    </persistence-unit>
</persistence>
```

① Choose Hibernate OGM as JPA Provider

② pick `infinispan_remote` as datastore

③ include Hot Rod configuration properties, just replacing/adding the OGM prefix.

In the next section we'll see a couple more advanced properties which might be of interest.

hibernate.ogm.infinispan_remote.schema_capture_service

If you set this to an implementation of `org.hibernate.ogm.datastore.infinispanremote.schema.spi.SchemaCapture` you can collect any generated Protobuf Schema. Could be useful for integrations with other tools. You can either provide a fully qualified classname or a `SchemaCapture`, or pass an instance of a `SchemaCapture` in the configuration properties, if you're booting Hibernate programmatically.

hibernate.ogm.infinispan_remote.schema_package_name

Defines the package name of the generated Protobuf schema. Defaults to `HibernateOGMGenerated`. Useful to isolate different applications using the same Infinispan Server instance.

9.3.3. Data encoding: Protobuf Schema

Using the *Infinispan Remote* backend your data will be encoded using Protocol Buffers, also known as Protobuf.

> Protocol Buffers are a language-neutral, platform-neutral extensible mechanism for serializing structured data
>
> — https://developers.google.com/protocol-buffers/

This encoding strategy will be used both during *transmission* to and from the datagrid, and as a *storage format* on the Infinispan Server.

Typical usage of Google's developer tools for Java would require you to download the `protoc` compiler to generate Java stubs; you won't need that when using Hibernate OGM as the backend will generate the encoding and decoding functions on the fly from your entities.

The benefit of having Hibernate OGM generate the schema for you will make it easier to get started, but there's a drawback: you are not directly in control of the protobuf schema It will deploy this schema - or expect a compatible schema to be deployed - as it will use its generated codecs to read and write data to the Infinispan Server.

The protobuf technology is designed to allow evolution of your schema: you can deploy a different schema on the Infinispan Server than the one OGM expects, but this is an advanced topic and you'll have to make sure the deployed schema is compatible with the one OGM is generating and using.

Another reason to make sure the deployed protobuf schema is a *compatible evolution* of a previous schema, is to make sure you can still read data which is already stored in the datagrid.

Remember that the Protobuf schema is used both during *transmission* and *storage*. The fact that it's used also during *transmission* of your data is a key difference to the schema of a SQL database.

For example even if a property "A" is not nullable in terms of storage, you will still want it to be flagged as `optional` in a protobuf schema to allow, for example, retrieving a subset of data properties without having to always retrieve the property "A".

You don't need to do anything regarding the schema: Hibernate OGM will automatically deploy it to the Infinispan datagrid at boostrap of Hibernate. You might want to keep this in mind though, both to be able to evolve your schema without data loss, and to be able to generate decoders for other Infinispan clients not using Hibernate OGM.

The deployed schemas can be fetched from the Infinispan Server; Hibernate OGM also logs the generated schemas at `INFO` level in the logging category `org.hibernate.ogm.datastore.infinispanremote.impl.protobuf.SchemaDefinitions`.

9.3.4. Storage Principles of the Infinispan Remote dataprovider

This is actually very simple.

Imagine you were mapping your entities to a traditional, table based `RDBMS`; now instead of tables, you have caches. Each cache has a name, and a consistent schema, and for each cache we define a key with some properties (the id, aka the primary key).

Relations are mapped by encoding a "foreign key"; these are used either as keys perform a key lookup on another table, or can be used in queries on other tables to identify relations which have a higher than one cardinality.

So let's highlight the differences with the relational world:

Referential integrity

While we can use relations based on foreign keys, Infinispan has no notion of referential integrity. Hibernate is able to maintain the integrity as it won't "forget" stale references, but since the storage doesn't support transactions either it is possible to interrupt Hibernate OGM during such maintenance and introduce breaks of integrity.

A key. And a Value.

In a key/value store the two elements *key* and *value* are different, separate objects. The schema - and consequentially all operations - generated by Hibernate OGM will treat and encode these two objects separately. You will notice that the attributes of the key are encoded in the value **as well**, as it is not possible to run e.g. range queries on attributes of

keys.

No Sequences, no auto-incrementing values

Infinispan does not support sequences, yet allows concurrent "compare and set" operations; Hibernate OGM makes use of such CAS operations to emulate the need of sequences or auto-incrementing primary keys if your entity mapping uses them, however this solution might not work under high load: make sure to use a different strategy, such as assigning IDs explicitly, or using the `org.hibernate.id.UUIDGenerator` generator. Hibernate OGM will log a warning if it detects excessive spinning on such CAS operations.

Not mapped to JDBC types, but to Protobuf types

Rather than mapping your Java properties to corresponding JDBC (SQL) types, your Java properties are mapped to Protobuf types. See the protobuf documentation for an overview of protocol buffer "primitive" types.

Example 48. Example auto-generated Protobuf Schema for a simple entity

```
import javax.persistence.Column;
import javax.persistence.Entity;
import javax.persistence.Id;

@Entity
public class Hypothesis {

    @Id String id;

    String description;

    @Column(name = "pos")
    int position;

}
```

```
package HibernateOGMGenerated; ①

message Hypothesis_id { ②
    required string id = 1;
}

message Hypothesis {
    required string id = 1;
    optional string description = 2;
    optional int32 pos = 3;  ③
}
```

① The default Protobuf package name.

② A dedicated message type for the Key of the Key/Value pair

③ The `pos` attribute name respects the option of the `@Column` annotation

The above example shows how a Protobuf schema looks like, as automatically generated from a mapped entity. Any property type supported by Hibernate ORM will be converted to a matching Protobuf type.

Each Table requires a Cache with the same name

In a relational database world, when Hibernate defines the schema this implicitly creates the tables; this is not the case on Infinispan.

With Infinispan, the *Protobuf Schema* just unlocks the capability to transmit messages with such payloads (read/write), and allows the remote servers to process the fields, for example to execute queries and extract projections out of the stored entries. So this establishes a transmission and storage encoding contract, but doesn't actually start or allocate any storing Cache.

Hibernate OGM by convention will write to several named `Cache`s, mapping each "table name" to a "cache name". In the above example, when having an `Hypothesis` entity this will write to a Cache named `Hypothesis`.

The benefit is that you can tune each cache (each "table") independently; for example you could configure the caches for the most important data to have a synchronous CacheStore which replicates data to a relational database, and have less important entries use an asynchronous CacheStore, or none at all, to favour performance over redundancy.

The drawback of this design choice is that each named cache must be pre-defined in the Infinispan Server configuration: at this point, the Hot Rod protocol is not allowed to start missing caches so Hibernate OGM can not define the missing tables automatically. It generates the encoding protobuf, but you have to list the Cache names in the server configuration.

For each "table name" your model would generate on a relational database, you have to define a matching Cache on the Infinispan Server.

If any Cache is missing, Hibernate OGM will fail to start and list which table names were expected, but not found. We plan to automate the creation of missing caches in the future.

9.3.5. Known Limitations & Future improvements

The Infinispan Remote dataprovider has some known limitations, some of which are unsolvable without further development of Infinispan itself.

Transaction Support

We're eagerly waiting for Infinispan to support transactions over Hot Rod, as it already provides this feature in Embedded Mode.

Queries

At this point the Hibernate OGM backend is able to run the queries it needs to materialize relations, but does not yet translate JPQL queries nor Criteria queries to the Infinispan remote queries.

Indexing

Infinispan supports Hibernate Search annotations directly embedded within its protobuf schema definitions; this would enable the queries on them to use indexes. Hibernate OGM doesn't generate these annotations in the schemas it generates yet.

Native support for write skew checks

The Hot Rod client has native support for versioning of datagrid entries, yet this is not supported on all of the client APIs. For Hibernate OGM to be able to consistently use versioning requires enhancements to the Hot Rod client API.

Enums

Protobuf has native support for Enum types, yet the JPA annotations force to choose between ordinal or string encoding. We might have to introduce a "native" encoding, probably via a novel mapping annotation. Hibernate OGM supports the native protobuf Encoding but the JPA metadata will always force the ordinal or string representations.

Nesting and embedding

The Protobuf schema could allow us to embed objects, including series of objects, as nested elements. This could allow mappings similar to the document based NoSQL stores, such as our MongoDB dialect, but is not supported yet.

Automatic creating of `Cache`*s*

When deploying the *Protobuf Schema*, we should also automatically define and start the needed Caches if they are not defined. This is currently not allowed over the Hot Rod protocol.

Chapter 10. Ehcache

When combined with Hibernate ORM, Ehcache is commonly used as a 2nd level cache to cache data whose primary storage is a relational database. When used with Hibernate OGM it is not "just a cache" but is used as the main (and exclusive) storage engine for your data.

This is not the reference manual for Ehcache itself: we're going to list only how Hibernate OGM should be configured to use Ehcache; for all the tuning and advanced options please refer to the Ehcache Documentation.

This version of Hibernate OGM is compatible with Ehcache version 2.6.11. Other versions might work, but this is the only version which has been regularly tested with this version of Hibernate OGM.

10.1. Configure Ehcache

Few steps:

- Add the dependencies to classpath
- And then choose one of:
  - Use the default Ehcache configuration (no action needed)
  - Point to your own configuration resource name
- If you need JPQL or HQL queries, add Hibernate Search (Using Hibernate Search)

10.1.1. Adding Ehcache dependencies

To add the dependencies via some Maven-definitions-using tool, add the following module:

```
<dependency>
    <groupId>org.hibernate.ogm</groupId>
    <artifactId>hibernate-ogm-ehcache</artifactId>
    <version>5.1.0.Final</version>
</dependency>
```

If you're not using a dependency management tool, copy all the dependencies from the distribution in the directories:

- `/lib/required`
- `/lib/ehcache`
- Optionally - depending on your container - you might need some of the jars from `/lib/provided`

10.1.2. Ehcache specific configuration properties

Hibernate OGM expects you to define an Ehcache configuration in its own configuration resource; all what we need to set it the resource name.

To use the default configuration provided by Hibernate OGM - which is a good starting point for new users - you don't have to set any property.

Ehcache datastore configuration properties

hibernate.ogm.datastore.provider

To use Ehcache as a datastore provider set it to `ehcache`.

hibernate.ogm.ehcache.configuration_resource_name

Should point to the resource name of an Ehcache configuration file. Defaults to `org/hibernate/ogm/datastore/ehcache/default-ehcache.xml`.

`hibernate.ogm.datastore.keyvalue.cache_storage`

The strategy for persisting data in EhCache. The following two strategies exist (values of the `org.hibernate.ogm.datastore.keyvalue.options.CacheMappingType` enum):

- `CACHE_PER_TABLE`: A dedicated cache will be used for each entity type, association type and id source table.
- `CACHE_PER_KIND`: Three caches will be used: one cache for all entities, one cache for all associations and one cache for all id sources.

Defaults to `CACHE_PER_TABLE`. It is the recommended strategy as it makes it easier to target a specific cache for a given entity.

When bootstrapping a session factory or entity manager factory programmatically, you should use the constants accessible via `EhcacheProperties` when specifying the configuration properties listed above.

Common properties shared between stores are declared on `OgmProperties` (a super interface of `EhcacheProperties`).

For maximum portability between stores, use the most generic interface possible.

10.1.3. Cache names used by Hibernate OGM

Depending on the cache mapping approach, Hibernate OGM will either:

- store each entity type, association type and id source table in a dedicated cache very much like what Hibernate ORM would do. This is the `CACHE_PER_TABLE` approach.
- store data in three different caches when using the `CACHE_PER_KIND` approach:
  - `ENTITIES`: is going to be used to store the main attributes of all your entities.
  - `ASSOCIATIONS`: stores the association information representing the links between entities.
  - `IDENTIFIER_STORE`: contains internal metadata that Hibernate OGM needs to provide sequences and auto-incremental numbers for primary key generation.

The preferred strategy is `CACHE_PER_TABLE` as it offers both more fine grained configuration options and the ability to work on specific entities in a more simple fashion.

10.2. Storage principles

To describe things simply, each entity is stored under a single key. The value itself is a map containing the columns / values pair.

Each association from one entity instance to (a set of) another is stored under a single key. The value contains the navigational information to the (set of) entity.

10.2.1. Properties and built-in types

Each entity is represented by a map. Each property or more precisely column is represented by an entry in this map, the key being the column name.

Hibernate OGM supports by default the following property types:

- `java.lang.String`
- `java.lang.Character` (or char primitive)
- `java.lang.Boolean` (or boolean primitive); Optionally the annotations `@Type(type = "true_false")`, `@Type(type = "yes_no")` and `@Type(type = "numeric_boolean")` can be used to map boolean properties to the characters 'T'/'F', 'Y'/'N' or the int values 0/1, respectively.
- `java.lang.Byte` (or byte primitive)
- `java.lang.Short` (or short primitive)
- `java.lang.Integer` (or integer primitive)
- `java.lang.Long` (or long primitive)
- `java.lang.Integer` (or integer primitive)

- `java.lang.Float` (or float primitive)
- `java.lang.Double` (or double primitive)
- `java.math.BigDecimal`
- `java.math.BigInteger`
- `java.util.Calendar`
- `java.util.Date`
- `java.util.UUID`
- `java.util.URL`

Hibernate OGM doesn't store null values in Ehcache, setting a value to null is the same as removing the corresponding entry from Ehcache.

This can have consequences when it comes to queries on null value.

10.2.2. Identifiers

Entity identifiers are used to build the key in which the entity is stored in the cache.

The key is comprised of the following information:

- the identifier column names
- the identifier column values
- the entity table (for the `CACHE_PER_KIND` strategy)

In `CACHE_PER_TABLE`, the table name is inferred from the cache name. In `CACHE_PER_KIND`, the table name is necessary to identify the entity in the generic cache.

Example 49. Define an identifier as a primitive type

```
@Entity
public class Bookmark {

    @Id
    private Long id;

    private String title;

    // getters, setters ...
}
```

Table 55. Content of the `Bookmark` cache in `CACHE_PER_TABLE`

KEY	MAP ENTRIES	
["id"], [42]	id	42
	title	"Hibernate OGM documentation"

Table 56. Content of the `ENTITIES` cache in `CACHE_PER_KIND`

KEY	MAP ENTRIES	
"Bookmark", ["id"], [42]	id	42
	title	"Hibernate OGM documentation"

Example 50. Define an identifier using @EmbeddedId

```
@Embeddable
public class NewsID implements Serializable {

    private String title;
    private String author;

    // getters, setters ...
}

@Entity
public class News {

    @EmbeddedId
    private NewsID newsId;
    private String content;

    // getters, setters ...
}
```

Table 57. Content of the `News` cache in `CACHE_PER_TABLE`

KEY	MAP ENTRIES	
[newsId.author, newsId.title], ["Guillaume", "How to use Hibernate OGM ?"]	newsId.author	"Guillaume"
	newsId.title	"How to use Hibernate OGM ?"
	content	"Simple, just like ORM but with a NoSQL database"

Table 58. Content of the `ENTITIES` cache in `CACHE_PER_KIND`

KEY	MAP ENTRIES	
"News", [newsId.author, newsId.title], ["Guillaume", "How to use Hibernate OGM ?"]	newsId.author	"Guillaume"
	newsId.title	"How to use Hibernate OGM ?"
	content	"Simple, just like ORM but with a NoSQL database"

Identifier generation strategies

Since Ehcache has not native sequence nor identity column support, these are simulated using the table strategy, however their default values vary. We highly recommend you explicitly use a `TABLE` strategy if you want to generate a monotonic identifier.

But if you can, use a pure in-memory and scalable strategy like a UUID generator.

Example 51. Id generation strategy TABLE using default values

```
@Entity
public class GuitarPlayer {

    @Id
    @GeneratedValue(strategy = GenerationType.TABLE)
    private long id;

    private String name;

    // getters, setters ...
}
```

Table 59. Content of the `hibernate_sequences` cache in `CACHE_PER_TABLE`

KEY	NEXT VALUE
["sequence_name"], ["default"]	2

Table 60. Content of the IDENTIFIERS cache in `CACHE_PER_KIND`

KEY	NEXT VALUE
"hibernate_sequences", ["sequence_name"], ["default"]	2

As you can see, in `CACHE_PER_TABLE`, the key does not contain the id source table name. It is inferred by the cache name hosting that key.

Example 52. Id generation strategy TABLE using a custom table

```
@Entity
public class GuitarPlayer {

    @Id
    @GeneratedValue(strategy = GenerationType.TABLE, generator =
"guitarGen")
    @TableGenerator(
        name = "guitarGen",
        table = "GuitarPlayerSequence",
        pkColumnName = "seq"
        pkColumnValue = "guitarPlayer",
    )
    private long id;

    // getters, setters ...
}
```

Table 61. Content of the `GuitarPlayerSequence` cache in `CACHE_PER_TABLE`

KEY	NEXT VALUE
["seq"], ["guitarPlayer"]	2

Table 62. Content of the IDENTIFIERS cache in `CACHE_PER_KIND`

KEY	NEXT VALUE
"GuitarPlayerSequence", ["seq"], ["guitarPlayer"]	2

Example 53. SEQUENCE id generation strategy

```
@Entity
public class Song {

  @Id
  @GeneratedValue(strategy = GenerationType.SEQUENCE, generator =
"songSequenceGenerator")
  @SequenceGenerator(
       name = "songSequenceGenerator",
       sequenceName = "song_sequence",
       initialValue = 2,
       allocationSize = 20
  )
  private Long id;

  private String title;

  // getters, setters ...
}
```

Table 63. Content of the `hibernate_sequences` cache in `CACHE_PER_TABLE`

KEY	NEXT VALUE
["sequence_name"], ["song_sequence"]	11

Table 64. Content of the `IDENTIFIERS` cache in `CACHE_PER_KIND`

KEY	NEXT VALUE
"hibernate_sequences", "["sequence_name"], ["song_sequence"]	11

10.2.3. Entities

Entities are stored in the cache named after the entity name when using the `CACHE_PER_TABLE` strategy. In the `CACHE_PER_KIND` strategy, entities are stored in a single cache named `ENTITIES`.

The key is comprised of the following information:

- the identifier column names
- the identifier column values
- the entity table (for the `CACHE_PER_KIND` strategy)

In `CACHE_PER_TABLE`, the table name is inferred from the cache name. In `CACHE_PER_KIND`, the table name is necessary to identify the entity in the generic cache.

The entry value is itself a map which contains all the entity properties - or to be specific

columns. Each column name and value is stored as a key / value pair in the map.

Example 54. Default JPA mapping for an entity

```
@Entity
public class News {

    @Id
    private String id;
    private String title;

    // getters, setters ...
}
```

Table 65. Content of the `News` cache in `CACHE_PER_TYPE`

KEY	MAP ENTRIES	
["id"], ["1234-5678"]	id	"1234-5678"
	title	"On the merits of NoSQL"

Table 66. Content of the `ENTITIES` cache in `CACHE_PER_KIND`

KEY	MAP ENTRIES	
"News", ["id"], ["1234-5678"]	id	"1234-5678"
	title	"On the merits of NoSQL"

As you can see, the table name is not part of the key for `CACHE_PER_TYPE`. In the rest of this section we will no longer show the `CACHE_PER_KIND` strategy.

Example 55. Rename field and collection using @Table and @Column

```
@Entity
@Table(name = "Article")
public class News {

    @Id
    private String id;

    @Column(name = "headline")
    private String title;

    // getters, setters ...
}
```

Table 67. Content of the `Article` cache

KEY	MAP ENTRIES	
["id"], ["1234-5678"]	id	"1234-5678"
	headline	"On the merits of NoSQL"

Embedded objects and collections

Example 56. Embedded object

```
@Entity
public class News {

    @Id
    private String id;
    private String title;

    @Embedded
    private NewsPaper paper;

    // getters, setters ...
}

@Embeddable
public class NewsPaper {

    private String name;
    private String owner;

    // getters, setters ...
}
```

Table 68. Content of the `News` cache

KEY	MAP ENTRIES	
["id"], ["1234-5678"]	id	"1234-5678"
	title	"On the merits of NoSQL"
	paper.name	"NoSQL journal of prophecies"
	paper.owner	"Delphy"

Example 57. @ElementCollection with one attribute

```
@Entity
public class GrandMother {

    @Id
    private String id;

    @ElementCollection
    private List<GrandChild> grandChildren = new ArrayList<GrandChild>();

    // getters, setters ...
}

@Embeddable
public class GrandChild {

    private String name;

    // getters, setters ...
}
```

Table 69. Content of the `GrandMother` cache

KEY	MAP ENTRIES	
["id"], ["granny"]	id	"granny"

Table 70. Content of the `associations_GrandMother_grandChildren` cache in `CACHE_PER_TYPE`

KEY	ROW KEY	ROW MAP ENTRIES	
["GrandMother_id"], ["granny"]	["GrandMother_id", "name"], ["granny", "Leia"]	GrandMother_id	"granny"
		name	"Leia"
	["GrandMother_id", "name"], ["granny", "Luke"]	GrandMother_id	"granny"
		name	"Luke"

Table 71. Content of the `ASSOCIATIONS` cache in `CACHE_PER_KIND`

KEY	ROW KEY	ROW MAP ENTRIES	
"GrandMother_grandChildren", ["GrandMother_id"], ["granny"]	["GrandMother_id", "name"], ["granny", "Leia"]	GrandMother_id	"granny"
		name	"Leia"
	["GrandMother_id", "name"], ["granny", "Luke"]	GrandMother_id	"granny"
		name	"Luke"

Here, we see that the collection of elements is stored in a separate cache and entry. The association key is made of:

- the foreign key column names pointing to the owner of this association
- the foreign key column values pointing to the owner of this association
- the association table name in the `CACHE_PER_KIND` approach where all associations share the same cache

The association entry is a map containing the representation of each entry in the collection. The keys of that map are made of:

- the names of the columns uniquely identifying that specific collection entry (e.g. for a `Set` this is all of the columns)
- the values of the columns uniquely identifying that specific collection entry

The value attack to that collection entry key is a Map containing the key value pairs column name / column value.

Example 58. @ElementCollection with @OrderColumn

```
@Entity
public class GrandMother {

    @Id
    private String id;

    @ElementCollection
    @OrderColumn( name = "birth_order" )
    private List<GrandChild> grandChildren = new ArrayList<GrandChild>();

    // getters, setters ...
}

@Embeddable
public class GrandChild {

    private String name;

    // getters, setters ...
}
```

Table 72. Content of the `GrandMother` cache

KEY	MAP ENTRIES	
["id"], ["granny"]	id	"granny"

Table 73. Content of the `GrandMother_grandChildren` cache

KEY	ROW KEY	ROW MAP ENTRIES	
["GrandMother_id"], ["granny"]	["GrandMother_id", "birth_order"], ["granny", 0]	GrandMother_id	"granny"
		birth_order	0
		name	"Leia"
	["GrandMother_id", "birth_order"], ["granny", 1]	GrandMother_id	"granny"
		birth_order	1
		name	"Luke"

Here we used an indexed collection and to identify the entry in the collection, only the owning entity id and the index value is enough.

Example 59. @ElementCollection with Map of @Embeddable

```
@Entity
public class ForumUser {

    @Id
    private String name;

    @ElementCollection
    private Map<String, JiraIssue> issues = new HashMap<>();

    // getters, setters ...
}

@Embeddable
public class JiraIssue {

    private Integer number;
    private String project;

    // getters, setters ...
}
```

Table 74. Content of the `ForumUser` cache

KEY	MAP ENTRIES	
["id"], ["Jane Doe"]	id	"Jane Doe"

Table 75. Content of the `ForumUser_issues` cache

KEY	ROW KEY	ROW MAP ENTRIES	
["ForumUser_id"], ["Jane Doe"]	["ForumUser_id", "issues_KEY"], ["Jane Doe", "issueWithNull"]	ForumUser_id	Jane Doe
		issue_KEY	"issueWithNull"
		issues.value.project	<null>
		issues.value.number	<null>
	["ForumUser_id", "issues_KEY"], ["Jane Doe", "issue1"]	ForumUser_id	"Jane Doe"
		issue_KEY	"issue1"
		issues.value.project	"OGM"
		issues.value.number	1253
	["ForumUser_id", "issues_KEY"], ["Jane Doe", "issue2"]	ForumUser_id	"Jane Doe"
		issue_KEY	"issue2"
		issues.value.project	"HSEARCH"
		issues.value.number	2000

10.2.4. Associations

Associations between entities are mapped like (collection of) embeddables except that the

target entity is represented by its identifier(s).

Example 60. Unidirectional one-to-one

```
@Entity
public class Vehicule {

    @Id
    private String id;
    private String brand;

    // getters, setters ...
}

@Entity
public class Wheel {

    @Id
    private String id;
    private double diameter;

    @OneToOne
    private Vehicule vehicule;

    // getters, setters ...
}
```

Table 76. Content of the `Vehicule` cache

KEY	MAP ENTRIES	
["id"], ["V_01"]	id	"V_01"
	brand	"Mercedes"

Table 77. Content of the `Wheel` cache

KEY	MAP ENTRIES	
["id"], ["W001"]	id	"W001"
	diameter	0.0
	vehicule_id	"V_01"

Example 61. Unidirectional one-to-one with @JoinColumn

```
@Entity
public class Vehicule {

    @Id
    private String id;
    private String brand;

    // getters, setters ...
}


@Entity
public class Wheel {

    @Id
    private String id;
    private double diameter;

    @OneToOne
    @JoinColumn( name = "part_of" )
    private Vehicule vehicule;

    // getters, setters ...
}
```

Table 78. Content of the `Vehicle` cache

KEY	MAP ENTRIES	
["id"], ["V_01"]	id	"V_01"
	brand	"Mercedes"

Table 79. Content of the `Wheel` cache

KEY	MAP ENTRIES	
"Wheel", ["id"], ["W001"]	id	"W001"
	diameter	0.0
	part_of	"V_01"

Example 62. Unidirectional one-to-one with @MapsId and @PrimaryKeyJoinColumn

```
@Entity
public class Vehicule {

    @Id
    private String id;
    private String brand;

    // getters, setters ...
}

@Entity
public class Wheel {

    @Id
    private String id;
    private double diameter;

    @OneToOne
    @PrimaryKeyJoinColumn
    @MapsId
    private Vehicule vehicule;

    // getters, setters ...
}
```

Table 80. Content of the `Vehicle` cache

KEY	MAP ENTRIES	
["id"], ["V_01"]	id	"V_01"
	brand	"Mercedes"

Table 81. Content of the `Wheel` cache

KEY	MAP ENTRIES	
["vehicule_id"], ["V_01"]	vehicule_id	"V_01"
	diameter	0.0

Example 63. Bidirectional one-to-one

```
@Entity
public class Husband {

    @Id
    private String id;
    private String name;

    @OneToOne
    private Wife wife;

    // getters, setters ...
}

@Entity
public class Wife {

    @Id
    private String id;
    private String name;

    @OneToOne(mappedBy="wife")
    private Husband husband;

    // getters, setters ...
}
```

Table 82. Content of the `Husband` cache

KEY	MAP ENTRIES	
["id"], ["alex"]	id	"alex"
	name	"Alex"
	wife	"bea"

Table 83. Content of the `Wife` cache

KEY	MAP ENTRIES	
["id"], ["bea"]	id	"bea"
	name	"Bea"

Table 84. Content of the `associations_Husband` cache

KEY	ROW KEY	MAP ENTRIES	
["wife"], ["bea"]	["id", "wife"], ["alex", "bea"]	id	"alex"
		wife	"bea"

Example 64. Unidirectional one-to-many

```
@Entity
public class Basket {

    @Id
    private String id;

    private String owner;

    @OneToMany
    private List<Product> products = new ArrayList<Product>();

    // getters, setters ...
}

@Entity
public class Product {

    @Id
    private String name;

    private String description;

    // getters, setters ...
}
```

Table 85. Content of the `Basket` cache

KEY	MAP ENTRIES	
["id"], ["davide_basket"]	id	"davide_basket"
	owner	"Davide"

Table 86. Content of the `Product` cache

KEY	MAP ENTRIES	
["name"], ["Beer"]	name	"Beer"
	description	"Tactical Nuclear Penguin"
["name"], ["Pretzel"]	name	"Pretzel"
	description	"Glutino Pretzel Sticks"

Table 87. Content of the `associations_Basket_Product` cache

KEY	ROW KEY	MAP ENTRIES	
["Basket_id"], ["davide_basket"]	["Basket_id", "products_name"], ["davide_basket", "Beer"]	Basket_id	"davide_basket"
		products_name	"Beer"
	["Basket_id", "products_name"], ["davide_basket", "Pretzel"]	Basket_id	"davide_basket"
		products_name	"Pretzel"

Example 65. Unidirectional one-to-many with `@JoinTable`

```
@Entity
public class Basket {

    @Id
    private String id;

    private String owner;

    @OneToMany
    @JoinTable( name = "BasketContent" )
    private List<Product> products = new ArrayList<Product>();

    // getters, setters ...
}

@Entity
public class Product {

    @Id
    private String name;

    private String description;

    // getters, setters ...
}
```

Table 88. Content of the `Basket` cache

KEY	MAP ENTRIES	
["id"], ["davide_basket"]	id	"davide_basket"
	owner	"Davide"

Table 89. Content of the `Basket` cache

KEY	MAP ENTRIES	
["name"], ["Beer"]	name	"Beer"
	description	"Tactical Nuclear Penguin"
["name"], ["Pretzel"]	name	"Pretzel"
	description	"Glutino Pretzel Sticks"

Table 90. Content of the `associations_BasketContent` cache

KEY	ROW KEY	MAP ENTRIES	
["Basket_id"], ["davide_basket"]	["Basket_id", "products_name"], ["davide_basket", "Beer"]	Basket_id	"davide_basket"
		products_name	"Beer"
	["Basket_id", "products_name"], ["davide_basket", "Pretzel"]	Basket_id	"davide_basket"
		products_name	"Pretzel"

Example 66. Unidirectional one-to-many using maps with defaults

```
@Entity
public class User {

    @Id
    private String id;

    @OneToMany
    private Map<String, Address> addresses = new HashMap<String, Address
>();

    // getters, setters ...
}

@Entity
public class Address {

    @Id
    private String id;
    private String city;

    // getters, setters ...
}
```

Table 91. Content of the `User` cache

KEY	MAP ENTRIES	
["id"], ["user_001"]	id	"user_001"

Table 92. Content of the `Address` cache

KEY	MAP ENTRIES	
["id"], ["address_001"]	id	"address_001"
	city	"Rome"
["id"], ["address_002"]	id	"address_002"
	city	"Paris"

Table 93. Content of the `associations_User_address` cache

KEY	ROW KEY	MAP ENTRIES	
["User_id"], "user_001"]	["User_id", "addresses_KEY"], ["user_001", "home"]	User_id	"user_001"
		addresses_KEY	"home"
		addresses_id	"address_001"
	["User_id", "addresses_KEY"], ["user_001", "work"]	User_id	"user_002"
		addresses_KEY	"work"
		addresses_id	"address_002"

Example 67. Unidirectional one-to-many using maps with @MapKeyColumn

```
@Entity
public class User {

    @Id
    private String id;

    @OneToMany
    @MapKeyColumn(name = "addressType")
    private Map<String, Address> addresses = new HashMap<String, Address
>();

    // getters, setters ...
}

@Entity
public class Address {

    @Id
    private String id;
    private String city;

    // getters, setters ...
}
```

Table 94. Content of the `User` cache

KEY	MAP ENTRIES	
["id"], ["user_001"]	id	"user_001"

Table 95. Content of the `Address` cache

KEY	MAP ENTRIES	
["id"], ["address_001"]	id	"address_001"
	city	"Rome"
["id"], ["address_002"]	id	"address_002"
	city	"Paris"

Table 96. Content of the `associations_User_address` cache

KEY	ROW KEY	MAP ENTRIES	
["User_id"], "user_001"]	["User_id", "addressType"], ["user_001", "home"]	User_id	"user_001"
		addressesType	"home"
		addresses_id	"address_001"
	["User_id", "addressType"], ["user_001", "work"]	User_id	"user_002"
		addressesType	"work"
		addresses_id	"address_002"

Example 68. Unidirectional many-to-one

```
@Entity
public class JavaUserGroup {

    @Id
    private String jugId;
    private String name;

    // getters, setters ...
}

@Entity
public class Member {

    @Id
    private String id;
    private String name;

    @ManyToOne
    private JavaUserGroup memberOf;

    // getters, setters ...
}
```

Table 97. Content of the `JavaUserGroup` cache

KEY	MAP ENTRIES	
["jugId"], ["summer_camp"]	jugId	"summer_camp"
	name	"JUG Summer Camp"

Table 98. Content of the `Member` cache

KEY	MAP ENTRIES	
["member_id"], ["emmanuel"]	member_id	"emmanuel"
	name	"Emmanuel Bernard"
	memberOf_jug_id	"summer_camp"
["member_id"], ["jerome"]	member_id	"jerome"
	name	"Jerome"
	memberOf_jug_id	"summer_camp"

Example 69. Bidirectional many-to-one

```
@Entity
public class SalesForce {

    @Id
    private String id;
    private String corporation;

    @OneToMany(mappedBy = "salesForce")
    private Set<SalesGuy> salesGuys = new HashSet<SalesGuy>();

    // getters, setters ...
}

@Entity
public class SalesGuy {
    private String id;
    private String name;

    @ManyToOne
    private SalesForce salesForce;

    // getters, setters ...
}
```

Table 99. Content of the `SalesForce` cache

KEY	MAP ENTRIES	
["id"], ["red_hat"]	id	"red_hat"
	corporation	"Red Hat"

Table 100. Content of the `SalesGuy` cache

KEY	MAP ENTRIES	
["id"], ["eric"]	id	"eric"
	name	"Eric"
	salesForce_id	"red_hat"
["id"], ["simon"]	id	"simon"
	name	"Simon"
	salesForce_id	"red_hat"

Table 101. Content of the `associations_SalesGuy` cache

KEY	ROW KEY	MAP ENTRIES	
["salesForce_id"], ["red_hat"]	["salesForce_id", "id"], ["red_hat", "eric"]	salesForce_id	"red_hat"
		id	"eric"
	["salesForce_id", "id"], ["red_hat", "simon"]	salesForce_id	"red_hat"
		id	"simon"

Example 70. Unidirectional many-to-many

```
@Entity
public class Student {

    @Id
    private String id;
    private String name;

    // getters, setters ...
}

@Entity
public class ClassRoom {

    @Id
    private long id;
    private String lesson;

    @ManyToMany
    private List<Student> students = new ArrayList<Student>();

    // getters, setters ...
}
```

The "Math" class has 2 students: John Doe and Mario Rossi

The "English" class has 2 students: Kate Doe and Mario Rossi

Table 102. Content of the `ClassRoom` cache

KEY	MAP ENTRIES	
["id"], [1]	id	1
	name	"Math"
["id"], [2]	id	2
	name	"English"

Table 103. Content of the `Student` cache

KEY	MAP ENTRIES	
["id"], ["john"]	id	"john"
	name	"John Doe"
["id"], ["mario"]	id	"mario"
	name	"Mario Rossi"
["id"], ["kate"]	id	"kate"
	name	"Kate Doe"

Table 104. Content of the `associations_ClassRoom_Student` cache

KEY	ROW KEY	MAP ENTRIES	
["ClassRoom_id"], [1]	["ClassRoom_id", "students_id"], [1, "mario"]	ClassRoom_id	1
		students_id	"mario"
	["ClassRoom_id", "students_id"], [1, "john"]	ClassRoom_id	1
		students_id	"john"
["ClassRoom_id"], [2]	["ClassRoom_id", "students_id"], [2, "kate"]	ClassRoom_id	2
		students_id	"kate"
	["ClassRoom_id", "students_id"], [2, "mario"]	ClassRoom_id	2
		students_id	"mario"

Example 71. Bidirectional many-to-many

```
@Entity
public class AccountOwner {

    @Id
    private String id;

    private String SSN;

    @ManyToMany
    private Set<BankAccount> bankAccounts;

    // getters, setters ...
}

@Entity
public class BankAccount {

    @Id
    private String id;

    private String accountNumber;

    @ManyToMany( mappedBy = "bankAccounts" )
    private Set<AccountOwner> owners = new HashSet<AccountOwner>();

    // getters, setters ...
}
```

David owns 2 accounts: "012345" and "ZZZ-009"

Table 105. Content of the `AccountOwner` cache

KEY	MAP ENTRIES	
["id"], ["David"]	id	"David"
	SSN	"0123456"

Table 106. Content of the `BankAccount` cache

KEY	MAP ENTRIES	
["id"], ["account_1"]	id	"account_1"
	accountNumber	"X2345000"
["id"], ["account_2"]	id	"account_2"
	accountNumber	"ZZZ-009"

Table 107. Content of the `AccountOwner_BankAccount` cache

KEY	ROW KEY	MAP ENTRIES	
["bankAccounts_id"], ["account_1"]	["bankAccounts_id", "owners_id"], ["account_1", "David"]	bankAccounts_id	"account_1"
		owners_id	"David"
["bankAccounts_id"], ["account_2"]	["bankAccounts_id", "owners_id"], ["account_2", "David"]	bankAccounts_id	"account_2"
		owners_id	"David"
["owners_id"], ["David"]	["owners_id", "banksAccounts_id"], ["David", "account_1"]	bankAccounts_id	"account_1"
		owners_id	"David"
	["owners_id", "banksAccounts_id"], ["David", "account_2"]	bankAccounts_id	"account_2"
		owners_id	"David"

10.3. Transactions

While Ehcache technically supports transactions, Hibernate OGM is currently unable to use them. Careful!

If you need this feature, it should be easy to implement: contributions welcome! See JIRA OGM-243.

Chapter 11. MongoDB

MongoDB is a document oriented datastore written in C++ with strong emphasis on ease of use. The nested nature of documents make it a particularly natural fit for most object representations.

This implementation is based upon the MongoDB Java driver. The currently supported version is 3.4.

11.1. Configuring MongoDB

Configuring Hibernate OGM to use MongoDb is easy:

- Add the MongoDB module and driver to the classpath
- provide the MongoDB URL to Hibernate OGM

11.1.1. Adding MongoDB dependencies

To add the dependencies via Maven, add the following module:

```
<dependency>
    <groupId>org.hibernate.ogm</groupId>
    <artifactId>hibernate-ogm-mongodb</artifactId>
    <version>5.1.0.Final</version>
</dependency>
```

This will pull the MongoDB driver transparently.

If you're not using a dependency management tool, copy all the dependencies from the distribution in the directories:

- `/lib/required`
- `/lib/mongodb`
- Optionally - depending on your container - you might need some of the jars from `/lib/provided`

MongoDB does not require Hibernate Search for the execution of JPQL or HQL queries.

11.1.2. MongoDB specific configuration properties

To get started quickly, pay attention to the following options:

- `hibernate.ogm.datastore.provider`

- `hibernate.ogm.datastore.host`
- `hibernate.ogm.datastore.database`

And we should have you running. The following properties are available to configure MongoDB support:

MongoDB datastore configuration properties

hibernate.ogm.datastore.provider

To use MongoDB as a datastore provider, this property must be set to `mongodb`

hibernate.ogm.option.configurator

The fully-qualified class name or an instance of a programmatic option configurator (see Programmatic configuration)

hibernate.ogm.datastore.host

The hostname and port of the MongoDB instance. The optional port is concatenated to the host and separated by a colon. When using replica sets, you can define the various servers in a comma separated list of hosts and ports. Let's see a few valid examples:

- `mongodb.example.com`
- `mongodb.example.com:27018`
- `2001:db8::ff00:42:8329` (IPv6)
- `[2001:db8::ff00:42:8329]:27018` (IPv6 with port requires the IPv6 to be surrounded by square brackets)
- `www.example.com, www2.example.com:123, 192.0.2.1, 192.0.2.2:123, 2001:db8::ff00:42:8329, [2001:db8::ff00:42:8329]:123` (replica set)

The default value is `127.0.0.1:27017`. If left undefined, the default port is `27017`.

hibernate.ogm.datastore.port

Deprecated: use `hibernate.ogm.datastore.host`. The port used by the MongoDB instance. Ignored when multiple hosts are defined. The default value is `27017`.

hibernate.ogm.datastore.database

The database to connect to. This property has no default value.

hibernate.ogm.datastore.create_database

If set to true, the database will be created if it doesn't exist. This property default value is false.

hibernate.ogm.datastore.username

The username used when connecting to the MongoDB server. This property has no default value.

hibernate.ogm.datastore.password

The password used to connect to the MongoDB server. This property has no default value. This property is ignored if the username isn't specified.

hibernate.ogm.error_handler

The fully-qualified class name, class object or an instance of `ErrorHandler` to get notified upon errors during flushes (see Acting upon errors during application of changes)

*hibernate.ogm.mongodb.driver.**

Defines a prefix for all options which should be passed through to the MongoDB driver. For available options refer to the JavaDocs of MongoClientOptions.Builder. All `String`, `int` and `boolean` properties can be set, eg `hibernate.ogm.mongodb.driver.serverSelectionTimeout`.

hibernate.ogm.mongodb.authentication_database

Defines the name of the authentication database, default value is *admin*.

hibernate.ogm.mongodb.authentication_mechanism

Defines the authentication mechanism to use. Possible values are:

- `BEST`: Handshakes with the server to find the best authentication mechanism.
- `SCRAM_SHA_1`: The SCRAM SHA 1 Challenge Response mechanism as described in this RFC.
- `MONGODB_CR`: The MongoDB Challenge Response mechanism (deprecated since MongoDB 3)
- `GSSAPI`: The GSSAPI mechanism. See the RFC
- `MONGODB_X509`: The MongoDB X.509
- `PLAIN`: The PLAIN mechanism. See the RFC

hibernate.ogm.datastore.document.association_storage

Defines the way OGM stores association information in MongoDB. The following two strategies exist (values of the `org.hibernate.ogm.datastore.document.options.AssociationStorageType` enum):

- `IN_ENTITY`: store association information within the entity
- `ASSOCIATION_DOCUMENT`: store association information in a dedicated document per association

`IN_ENTITY` is the default and recommended option unless the association navigation data is much bigger than the core of the document and leads to performance degradation.

hibernate.ogm.mongodb.association_document_storage

Defines how to store assocation documents (applies only if the `ASSOCIATION_DOCUMENT` association storage strategy is used). Possible strategies are (values of the `org.hibernate.ogm.datastore.mongodb.options.AssociationDocumentStorageType` enum):

- `GLOBAL_COLLECTION` (default): stores the association information in a unique MongoDB collection for all associations
- `COLLECTION_PER_ASSOCIATION` stores the association in a dedicated MongoDB collection per association

hibernate.ogm.datastore.document.map_storage

Defines the way OGM stores the contents of map-typed associations in MongoDB. The following two strategies exist (values of the `org.hibernate.ogm.datastore.document.options.MapStorageType` enum):

- `BY_KEY`: map-typed associations with a single key column which is of type `String` will be stored as a sub-document, organized by the given key; Not applicable for other types of key columns, in which case always `AS_LIST` will be used
- `AS_LIST`: map-typed associations will be stored as an array containing a sub-document for each map entry. All key and value columns will be contained within the array elements

hibernate.ogm.mongodb.write_concern

Defines the write concern setting to be applied when issuing writes against the MongoDB datastore. Possible settings are (values of the `WriteConcernType` enum): `ACKNOWLEDGED`, `UNACKNOWLEDGED`, `FSYNCED`, `JOURNALED`, `REPLICA_ACKNOWLEDGED`, `MAJORITY` and `CUSTOM`. When set to `CUSTOM`, a custom `WriteConcern` implementation type has to be specified.

This option is case insensitive and the default value is `ACKNOWLEDGED`.

hibernate.ogm.mongodb.write_concern_type

Specifies a custom `WriteConcern` implementation type (fully-qualified name, class object or instance). This is useful in cases where the pre-defined configurations are not sufficient, e.g. if you want to ensure that writes are propagated to a specific number of replicas or given "tag set". Only takes effect if `hibernate.ogm.mongodb.write_concern` is set to `CUSTOM`.

hibernate.ogm.mongodb.read_preference

Specifies the `ReadPreference` to be applied when issuing reads against the MongoDB datastore. Possible settings are (values of the `ReadPreferenceType` enum): `PRIMARY`,

`PRIMARY_PREFERRED`, `SECONDARY`, `SECONDARY_PREFERRED` and `NEAREST`. It's currently not possible to plug in custom read preference types. If you're interested in such a feature, please let us know.

For more information, please refer to the official documentation.

When bootstrapping a session factory or entity manager factory programmatically, you should use the constants accessible via `org.hibernate.ogm.datastore.mongodb.MongoDBProperties` when specifying the configuration properties listed above.

Common properties shared between stores are declared on `OgmProperties` (a super interface of `MongoDBProperties`).

For maximum portability between stores, use the most generic interface possible.

11.1.3. FongoDB Provider

Fongo is an in-memory java implementation of MongoDB. It intercepts calls to the standard mongo-java-driver for finds, updates, inserts, removes and other methods. The primary use is for lightweight unit testing where you don't want to spin up a `mongod` process.

Hibernate OGM provides a FongoDB provider so during tests it can be used instead of MongoDB driver. Note that you don't need to change your business code to adapt to FongoDB because all adaptations are done under the cover by Hibernate OGM.

To start using FongoDB provider, you should do two things:

The first one is register the provider by using `hibernate.ogm.datastore.provider` and setting to `fongodb`.

Example 72. Configuring FongoDB provider

```
<persistence-unit name="ogm-jpa-tutorial" transaction-type="JTA">
    <provider>org.hibernate.ogm.jpa.HibernateOgmPersistence</provider>
    <properties>
        <property name="hibernate.ogm.datastore.provider" value="fongodb
"/>
        <property name="hibernate.transaction.jta.platform"
                  value=
"org.hibernate.service.jta.platform.internal.JBossStandAloneJtaPlatform"/
>
    </properties>
</persistence-unit>
```

The second one is adding FongoDB and SLF4J dependencies in your project.

```
<dependency>
    <groupId>com.github.fakemongo</groupId>
    <artifactId>fongo</artifactId>
    <version>2.0.7</version>
    <scope>test</scope>
</dependency>
<dependency>
    <groupId>org.slf4j</groupId>
    <artifactId>slf4j-simple</artifactId>
    <version>1.7.7</version>
    <scope>test</scope>
</dependency>
```

You can read more about FongoDB project and its limitations at https://github.com/fakemongo/fongo

11.1.4. Annotation based configuration

Hibernate OGM allows to configure store-specific options via Java annotations. You can override global configurations for a specific entity or even a specify property by virtue of the location where you place that annotation.

When working with the MongoDB backend, you can specify the following settings:

- the write concern for entities and associations using the `@WriteConcern` annotation
- the read preference for entities and associations using the `@ReadPreference` annotation
- a strategy for storing associations using the `@AssociationStorage` and `@AssociationDocumentStorage` annotations
- a strategy for storing the contents of map-typed associations using the `@MapStorage` annotation

Refer to <<mongodb-associations> to learn more about the options related to storing associations.

The following shows an example:

Example 73. Configuring the association storage strategy using annotations

```
@Entity
@WriteConcern(WriteConcernType.JOURNALED)
@ReadPreference(ReadPreferenceType.PRIMARY_PREFERRED)
@AssociationStorage(AssociationStorageType.ASSOCIATION_DOCUMENT)
@AssociationDocumentStorage(AssociationDocumentStorageType.COLLECTION_PER
_ASSOCIATION)
@MapStorage(MapStorageType.AS_LIST)
public class Zoo {

    @OneToMany
    private Set<Animal> animals;

    @OneToMany
    private Set<Person> employees;

    @OneToMany
    @AssociationStorage(AssociationStorageType.IN_ENTITY)
    private Set<Person> visitors;

    // getters, setters ...
}
```

The `@WriteConcern` annotation on the entity level expresses that all writes should be done using the `JOURNALED` setting. Similarly, the `@ReadPreference` annotation advices the engine to preferably read that entity from the primary node if possible. The other two annotations on the type-level specify that all associations of the `Zoo` class should be stored in separate assocation documents, using a dedicated collection per association. This setting applies to the `animals` and `employees` associations. Only the elements of the `visitors` association will be stored in the document of the corresponding `Zoo` entity as per the configuration of that specific property which takes precedence over the entity-level configuration.

11.1.5. Programmatic configuration

In addition to the annotation mechanism, Hibernate OGM also provides a programmatic API for applying store-specific configuration options. This can be useful if you can't modify certain entity types or don't want to add store-specific configuration annotations to them. The API allows set options in a type-safe fashion on the global, entity and property levels.

When working with MongoDB, you can currently configure the following options using the API:

- write concern
- read preference
- association storage strategy
- association document storage strategy

- strategy for storing the contents of map-typed associations

To set these options via the API, you need to create an `OptionConfigurator` implementation as shown in the following example:

Example 74. Example of an option configurator

```
public class MyOptionConfigurator extends OptionConfigurator {

    @Override
    public void configure(Configurable configurable) {
        configurable.configureOptionsFor( MongoDB.class )
            .writeConcern( WriteConcernType.REPLICA_ACKNOWLEDGED )
            .readPreference( ReadPreferenceType.NEAREST )
            .entity( Zoo.class )
                .associationStorage( AssociationStorageType
.ASSOCIATION_DOCUMENT )
                .associationDocumentStorage(
AssociationDocumentStorageType.COLLECTION_PER_ASSOCIATION )
                .mapStorage( MapStorageType.ASLIST )
                .property( "animals", ElementType.FIELD )
                    .associationStorage( AssociationStorageType.IN_ENTITY
)
            .entity( Animal.class )
                .writeConcern( new RequiringReplicaCountOf( 3 ) )
                .associationStorage( AssociationStorageType
.ASSOCIATION_DOCUMENT );
    }
}
```

The call to `configureOptionsFor()`, passing the store-specific identifier type `MongoDB`, provides the entry point into the API. Following the fluent API pattern, you then can configure global options (`writeConcern()`, `readPreference()`) and navigate to single entities or properties to apply options specific to these (`associationStorage()` etc.). The call to `writeConcern()` for the `Animal` entity shows how a specific write concern type can be used. Here `RequiringReplicaCountOf` is a custom implementation of `WriteConcern` which ensures that writes are propagated to a given number of replicas before a write is acknowledged.

Options given on the property level precede entity-level options. So e.g. the `animals` association of the `Zoo` class would be stored using the in entity strategy, while all other associations of the `Zoo` entity would be stored using separate association documents.

Similarly, entity-level options take precedence over options given on the global level. Global-level options specified via the API complement the settings given via configuration properties. In case a setting is given via a configuration property and the API at the same time, the latter takes precedence.

Note that for a given level (property, entity, global), an option set via annotations is overridden

by the same option set programmatically. This allows you to change settings in a more flexible way if required.

To register an option configurator, specify its class name using the `hibernate.ogm.option.configurator` property. When bootstrapping a session factory or entity manager factory programmatically, you also can pass in an `OptionConfigurator` instance or the class object representing the configurator type.

11.2. Storage principles

Hibernate OGM tries to make the mapping to the underlying datastore as natural as possible so that third party applications not using Hibernate OGM can still read and update the same datastore. We worked particularly hard on the MongoDB model to offer various classic mappings between your object model and the MongoDB documents.

To describe things simply, each entity is stored as a MongoDB document. This document is stored in a MongoDB collection named after the entity type. The navigational information for each association from one entity to (a set of) entity is stored in the document representing the entity we are departing from.

11.2.1. Properties and built-in types

Each entity is represented by a document. Each property or more precisely column is represented by a field in this document, the field name being the column name.

Hibernate OGM supports by default the following property types:

- `java.lang.String`

```
{ "text" : "Hello world!" }
```

- `java.lang.Character` (or char primitive)

```
{ "delimiter" : "/" }
```

- `java.lang.Boolean` (or boolean primitive)

```
{ "favorite" : true } # default mapping
{ "favorite" : "T" } # if @Type(type = "true_false") is given
{ "favorite" : "Y" } # if @Type(type = "yes_no") is given
{ "favorite" : 1 } # if @Type(type = "numeric_boolean") is given
```

- `java.lang.Byte` (or byte primitive)

```
{ "display_mask" : "70" }
```

- `java.lang.Byte[]` (or byte[])

```
{ "pdfAsBytes" : BinData(0,"MTIzNDU=") }
```

- `java.lang.Short` (or short primitive)

```
{ "urlPort" : 80 }
```

- `java.lang.Integer` (or integer primitive)

```
{ "stockCount" : 12309 }
```

- `java.lang.Long` (or long primitive)

```
{ "userId" : NumberLong("-6718902786625749549") }
```

- `java.lang.Float` (or float primitive)

```
{ "visitRatio" : 10.39 }
```

- `java.lang.Double` (or double primitive)

```
{ "tax_percentage" : 12.34 }
```

- `java.math.BigDecimal`

```
{ "site_weight" : "21.77" }
```

- `java.math.BigInteger`

```
{ "site_weight" : "444" }
```

- `java.util.Calendar`

```
{ "creation" : "2014/11/03 16:19:49:283 +0000" }
```

- `java.util.Date`

```
{ "last_update" : ISODate("2014-11-03T16:19:49.283Z") }
```

- `java.util.UUID`

```
{ "serialNumber" : "71f5713d-69c4-4b62-ad15-aed8ce8d10e0" }
```

- `java.util.URL`

```
{ "url" : "http://www.hibernate.org/" }
```

- `org.bson.types.ObjectId`

```
{ "object_id" : ObjectId("547d9b40e62048750f25ef77") }
```

Hibernate OGM doesn't store null values in MongoDB, setting a value to null is the same as removing the field in the corresponding object in the db.

This can have consequences when it comes to queries on null value.

11.2.2. Entities

Entities are stored as MongoDB documents and not as BLOBs: each entity property will be translated into a document field. You can use `@Table` and `@Column` annotations to rename respectively the collection the document is stored in and the document's field a property is persisted in.

Example 75. Default JPA mapping for an entity

```
@Entity
public class News {

    @Id
    private String id;
    private String title;

    // getters, setters ...
}
```

```
// Stored in the Collection "News"
{
    "_id" : "1234-5678-0123-4567",
    "title": "On the merits of NoSQL",
}
```

Example 76. Rename field and collection using @Table and @Column

```
@Entity
// Overrides the collection name
@Table(name = "News_Collection")
public class News {

    @Id
    private String id;

    // Overrides the field name
    @Column(name = "headline")
    private String title;

    // getters, setters ...
}
```

```
// Stored in the Collection "News"
{
    "_id" : "1234-5678-0123-4567",
    "headline": "On the merits of NoSQL",
}
```

Identifiers

Hibernate OGM always store identifiers using the `_id` field of a MongoDB document ignoring the name of the property in the entity.

That's a good thing as MongoDB has special treatment and expectation of the property `_id`.

An identifier type may be one of the built-in types or a more complex type represented by an embedded class. When you use a built-in type, the identifier is mapped like a regular property. When you use an embedded class, then the `_id` is representing a nested document containing the embedded class properties.

Example 77. Define an identifier as a primitive type

```
@Entity
public class Bookmark {

    @Id
    private String id;

    private String title;

    // getters, setters ...
}
```

```
{
  "_id" : "bookmark_1"
  "title" : "Hibernate OGM documentation"
}
```

Example 78. Define an identifier using @EmbeddedId

```
@Embeddable
public class NewsID implements Serializable {

    private String title;
    private String author;

    // getters, setters ...
}

@Entity
public class News {

    @EmbeddedId
    private NewsID newsId;
    private String content;

    // getters, setters ...
}
```

News collection as JSON in MongoDB

```
{
  "_id" : {
      "author" : "Guillaume",
      "title" : "How to use Hibernate OGM ?"
  },
  "content" : "Simple, just like ORM but with a NoSQL database"
}
```

Generally, it is recommended though to work with MongoDB's object id data type. This will facilitate the integration with other applications expecting that common MongoDB id type. To do so, you have two options:

- Define your id property as `org.bson.types.ObjectId`
- Define your id property as `String` and annotate it with `@Type(type="objectid")`

In both cases the id will be stored as native `ObjectId` in the datastore.

Example 79. Define an id as ObjectId

```
@Entity
public class News {

    @Id
    private ObjectId id;

    private String title;

    // getters, setters ...
}
```

Example 80. Define an id of type String as ObjectId

```
@Entity
public class News {

    @Id
    @Type(type = "objectid")
    private String id;

    private String title;

    // getters, setters ...
}
```

Identifier generation strategies

You can assign id values yourself or let Hibernate OGM generate the value using the `@GeneratedValue` annotation.

There are 4 different strategies:

1. IDENTITY (suggested)
2. TABLE
3. SEQUENCE
4. AUTO

1) IDENTITY generation strategy

The preferable strategy, Hibernate OGM will create the identifier upon insertion. To apply this strategy the id must be one of the following:

- annotated with `@Type(type="objectid")`

- `org.bson.types.ObjectId`

like in the following examples:

Example 81. Define an id of type String as ObjectId

```
@Entity
public class News {

    @Id
    @GeneratedValue(strategy = GenerationType.IDENTITY)
    @Type(type = "objectid")
    private String id;

    private String title;

    // getters, setters ...
}
```

```
{
    "_id" : ObjectId("5425448830048b67064d40b1"),
    "title" : "Exciting News"
}
```

Example 82. Define an id as ObjectId

```
@Entity
public class News {

    @Id
    @GeneratedValue(strategy = GenerationType.IDENTITY)
    private ObjectId id;

    private String title;

    // getters, setters ...
}
```

```
{
    "_id" : ObjectId("5425448830048b67064d40b1"),
    "title" : "Exciting News"
}
```

2) TABLE generation strategy

Example 83. Id generation strategy TABLE using default values

```
@Entity
public class GuitarPlayer {

    @Id
    @GeneratedValue(strategy = GenerationType.TABLE)
    private Long id;

    private String name;

    // getters, setters ...
}
```

GuitarPlayer collection

```
{
    "_id" : NumberLong(1),
    "name" : "Buck Cherry"
}
```

hibernate_sequences collection

```
{
    "_id" : "GuitarPlayer",
    "next_val" : 101
}
```

Example 84. Id generation strategy TABLE using a custom table

```
@Entity
public class GuitarPlayer {

    @Id
    @GeneratedValue(strategy = GenerationType.TABLE, generator =
"guitarGen")
    @TableGenerator(
        name = "guitarGen",
        table = "GuitarPlayerSequence",
        pkColumnValue = "guitarPlayer",
        valueColumnName = "nextGuitarPlayerId"
    )
    private long id;

    // getters, setters ...
}
```

GuitarPlayer collection

```
{
    "_id" : NumberLong(1),
    "name" : "Buck Cherry"
}
```

GuitarPlayerSequence collection

```
{
    "_id" : "guitarPlayer",
    "nextGuitarPlayerId" : 2
}
```

3) SEQUENCE generation strategy

Example 85. SEQUENCE id generation strategy using default values

```
@Entity
public class Song {

  @Id
  @GeneratedValue(strategy = GenerationType.SEQUENCE)
  private Long id;

  private String title;

  // getters, setters ...
}
```

Song collection

```
{
  "_id" : NumberLong(2),
  "title" : "Flower Duet"
}
```

hibernate_sequences collection

```
{ "_id" : "song_sequence_name", "next_val" : 21 }
```

Example 86. SEQUENCE id generation strategy using custom values

```
@Entity
public class Song {

  @Id
  @GeneratedValue(strategy = GenerationType.SEQUENCE, generator =
"songSequenceGenerator")
  @SequenceGenerator(
       name = "songSequenceGenerator",
       sequenceName = "song_seq",
       initialValue = 2,
       allocationSize = 20
  )
  private Long id;

  private String title;

  // getters, setters ...
}
```

Song collection

```
{
  "_id" : NumberLong(2),
  "title" : "Flower Duet"
}
```

hibernate_sequences collection

```
{ "_id" : "song_seq", "next_val" : 42 }
```

4) AUTO generation strategy

Care must be taken when using the `GenerationType.AUTO` strategy. When the property `hibernate.id.new_generator_mappings` is set to `false` (default), it will map to the `IDENTITY` strategy. As described before, this requires your ids to be of type `ObjectId` or `@Type(type = "objectid") String`. If `hibernate.id.new_generator_mappings` is set to true, `AUTO` will be mapped to the `TABLE` strategy. This requires your id to be of a numeric type.

We recommend to not use `AUTO` but one of the explicit strategies (`IDENTITY` or `TABLE`) to avoid potential misconfigurations.

For more details you can check the issue OGM-663.

If the property `hibernate.id.new_generator_mappings` is set to `false`, `AUTO` will behave as the `IDENTITY` strategy.

If the property `hibernate.id.new_generator_mappings` is set to `true`, `AUTO` will behave as the `SEQUENCE` strategy.

Example 87. AUTO id generation strategy using default values

```
@Entity
public class DistributedRevisionControl {

  @Id
  @GeneratedValue(strategy = GenerationType.AUTO)
  private Long id;

  private String name;

  // getters, setters ...
}
```

DistributedRevisionControl collection

```
{ "_id" : NumberLong(1), "name" : "Git" }
```

hibernate_sequences collection

```
{ "_id" : "hibernate_sequence", "next_val" : 2 }
```

Example 88. AUTO id generation strategy wih `hibernate.id.new_generator_mappings` set to false and ObjectId

```
@Entity
public class Comedian {

  @Id
  @GeneratedValue(strategy = GenerationType.AUTO)
  private ObjectId id;

  private String name;

  // getters, setters ...
}
```

Comedian collection

```
{ "_id" : ObjectId("5458b11693f4add0f90519c5"), "name" : "Louis C.K." }
```

Example 89. Entity with @EmbeddedId

```
@Entity
public class News {

    @EmbeddedId
    private NewsID newsId;

    // getters, setters ...
}

@Embeddable
public class NewsID implements Serializable {

    private String title;
    private String author;

    // getters, setters ...
}
```

Rendered as JSON in MongoDB

```
{
    "_id" :{
        "title": "How does Hibernate OGM MongoDB work?",
        "author": "Guillaume"
    }
}
```

Embedded objects and collections

Hibernate OGM stores elements annotated with `@Embedded` or `@ElementCollection` as nested documents of the owning entity.

Example 90. Embedded object

```
@Entity
public class News {

    @Id
    private String id;
    private String title;

    @Embedded
    private NewsPaper paper;

    // getters, setters ...
}

@Embeddable
public class NewsPaper {

    private String name;
    private String owner;

    // getters, setters ...
}
```

```
{
    "_id" : "1234-5678-0123-4567",
    "title": "On the merits of NoSQL",
    "paper": {
        "name": "NoSQL journal of prophecies",
        "owner": "Delphy"
    }
}
```

Example 91. @ElementCollection with primitive types

```
@Entity
public class AccountWithPhone {

    @Id
    private String id;

    @ElementCollection
    private List<String> mobileNumbers;

    // getters, setters ...
}
```

AccountWithPhone collection

```
{
    "_id" : "john_account",
    "mobileNumbers" : [ "+1-222-555-0222", "+1-202-555-0333" ]
}
```

Example 92. @ElementCollection with one attribute

```
@Entity
public class GrandMother {

    @Id
    private String id;

    @ElementCollection
    private List<GrandChild> grandChildren = new ArrayList<GrandChild>();

    // getters, setters ...
}

@Embeddable
public class GrandChild {

    private String name;

    // getters, setters ...
}
```

```
{
    "_id" : "df153180-c6b3-4a4c-a7da-d5de47cf6f00",
    "grandChildren" : [ "Luke", "Leia" ]
}
```

The class `GrandChild` has only one attribute `name`, this means that Hibernate OGM doesn't

need to store the name of the attribute.

If the nested document has two or more fields, like in the following example, Hibernate OGM will store the name of the fields as well.

Example 93. @ElementCollection with @OrderColumn

```
@Entity
public class GrandMother {

    @Id
    private String id;

    @ElementCollection
    @OrderColumn( name = "birth_order" )
    private List<GrandChild> grandChildren = new ArrayList<GrandChild>();

    // getters, setters ...
}

@Embeddable
public class GrandChild {

    private String name;

    // getters, setters ...
}
```

```
{
    "_id" : "e3e1ed4e-c685-4c3f-9a67-a5aeec6ff3ba",
    "grandChildren" :
        [
            {
                "name" : "Luke",
                "birth_order" : 0
            },
            {
                "name" : "Leia",
                "birthorder" : 1
            }
        ]
}
```

Example 94. @ElementCollection with Map of @Embeddable

```
@Entity
public class ForumUser {

    @Id
    private String name;

    @ElementCollection
    private Map<String, JiraIssue> issues = new HashMap<>();

    // getters, setters ...
}

@Embeddable
public class JiraIssue {

    private Integer number;
    private String project;

    // getters, setters ...
}
```

```
{
        "_id" : "Jane Doe",
        "issues" : {
                "issueWithNull" : {
                },
                "issue2" : {
                    "number" : 2000,
                    "project" : "OGM"
                },
                "issue1" : {
                    "number" : 1253,
                    "project" : "HSEARCH"
                }
        }
}
```

You can override the column name used for a property of an embedded object. But you need to know that the default column name is the concatenation of the embedding property, a `.` (dot) and the embedded property (recursively for several levels of embedded objects).

The MongoDB datastore treats dots specifically as it transforms them into nested documents. If you want to override one column name and still keep the nested structure, don't forget the dots.

That's a bit abstract, so let's use an example.

```
@Entity
class Order {
    @Id String number;
    User user;
    Address shipping;
    @AttributeOverrides({
        @AttributeOverride(name="name", column=@Column(name=
"delivery.provider"),
        @AttributeOverride(name="expectedDelaysInDays",
column=@Column(name="delivery.delays")
    })
    DeliveryProvider deliveryProvider;
    CreditCardType cardType;
}

// default columns
@Embedded
class User {
    String firstname;
    String lastname;
}

// override one column
@Embeddable
public Address {
    String street;
    @Column(name="shipping.dest_city")
    String city;
}

// both columns overridden from the embedding side
@Embeddable
public DeliveryProvider {
    String name;
    Integer expectedDelaysInDays;
}

// do not use dots in the overriding
// and mix levels (bad form)
@Embedded
class CreditCardType {
    String merchant;
    @Column(name="network")
    String network;
}
```

```
{
    "_id": "123RF33",
    "user": {
        "firstname": "Emmanuel",
        "lastname": "Bernard"
    },
    "shipping": {
        "street": "1 av des Champs Elysées",
        "dest_city": "Paris"
    },
    "delivery": {
        "provider": "Santa Claus Inc.",
        "delays": "1"
    }
    "network": "VISA",
    "cardType: {
        "merchant": "Amazon"
    }
}
```

If you share the same embeddable in different places, you can use JPA's `@AttributeOverride` to override columns from the embedding side. This is the case of `DeliveryProvider` in our example.

If you omit the dot in one of the columns, this column will not be part of the nested document. This is demonstrated by the `CreditCardType`. We advise you against it. Like crossing streams, it is bad form. This approach might not be supported in the future.

11.2.3. Associations

Hibernate OGM MongoDB proposes three strategies to store navigation information for associations. The three possible strategies are:

- IN_ENTITY (default)
- ASSOCIATION_DOCUMENT, using a global collection for all associations
- COLLECTION_PER_ASSOCIATION, using a dedicated collection for each association

To switch between these strategies, use of the three approaches to options:

- annotate your entity with `@AssocationStorage` and `@AssociationDocumentStorage` annotations (see Annotation based configuration),
- use the API for programmatic configuration (see Programmatic configuration)
- or specify a default strategy via the `hibernate.ogm.datastore.document.association_storage` and `hibernate.ogm.mongodb.association_document_storage` configuration properties.

In Entity strategy

- *-to-one associations
- *-to-many associations

In this strategy, Hibernate OGM stores the id(s) of the associated entity(ies) into the entity document itself. This field stores the id value for to-one associations and an array of id values for to-many associations. An embedded id will be represented by a nested document. For indexed collections (i.e. `List` or `Map`), the index will be stored along the id.

When using this strategy the annotations `@JoinTable` will be ignored because no collection is created for associations.

You can use `@JoinColumn` to change the name of the field that stores the foreign key (as an example, see Unidirectional one-to-one with @JoinColumn).

To-one associations

Example 95. Unidirectional one-to-one

```
@Entity
public class Vehicule {

    @Id
    private String id;
    private String brand;

    // getters, setters ...
}


@Entity
public class Wheel {

    @Id
    private String id;
    private double diameter;

    @OneToOne
    private Vehicule vehicule;

    // getters, setters ...
}
```

```
{
  "_id" : "V_01",
  "brand" : "Mercedes"
}
```

Wheel collection as JSON in MongoDB

```
{
  "_id" : "W001",
  "diameter" : 0,
  "vehicule_id" : "V_01"
}
```

Example 96. Unidirectional one-to-one with @JoinColumn

```
@Entity
public class Vehicule {

    @Id
    private String id;
    private String brand;

    // getters, setters ...
}


@Entity
public class Wheel {

    @Id
    private String id;
    private double diameter;

    @OneToOne
    @JoinColumn( name = "part_of" )
    private Vehicule vehicule;

    // getters, setters ...
}
```

```
{
  "_id" : "V_01",
  "brand" : "Mercedes"
}
```

Wheel collection as JSON in MongoDB

```
{
  "_id" : "W001",
  "diameter" : 0,
  "part_of" : "V_01"
}
```

In a true one-to-one association, it is possible to share the same id between the two entities and therefore a foreign key is not required. You can see how to map this type of association in the following example:

Example 97. Unidirectional one-to-one with @MapsId and @PrimaryKeyJoinColumn

```
@Entity
public class Vehicule {

    @Id
    private String id;
    private String brand;

    // getters, setters ...
}

@Entity
public class Wheel {

    @Id
    private String id;
    private double diameter;

    @OneToOne
    @PrimaryKeyJoinColumn
    @MapsId
    private Vehicule vehicule;

    // getters, setters ...
}
```

Vehicule collection as JSON in MongoDB

```
{
  "_id" : "V_01",
  "brand" : "Mercedes"
}
```

Wheel collection as JSON in MongoDB

```
{
  "_id" : "V_01",
  "diameter" : 0,
}
```

Example 98. Bidirectional one-to-one

```
@Entity
public class Husband {

    @Id
    private String id;
    private String name;

    @OneToOne
    private Wife wife;

    // getters, setters ...
}

@Entity
public class Wife {

    @Id
    private String id;
    private String name;

    @OneToOne
    private Husband husband;

    // getters, setters ...
}
```

Husband collection as JSON in MongoDB

```
{
  "_id" : "alex",
  "name" : "Alex",
  "wife" : "bea"
}
```

Wife collection as JSON in MongoDB

```
{
  "_id" : "bea",
  "name" : "Bea",
  "husband" : "alex"
}
```

Example 99. Unidirectional many-to-one

```
@Entity
public class JavaUserGroup {

    @Id
    private String jugId;
    private String name;

    // getters, setters ...
}

@Entity
public class Member {

    @Id
    private String id;
    private String name;

    @ManyToOne
    private JavaUserGroup memberOf;

    // getters, setters ...
}
```

JavaUserGroup collection as JSON in MongoDB

```
{
    "_id" : "summer_camp",
    "name" : "JUG Summer Camp"
}
```

Member collection as JSON in MongoDB

```
{
    "_id" : "jerome",
    "name" : "Jerome"
    "memberOf_jugId" : "summer_camp"
}
{
    "_id" : "emmanuel",
    "name" : "Emmanuel Bernard"
    "memberOf_jugId" : "summer_camp"
}
```

Example 100. Bidirectional many-to-one

```
@Entity
public class SalesForce {

    @Id
    private String id;
    private String corporation;

    @OneToMany(mappedBy = "salesForce")
    private Set<SalesGuy> salesGuys = new HashSet<SalesGuy>();

    // getters, setters ...
}

@Entity
public class SalesGuy {
    private String id;
    private String name;

    @ManyToOne
    private SalesForce salesForce;

    // getters, setters ...
}
```

SalesForce collection

```
{
    "_id" : "red_hat",
    "corporation" : "Red Hat",
    "salesGuys" : [ "eric", "simon" ]
}
```

SalesGuy collection

```
{
    "_id" : "eric",
    "name" : "Eric"
    "salesForce_id" : "red_hat",
}
{
    "_id" : "simon",
    "name" : "Simon",
    "salesForce_id" : "red_hat"
}
```

Example 101. Bidirectional many-to-one between entities with embedded ids

```java
@Entity
public class Game {

    @EmbeddedId
    private GameId id;

    private String name;

    @ManyToOne
    private Court playedOn;

    // getters, setters ...
}


public class GameId implements Serializable {

    private String category;

    @Column(name = "id.gameSequenceNo")
    private int sequenceNo;

    // getters, setters ...
    // equals / hashCode
}

@Entity
public class Court {

    @EmbeddedId
    private CourtId id;

    private String name;

    @OneToMany(mappedBy = "playedOn")
    private Set<Game> games = new HashSet<Game>();

    // getters, setters ...
}

public class CourtId implements Serializable {

    private String countryCode;
    private int sequenceNo;

    // getters, setters ...
    // equals / hashCode
}
```

Court collection

```
{
    "_id" : {
        "countryCode" : "DE",
        "sequenceNo" : 123
    },
    "name" : "Hamburg Court",
    "games" : [
        { "gameSequenceNo" : 457, "category" : "primary" },
        { "gameSequenceNo" : 456, "category" : "primary" }
    ]
}
```

Game collection

```
{
    "_id" : {
        "category" : "primary",
        "gameSequenceNo" : 456
    },
    "name" : "The game",
    "playedOn_id" : {
        "countryCode" : "DE",
        "sequenceNo" : 123
    }
}
{
    "_id" : {
        "category" : "primary",
        "gameSequenceNo" : 457
    },
    "name" : "The other game",
    "playedOn_id" : {
        "countryCode" : "DE",
        "sequenceNo" : 123
    }
}
```

Here we see that the embedded id is represented as a nested document and directly referenced by the associations.

To-many associations

Example 102. Unidirectional one-to-many

```
@Entity
public class Basket {

    @Id
    private String id;

    private String owner;

    @OneToMany
    private List<Product> products = new ArrayList<Product>();

    // getters, setters ...
}

@Entity
public class Product {

    @Id
    private String name;

    private String description;

    // getters, setters ...
}
```

Basket collection

```
{
  "_id" : "davide_basket",
  "owner" : "Davide",
  "products" : [ "Beer", "Pretzel" ]
}
```

Product collection

```
{
  "_id" : "Pretzel",
  "description" : "Glutino Pretzel Sticks"
}
{
  "_id" : "Beer",
  "description" : "Tactical nuclear penguin"
}
```

Example 103. Unidirectional one-to-many with @OrderColumn

```
@Entity
public class Basket {

    @Id
    private String id;

    private String owner;

    @OneToMany
    private List<Product> products = new ArrayList<Product>();

    // getters, setters ...
}

@Entity
public class Product {

    @Id
    private String name;

    private String description;

    // getters, setters ...
}
```

Basket collection

```
{
  "_id" : "davide_basket",
  "owner" : "Davide",
  "products" : [
    {
      "products_name" : "Pretzel",
      "products_ORDER" : 1
    },
    {
      "products_name" : "Beer",
      "products_ORDER" : 0
    }
  ]
}
```

Product collection

```
{
  "_id" : "Pretzel",
  "description" : "Glutino Pretzel Sticks"
}
{
  "_id" : "Beer",
  "description" : "Tactical nuclear penguin"
}
```

A map can be used to represent an association, in this case Hibernate OGM will store the key of the map and the associated id.

Example 104. Unidirectional one-to-many using maps with defaults

```
@Entity
public class User {

    @Id
    private String id;

    @OneToMany
    private Map<String, Address> addresses = new HashMap<String, Address
>();

    // getters, setters ...
}

@Entity
public class Address {

    @Id
    private String id;
    private String city;

    // getters, setters ...
}
```

User collection as JSON in MongoDB

```
{
  "_id" : "user_001",
  "addresses" : [
    {
      "work" : "address_001",
      "home" : "address_002"
    }
  ]
}
```

Address collection as JSON in MongoDB

```
{ "_id" : "address_001", "city" : "Rome" }
{ "_id" : "address_002", "city" : "Paris" }
```

If the map value cannot be represented by a single field (e.g. when referencing a type with a composite id or using an embeddable type as map value type), a sub-document containing all the required fields will be stored as value.

If the map key either is not of type `String` or it is made up of several columns (composite map

key), the optimized structure shown in the example above cannot be used as MongoDB only allows for Strings as field names. In that case the association will be represented by a list of sub-documents, also containing the map key column(s). You can use `@MapKeyColumn` to rename the field containing the key of the map, otherwise it will default to "<%COLLECTION_ROLE%>_KEY", e.g. "addresses_KEY".

Example 105. Unidirectional one-to-many using maps with @MapKeyColumn

```
@Entity
public class User {

    @Id
    private String id;

    @OneToMany
    @MapKeyColumn(name = "addressType")
    private Map<Long, Address> addresses = new HashMap<Long, Address>();

    // getters, setters ...
}

@Entity
public class Address {

    @Id
    private String id;
    private String city;

    // getters, setters ...
}
```

User collection as JSON in MongoDB

```
{
  "_id" : "user_001",
  "addresses" : [
    {
      "addressType" : 1,
      "addresses_id" : "address_001"
    },
    {
      "addressType" : 2,
      "addresses_id" : "address_002"
    }
  ]
}
```

Address collection as JSON in MongoDB

```
{ "_id" : "address_001", "city" : "Rome" }
{ "_id" : "address_002", "city" : "Paris" }
```

In case you want to enforce the list-style represention also for maps with a single key column of type `String` (e.g. when reading back data persisted by earlier versions of Hibernate OGM), you can do so by setting the option `hibernate.ogm.datastore.document.map_storage` to the value `AS_LIST`.

Example 106. Unidirectional many-to-many using in entity strategy

```
@Entity
public class Student {

    @Id
    private String id;
    private String name;

    // getters, setters ...
}

@Entity
public class ClassRoom {

    @Id
    private long id;
    private String lesson;

    @ManyToMany
    private List<Student> students = new ArrayList<Student>();

    // getters, setters ...
}
```

Student collection

```
{
  "_id" : "john",
  "name" :"John Doe" }
{
  "_id" : "mario",
  "name" : "Mario Rossi"
}
{
  "_id" : "kate",
  "name" : "Kate Doe"
}
```

ClassRoom collection

```
{
  "_id" : NumberLong(1),
  "lesson" : "Math"
  "students" : [
     "mario",
     "john"
  ]
}
{
  "_id" : NumberLong(2),
  "lesson" : "English"
  "students" : [
     "mario",
     "kate"
  ]
}
```

Example 107. Bidirectional many-to-many

```
@Entity
public class AccountOwner {

    @Id
    private String id;

    private String SSN;

    @ManyToMany
    private Set<BankAccount> bankAccounts;

    // getters, setters ...
}

@Entity
public class BankAccount {

    @Id
    private String id;

    private String accountNumber;

    @ManyToMany( mappedBy = "bankAccounts" )
    private Set<AccountOwner> owners = new HashSet<AccountOwner>();

    // getters, setters ...
}
```

AccountOwner collection

```
{
    "_id" : "owner_1",
    "SSN" : "0123456"
    "bankAccounts" : [ "account_1" ]
}
```

BankAccount collection

```
{
    "_id" : "account_1",
    "accountNumber" : "X2345000"
    "owners" : [ "owner_1", "owner2222" ]
}
```

Example 108. Ordered list with embedded id

```java
@Entity
public class Race {
    @EmbeddedId
    private RaceId raceId;

    @OrderColumn(name = "ranking")
    @OneToMany @JoinTable(name = "Race_Runners")
    private List<Runner> runnersByArrival = new ArrayList<Runner>();

    // getters, setters ...
}

public class RaceId implements Serializable {
    private int federationSequence;
    private int federationDepartment;

    // getters, setters, equals, hashCode
}

@Entity
public class Runner {
    @EmbeddedId
    private RunnerId runnerId;
    private int age;

    // getters, setters ...
}

public class RunnerId implements Serializable {
    private String firstname;
    private String lastname;

    // getters, setters, equals, hashCode
}
```

Race collection

```json
{
    "_id": {
        "federationDepartment": 75,
        "federationSequence": 23
    },
    "runnersByArrival": [{
        "firstname": "Pere",
        "lastname": "Noel",
        "ranking": 1
    }, {
        "firstname": "Emmanuel",
        "lastname": "Bernard",
        "ranking": 0
    }]
}
```

Runner collection

```
{
    "_id": {
        "firstname": "Pere",
        "lastname": "Noel"
    },
    "age": 105
} {
    "_id": {
        "firstname": "Emmanuel",
        "lastname": "Bernard"
    },
    "age": 37
}
```

One collection per association strategy

In this strategy, Hibernate OGM creates a MongoDB collection per association in which it will store all navigation information for that particular association.

This is the strategy closest to the relational model. If an entity A is related to B and C, 2 collections will be created. The name of this collection is made of the association table concatenated with `associations_`.

For example, if the `BankAccount` and `Owner` are related, the collection used to store will be named `associations_Owner_BankAccount`. You can rename The prefix is useful to quickly identify the association collections from the entity collections. You can also decide to rename the collection representing the association using `@JoinTable` (see an example)

Each document of an association collection has the following structure:

- `_id` contains the id of the owner of relationship
- `rows` contains all the id of the related entities

The preferred approach is to use the in-entity strategy but this approach can alleviate the problem of having documents that are too big.

Example 109. Unidirectional relationship

```
{
    "_id" : { "owners_id" : "owner0001" },
    "rows" : [
        "accountABC",
        "accountXYZ"
    ]
}
```

Example 110. Bidirectional relationship

```
{
    "_id" : { "owners_id" : "owner0001" },
    "rows" : [ "accountABC", "accountXYZ" ]
}
{
    "_id" : { "bankAccounts_id" : "accountXYZ" },
    "rows" : [ "owner0001" ]
}
```

This strategy won't affect *-to-one associations or embedded collections.

Example 111. Unidirectional one-to-many using one collection per strategy

```
@Entity
public class Basket {

    @Id
    private String id;

    private String owner;

    @OneToMany
    private List<Product> products = new ArrayList<Product>();

    // getters, setters ...
}

@Entity
public class Product {

    @Id
    private String name;

    private String description;

    // getters, setters ...
}
```

Basket collection

```
{
  "_id" : "davide_basket",
  "owner" : "Davide"
}
```

Product collection

```
{
  "_id" : "Pretzel",
  "description" : "Glutino Pretzel Sticks"
}
{
  "_id" : "Beer",
  "description" : "Tactical nuclear penguin"
}
```

associations_Basket_Product collection

```
{
  "_id" : { "Basket_id" : "davide_basket" },
  "rows" : [ "Beer", "Pretzel" ]
}
```

The order of the element in the list might be preserved using @OrderColumn. Hibernate OGM will store the order adding an additional fieldd to the document containing the association.

Example 112. Unidirectional one-to-many using one collection per strategy with @OrderColumn

```
@Entity
public class Basket {

    @Id
    private String id;

    private String owner;

    @OneToMany
    @OrderColumn
    private List<Product> products = new ArrayList<Product>();

    // getters, setters ...
}

@Entity
public class Product {

    @Id
    private String name;

    private String description;

    // getters, setters ...
}
```

Basket collection

```
{
  "_id" : "davide_basket",
  "owner" : "Davide"
}
```

Product collection

```
{
  "_id" : "Pretzel",
  "description" : "Glutino Pretzel Sticks"
}
{
  "_id" : "Beer",
  "description" : "Tactical nuclear penguin"
}
```

associations_Basket_Product collection

```
{
  "_id" : { "Basket_id" : "davide_basket" },
  "rows" : [
    {
      "products_name" : "Pretzel",
      "products_ORDER" : 1
    },
    {
      "products_name" : "Beer",
      "products_ORDER" : 0
    }
  ]
}
```

Example 113. Unidirectional many-to-many using one collection per association strategy

```
@Entity
public class Student {

    @Id
    private String id;
    private String name;

    // getters, setters ...
}

@Entity
public class ClassRoom {

    @Id
    private long id;
    private String lesson;

    @ManyToMany
    private List<Student> students = new ArrayList<Student>();

    // getters, setters ...
}
```

Student collection

```
{
  "_id" : "john",
  "name" : "John Doe"
}
{
  "_id" : "mario",
  "name" : "Mario Rossi"
}
{
  "_id" : "kate",
  "name" : "Kate Doe"
}
```

ClassRoom collection

```
{
  "_id" : NumberLong(1),
  "lesson" : "Math"
}
{
  "_id" : NumberLong(2),
  "lesson" : "English"
}
```

associations_ClassRoom_Student

```
{
  "_id" : {
    "ClassRoom_id" : NumberLong(1),
  },
  "rows" : [ "john", "mario" ]
}
{
  "_id" : {
    "ClassRoom_id" : NumberLong(2),
  },
  "rows" : [ "mario", "kate" ]
}
```

Example 114. Bidirectional many-to-many using one collection per association strategy

```java
@Entity
public class AccountOwner {

    @Id
    private String id;

    private String SSN;

    @ManyToMany
    private Set<BankAccount> bankAccounts;

    // getters, setters ...
}

@Entity
public class BankAccount {

    @Id
    private String id;

    private String accountNumber;

    @ManyToMany(mappedBy = "bankAccounts")
    private Set<AccountOwner> owners = new HashSet<AccountOwner>();

    // getters, setters ...
}
```

AccountOwner collection

```
{
  "_id" : "owner_1",
  "SSN" : "0123456"
}
```

BankAccount collection

```
{
  "_id" : "account_1",
  "accountNumber" : "X2345000"
}
```

associations_AccountOwner_BankAccount collection

```
{
  "_id" : {
    "bankAccounts_id" : "account_1"
  },
  "rows" : [ "owner_1" ]
}
{
  "_id" : {
    "owners_id" : "owner_1"
  },
  "rows" : [ "account_1" ]
}
```

You can change the name of the collection containing the association using the `@JoinTable` annotation. In the following example, the name of the collection containing the association is `OwnerBankAccounts` (instead of the default `associations_AccountOwner_BankAccount`)

Example 115. Bidirectional many-to-many using one collection per association strategy and @JoinTable

```
@Entity
public class AccountOwner {

    @Id
    private String id;

    private String SSN;

    @ManyToMany
    @JoinTable( name = "OwnerBankAccounts" )
    private Set<BankAccount> bankAccounts;

    // getters, setters ...
}

@Entity
public class BankAccount {

    @Id
    private String id;

    private String accountNumber;

    @ManyToMany(mappedBy = "bankAccounts")
    private Set<AccountOwner> owners = new HashSet<AccountOwner>();

    // getters, setters ...
}
```

AccountOwner collection

```
{
  "_id" : "owner_1",
  "SSN" : "0123456"
}
```

BankAccount collection

```
{
  "_id" : "account_1",
  "accountNumber" : "X2345000"
}
```

OwnerBankAccount

```
{
  "_id" : {
    "bankAccounts_id" : "account_1"
  },
  "rows" : [ "owner_1" ]
}
{
  "_id" : {
    "owners_id" : "owner_1"
  },
  "rows" : [ "account_1" ]
}
```

Global collection strategy

With this strategy, Hibernate OGM creates a single collection named `Associations` in which it will store all navigation information for all associations. Each document of this collection is structured in 2 parts. The first is the `_id` field which contains the identifier information of the association owner and the name of the association table. The second part is the `rows` field which stores (into an embedded collection) all ids that the current instance is related to.

This strategy won't affect *-to-one associations or embedded collections.

Generally, you should not make use of this strategy unless embedding the association information proves to be too big for your document and you wish to separate them.

Example 116. Associations collection containing unidirectional association

```
{
    "_id": {
        "owners_id": "owner0001",
        "table": "AccountOwner_BankAccount"
    },
    "rows": [ "accountABC", "accountXYZ" ]
}
```

For a bidirectional relationship, another document is created where ids are reversed. Don't worry, Hibernate OGM takes care of keeping them in sync:

Example 117. Associations collection containing a bidirectional association

```
{
    "_id": {
        "owners_id": "owner0001",
        "table": "AccountOwner_BankAccount"
    },
    "rows": [ "accountABC", "accountXYZ" ]
}
{
    "_id": {
        "bankAccounts_id": "accountXYZ",
        "table": "AccountOwner_BankAccount"
    },
    "rows": [ "owner0001" ]
}
```

Example 118. Unidirectional one-to-many using global collection strategy

```java
@Entity
public class Basket {

    @Id
    private String id;

    private String owner;

    @OneToMany
    private List<Product> products = new ArrayList<Product>();

    // getters, setters ...
}

@Entity
public class Product {

    @Id
    private String name;

    private String description;

    // getters, setters ...
}
```

Basket collection

```
{
  "_id" : "davide_basket",
  "owner" : "Davide"
}
```

Product collection

```
{
  "_id" : "Pretzel",
  "description" : "Glutino Pretzel Sticks"
}
{
  "_id" : "Beer",
  "description" : "Tactical nuclear penguin"
}
```

Associations collection

```
{
  "_id" : {
    "Basket_id" : "davide_basket",
    "table" : "Basket_Product"
  },
  "rows" : [
    {
      "products_name" : "Pretzel",
      "products_ORDER" : 1
    },
    {
      "products_name" : "Beer",
    "products_ORDER" : 0
    }
  ]
}
```

Example 119. Unidirectional one-to-many using global collection strategy with `@JoinTable`

```
@Entity
public class Basket {

    @Id
    private String id;

    private String owner;

    @OneToMany
    // It will change the value stored in the field table in the
Associations collection
    @JoinTable( name = "BasketContent" )
    private List<Product> products = new ArrayList<Product>();

    // getters, setters ...
}

@Entity
public class Product {

    @Id
    private String name;

    private String description;

    // getters, setters ...
}
```

Basket collection

```
{
  "_id" : "davide_basket",
  "owner" : "Davide"
}
```

Product collection

```
{
  "_id" : "Pretzel",
  "description" : "Glutino Pretzel Sticks"
}
{
  "_id" : "Beer",
  "description" : "Tactical nuclear penguin"
}
```

Associations collection

```
{
  "_id" : {
    "Basket_id" : "davide_basket",
    "table" : "BasketContent"
  },
  "rows" : [ "Beer", "Pretzel" ]
}
```

Example 120. Unidirectional many-to-many using global collection strategy

```
@Entity
public class Student {

    @Id
    private String id;
    private String name;

    // getters, setters ...
}

@Entity
public class ClassRoom {

    @Id
    private long id;
    private String lesson;

    @ManyToMany
    private List<Student> students = new ArrayList<Student>();

    // getters, setters ...
}
```

Student collection

```
{
  "_id" : "john",
  "name" : "John Doe"
}
{
  "_id" : "mario",
  "name" : "Mario Rossi"
}
{
  "_id" : "kate",
  "name" : "Kate Doe"
}
```

ClassRoom collection

```
{
  "_id" : NumberLong(1),
  "lesson" : "Math"
}
{
  "_id" : NumberLong(2),
  "lesson" : "English"
}
```

Associations collection

```
{
  "_id" : {
    "ClassRoom_id" : NumberLong(1),
    "table" : "ClassRoom_Student"
  },
  "rows" : [ "john", "mario" ]
}
{
  "_id" : {
    "ClassRoom_id" : NumberLong(2),
    "table" : "ClassRoom_Student"
  },
  "rows" : [ "mario", "kate" ]
}
```

Example 121. Bidirectional many-to-many using global collection strategy

```
@Entity
public class AccountOwner {

    @Id
    private String id;

    private String SSN;

    @ManyToMany
    private Set<BankAccount> bankAccounts;

    // getters, setters ...
}

@Entity
public class BankAccount {

    @Id
    private String id;

    private String accountNumber;

    @ManyToMany(mappedBy = "bankAccounts")
    private Set<AccountOwner> owners = new HashSet<AccountOwner>();

    // getters, setters ...
}
```

AccountOwner collection

```
{
  "_id" : "owner0001",
  "SSN" : "0123456"
}
```

BankAccount collection

```
{
  "_id" : "account_1",
  "accountNumber" : "X2345000"
}
```

Associations collection

```
{
  "_id" : {
    "bankAccounts_id" : "account_1",
    "table" : "AccountOwner_BankAccount"
    },

  "rows" : [ "owner0001" ]
}
{
  "_id" : {
    "owners_id" : "owner0001",
    "table" : "AccountOwner_BankAccount"
  },

  "rows" : [ "account_1" ]
}
```

11.3. Indexes and unique constraints

11.3.1. Standard indexes and unique constraints

You can create your index and unique constraints in MongoDB using the standard JPA annotations.

Example 122. Creating indexes and unique constraints using JPA annotations

```
@Entity
@Table(indexes = {
    @Index(columnList = "author, name", name = "author_name_idx", unique
= true),
    @Index(columnList = "name DESC", name = "name_desc_idx")
})
public class Poem {

    @Id
    private String id;
    private String name;
    private String author;

    @Column(unique = true)
    private String url;

   // getters, setters ...
}
```

MongoDB supports unique constraints via unique indexes. It considers `null` as a value to be unique: you can only have one `null` value per unique index. This is not what is commonly accepted as the definition of a unique constraint in the JPA world. Thus, by default, we create the unique indexes as `sparse`: it only indexes defined values so that the unique constraints accept multiple `null` values.

11.3.2. Using MongoDB specific index options

MongoDB supports a number of options for index creation.

It is possible to define them using the `@IndexOption` annotation.

Example 123. Creating indexes with MongoDB specific options

```
@Entity
@Table(indexes = {
    @Index(columnList = "author", name = "author_idx")
})
@IndexOptions(
    @IndexOption(forIndex = "author_idx", options = "{ background : true,
sparse : true, partialFilterExpression : { author: 'Verlaine' } }")
)
public class Poem {

    @Id
    private String id;
    private String name;
    private String author;

   // getters, setters ...
}
```

`@IndexOption` simply passes the options to MongoDB at index creation: you can use every option available in MongoDB.

11.3.3. Full text indexes

MongoDB supports the ability to create one (and only one) full text index per collection.

As JPA does not support the ability to define `text` as an order in the `@Index` annotation (only `ASC` and `DESC` are supported), this ability has been included inside the `@IndexOption` mechanism. You simply need to add `text: true` to the options passed to MongoDB, Hibernate OGM interprets it and translates the index to a full text index.

Example 124. Creating a full text index

```
@Entity
@Table(indexes = {
    @Index(columnList = "author, name", name = "author_name_text_idx")
})
@IndexOptions(
    @IndexOption(forIndex = "author_name_text_idx", options = "{ text:
true, default_language : 'fr', weights : { author: 2, name: 5 } }")
)
public class Poem {

    @Id
    private String id;
    private String name;
    private String author;

   // getters, setters ...
}
```

11.4. Transactions

MongoDB does not support transactions. Only changes applied to the same document are done atomically. A change applied to more than one document will not be applied atomically. This problem is slightly mitigated by the fact that Hibernate OGM queues all changes before applying them during flush time. So the window of time used to write to MongoDB is smaller than what you would have done manually.

We recommend that you still use transaction demarcations with Hibernate OGM to trigger the flush operation transparently (on commit). But do not consider rollback as a possibility, this won't work.

11.5. Optimistic Locking

MongoDB does not provide a built-in mechanism for detecting concurrent updates to the same document but it provides a way to execute atomic find and update operations. By exploiting this commands Hibernate OGM can detect concurrent modifications to the same document.

You can enable optimistic locking detection using the annotation `@Version`:

Example 125. Optimistic locking detection via `@Version`

```
@Entity
public class Planet implements Nameable {

    @Id
    private String id;
    private String name;

    @Version
    private int version;

   // getters, setters ...
}
```

```
{
  "_id" : "planet-1",
  "name" : "Pluto",
  "version" : 0
}
```

The `@Version` annotation define which attribute will keep track of the version of the document, Hibernate OGM will update the field when required and if two changes from two different sessions (for example) are applied to the same document a `org.hibernate.StaleObjectStateException` is thrown.

You can use `@Column` to change the name of the field created on MongoDB:

Example 126. Optimistic locking detection via `@Version` using `@Column`

```
@Entity
public class Planet implements Nameable {

    @Id
    private String id;
    private String name;

    @Version
    @Column(name="OPTLOCK")
    private int version;

   // getters, setters ...
}
```

```
{
  "_id" : "planet-1",
  "name" : "Pluto",
  "OPTLOCK" : 0
}
```

11.6. Queries

You can express queries in a few different ways:

- using JP-QL
- using a native MongoQL query
- using a Hibernate Search query (brings advanced full-text and geospatial queries)

While you can use JP-QL for simple queries, you might hit limitations. The current recommended approach is to use native MongoQL if your query involves nested (list of) elements.

MongoDB doesn't require Hibernate Search to run queries.

In order to reflect changes performed in the current session, all entities affected by a given query are flushed to the datastore prior to query execution (that's the case for Hibernate ORM as well as Hibernate OGM).

For not fully transactional stores such as MongoDB this can cause changes to be written as a side-effect of running queries which cannot be reverted by a possible later rollback.

Depending on your specific use cases and requirements you may prefer to disable auto-flushing, e.g. by invoking `query.setFlushMode( FlushMode.MANUAL )`. Bear in mind though that query results will then not reflect changes applied within the current session.

11.6.1. JP-QL queries

Hibernate OGM is a work in progress, so only a sub-set of JP-QL constructs is available when using the JP-QL query support. This includes:

- simple comparisons using "<", "<=", "=", ">=" and ">"
- `IS NULL` and `IS NOT NULL`
- the boolean operators `AND`, `OR`, `NOT`
- `LIKE`, `IN` and `BETWEEN`
- `ORDER BY`
- inner `JOIN` on embedded collections
- projections of regular and embedded properties

Queries using these constructs will be transformed into equivalent native MongoDB queries.

Let us know by opening an issue or sending an email what query you wish to execute. Expanding our support in this area is high on our priority list.

11.6.2. Native MongoDB queries

Hibernate OGM also supports certain forms of native queries for MongoDB. Currently two forms of native queries are available via the MongoDB backend:

- find queries specifying the search criteria only
- queries specified using the MongoDB CLI syntax (CLI Syntax)

The former always maps results to entity types. The latter either maps results to entity types or to certain supported forms of projection. Note that parameterized queries are not supported by

MongoDB, so don't expect `Query#setParameter()` to work.

You can execute native queries as shown in the following example:

Example 127. Using the JPA API

```
@Entity
public class Poem {

    @Id
    private Long id;

    private String name;

    private String author;

   // getters, setters ...
}

...

javax.persistence.EntityManager em = ...

// criteria-only find syntax
String query1 = "{ $and: [ { name : 'Portia' }, { author : 'Oscar Wilde'
} ] }";
Poem poem = (Poem) em.createNativeQuery( query1, Poem.class )
.getSingleResult();

// criteria-only find syntax with order-by
String query2 = "{ $query : { author : 'Oscar Wilde' }, $orderby : { name
: 1 } }";
List<Poem> poems = em.createNativeQuery( query2, Poem.class )
.getResultList();

// projection via CLI-syntax
String query3 = "db.WILDE_POEM.find(" +
    "{ '$query' : { 'name' : 'Athanasia' }, '$orderby' : { 'name' : 1 }
}" +
    "{ 'name' : 1 }" +
    ")";

// will contain name and id as MongoDB always returns the id for
projections
List<Object[]> poemNames = (List<Object[]>)em.createNativeQuery( query3
).getResultList();

// projection via CLI-syntax
String query4 = "db.WILDE_POEM.count({ 'name' : 'Athanasia' })";

Object[] count = (Object[])em.createNativeQuery( query4 ).
getSingleResult();
```

The result of a query is a managed entity (or a list thereof) or a projection of attributes in form of an object array, just like you would get from a JP-QL query.

Example 128. Using the Hibernate native API

```
OgmSession session = ...

String query1 = "{ $and: [ { name : 'Portia' }, { author : 'Oscar Wilde'
} ] }";
Poem poem = session.createNativeQuery( query1 )
                      .addEntity( "Poem", Poem.class )
                      .uniqueResult();

String query2 = "{ $query : { author : 'Oscar Wilde' }, $orderby : { name
: 1 } }";
List<Poem> poems = session.createNativeQuery( query2 )
                      .addEntity( "Poem", Poem.class )
                      .list();
```

Native queries can also be created using the `@NamedNativeQuery` annotation:

Example 129. Using @NamedNativeQuery

```
@Entity
@NamedNativeQuery(
   name = "AthanasiaPoem",
   query = "{ $and: [ { name : 'Athanasia' }, { author : 'Oscar Wilde' }
] }",
   resultClass = Poem.class )
public class Poem { ... }

...

// Using the EntityManager
Poem poem1 = (Poem) em.createNamedQuery( "AthanasiaPoem" )
                      .getSingleResult();

// Using the Session
Poem poem2 = (Poem) session.getNamedQuery( "AthanasiaPoem" )
                      .uniqueResult();
```

Hibernate OGM stores data in a natural way so you can still execute queries using the MongoDB driver, the main drawback is that the results are going to be raw MongoDB documents and not managed entities.

CLI Syntax

Specifying native MongoDB queries using the CLI syntax is an EXPERIMENTAL feature for the time being.

Hibernate OGM can execute native queries expressed using the MongoDB CLI syntax with some

limitations. Currently `find()`, `findOne()`, `findAndModify()`, and `count()` queries are supported. Furthermore, three types of write queries are supported via the CLI syntax: `insert()`, `remove()`, and `update()`. Other query types may be supported in future versions.

As one would expect, `find()`, `findOne()`, `findAndModify()`, and `count()` can be executed using `javax.persistence.Query.getSingleResult()` or `javax.persistence.Query.getResultList()`, while `insert()`, `remove()`, and `update()` require using `javax.persistence.Query.executeUpdate()`. Also note that, `javax.persistence.Query.executeUpdate()` may return `-1` in case execution of a query was not acknowledged relative to the write concern used.

The following functions can be used in the provided JSON: `BinData`, `Date`, `HexData`, `ISODate`, `NumberLong`, `ObjectId`, `Timestamp`, `RegExp`, `DBPointer`, `UUID`, `GUID`, `CSUUID`, `CSGUID`, `JUUID`, `JGUID`, `PYUUID`, `PYGUID`.

`NumberInt` is not supported as it is currently not supported by the MongoDB Java driver.

No cursor operations such as `sort()` are supported. Instead use the corresponding MongoDB query modifiers such as `$orderby` within the criteria parameter.

You can limit the results of a query using the `setMaxResults(…)` method.

JSON parameters passed via the CLI syntax must be specified using the strict mode. Specifically, keys need to be given within quotes; the only relaxation of this is that single quotes may be used when specifying attribute names/values to facilitate embedding queries within Java strings.

Note that results of projections are returned as retrieved from the MongoDB driver at the moment and are not (yet) converted using suitable Hibernate OGM type implementations. This requirement is tracked under OGM-1031.

Example 130. CLI syntax examples

```
// Valid syntax
String valid = "db.Poem.find({ \"name\" : \"Athanasia\" })";

String alsoValid = "db.Poem.find({ '$or' : [{'name': 'Athanasia' },
{'name': 'Portia' }]})";

String validAggregation = "db.Poem.aggregate([{ '$match': {'author': {
'$regex': 'oscar.*', '$options': 'i' } } }, { '$sort': {'name': -1 } }
])";

// NOT Valid syntax, it will throw an exception:
com.mongodb.util.JSONParseException
String notValid =  "db.Poem.find({ name : \"Athanasia\" })";

String alsoNotValid = "db.Poem.find({ $or : [{name: 'Athanasia' }, {name:
'Portia' }]})";
```

Example 131. CLI syntax sort and limit results alternatives

```
String nativeQuery = "db.Poem.find({ '$query': { 'author': 'Oscar Wilde'
}, '$orderby' : { 'name' : 1 } })";

// Using hibernate session
List<Poem> result = session.createNativeQuery( nativeQuery )
    .addEntity( Poem.class )
    .setMaxResults( 2 )
    .list();

// Using JPA entity manager
List<Poem> results = em.createNativeQuery( nativeQuery, Poem.class )
    .setMaxResults( 2 )
    .getResultList();
```

Example 132. CLI syntax update examples

```
String updateQuery = "db.Poem.findAndModify({ 'query': {'_id': 1},
'update': { '$set': { 'author': 'Oscar Wilde' } }, 'new': true })";
List<Poem> updated = session.createNativeQuery( updateQuery ).addEntity(
Poem.class ).list();

String insertQuery = "db.Poem.insert({ '_id': { '$numberLong': '11' },
'author': 'Oscar Wilder', 'name': 'The one and wildest', 'rating': '1' }
)";
int inserted = session.createNativeQuery( insertQuery ).executeUpdate();

String removeQuery = "db.Poem.remove({ '_id': { '$numberLong': '11' } })
";
int removed = session.createNativeQuery( removeQuery ).executeUpdate();
```

Support for the `$regexp` operator is limited to the string syntax. We do not support the `/pattern/` syntax as it is not currently supported by the MongoDB Java driver.

```
// Valid syntax
String nativeQuery = "{ $query : { author : { $regex :
'^Oscar' } }, $orderby : { name : 1 } }";
List<Poem> result = session.createNativeQuery( nativeQuery )
.addEntity( Poem.class ).list();
```

11.6.3. Hibernate Search

You can index your entities using Hibernate Search. That way, a set of secondary indexes independent of MongoDB is maintained by Hibernate Search and you can run Lucene queries on top of them. The benefit of this approach is a nice integration at the JPA / Hibernate API level (managed entities are returned by the queries). The drawback is that you need to store the Lucene indexes somewhere (file system, infinispan grid, etc). Have a look at the Infinispan section (Storing a Lucene index in Infinispan) for more info on how to use Hibernate Search.

Chapter 12. Neo4j

Neo4j is a robust (fully ACID) transactional property graph database. This kind of databases are suited for those type of problems that can be represented with a graph like social relationships or road maps for example.

Hibernate OGM can connect to an embedded Neo4j or a remote server. The connection to the remote server can occur via the Bolt protocol or the HTTP API.

12.1. How to add Neo4j integration

1. Add the dependencies to your project

If your project uses Maven you can add this to the pom.xml:

```
<dependency>
    <groupId>org.hibernate.ogm</groupId>
    <artifactId>hibernate-ogm-neo4j</artifactId>
    <version>5.1.0.Final</version>
</dependency>
```

Alternatively you can find the required libraries in the distribution package on SourceForge

2. Use the following properties

If you want to use Neo4j in embedded mode:

```
hibernate.ogm.datastore.provider = neo4j_embedded
hibernate.ogm.neo4j.database_path = C:\example\mydb
```

If you want to connect to a remote server without authentication on localhost, you can use:

```
hibernate.ogm.datastore.provider = neo4j_bolt
```

or

```
hibernate.ogm.datastore.provider = neo4j_http
```

The difference between `neo4j_bolt` and `neo4j_http` is that in the first case Hibernate OGM

will connect to the server using the Bolt protocol, in the second case it will use the HTTP interface.

You can select a different host, port and enable authentication with the following additional properties:

```
hibernate.ogm.datastore.provider = neo4j_bolt # or neo4j_http
hibernate.ogm.datastore.host = example.com:8989
hibernate.ogm.datastore.username = example_username
hibernate.ogm.datastore.password = example_password
```

The Neo4j dialects don't require Hibernate Search to run JPQL or HQL queries.

12.2. Configuring Neo4j

The following properties are available to configure Neo4j support:

Neo4j datastore configuration properties

hibernate.ogm.neo4j.database_path

The absolute path representing the location of the Neo4j database. Example: `C:\neo4jdb\mydb`

hibernate.ogm.neo4j.configuration_resource_name (optional)

Location of the Neo4j embedded properties file. It can be an URL, name of a classpath resource or file system path.

hibernate.schema_update.unique_constraint_strategy (optional)

If set to `SKIP`, Hibernate OGM won't create any unique constraints on the nodes representing the entities. This property won't affect the unique constraints generated for sequences. Other possible values (defined on the `org.hibernate.tool.hbm2ddl.UniqueConstraintSchemaUpdateStrategy` enum) are `DROP_RECREATE_QUIETLY` and `RECREATE_QUIETLY` but the effect will be the same (since Neo4j constraints don't have a name): keep the existing constraints and create the missing one. Default value is `DROP_RECREATE_QUIETLY`.

hibernate.ogm.datastore.host (optional)

The host name and the port to use when connecting to a remote server. Default value for HTTP is `localhost:7474`. Default value for Bolt is `localhost:7687`.

hibernate.ogm.datastore.username (optional)

The authentication username for the remote server. Hibernate OGM will try to authenticate only if this property is set.

hibernate.ogm.datastore.password (optional)

The password to use when connecting remotely.

When bootstrapping a session factory or entity manager factory programmatically, you should use the constants defined on `org.hibernate.ogm.datastore.neo4j.Neo4jProperties` when specifying the configuration properties listed above.

Common properties shared between stores are declared on `OgmProperties` (a super interface of `Neo4jProperties`).

For maximum portability between stores, use the most generic interface possible.

12.3. Storage principles

Hibernate OGM tries to make the mapping to the underlying datastore as natural as possible so that third party applications not using Hibernate OGM can still read and update the same datastore.

To make things simple, each entity is represented by a node, each embedded object is also represented by a node. Links between entities (whether to-one to to-many associations) are represented by relationships between nodes. Entity and embedded nodes are labelled `ENTITY` and `EMBEDDED` respectively.

12.3.1. Properties and built-in types

Each entity is represented by a node. Each property or more precisely column is represented by an attribute of this node.

The following types (and corresponding primitives) get passed to Neo4j without any conversion:

- `java.lang.Boolean`; Optionally the annotations `@Type(type = "true_false")`, `@Type(type = "yes_no")` and `@Type(type = "numeric_boolean")` can be used to map boolean properties to the characters 'T'/'F', 'Y'/'N' or the int values 0/1, respectively.
- `java.lang.Character`
- `java.lang.Byte`
- `java.lang.Short`
- `java.lang.Integer`
- `java.lang.Long`
- `java.lang.Float`

- `java.lang.Double`
- `java.lang.String`

The following types get converted into `java.lang.String`:

- `java.math.BigDecimal`
- `java.math.BigInteger`
- `java.util.Calendar`

  ```
  stored as `String` with the format "yyyy/MM/dd HH:mm:ss:SSS Z"
  ```

- `java.util.Date`

  ```
  stored as `String` with the format "yyyy/MM/dd HH:mm:ss:SSS Z"
  ```

- `java.util.UUID`
- `java.util.URL`

Hibernate OGM doesn't store null values in Neo4J, setting a value to null is the same as removing the corresponding entry from Neo4J.

This can have consequences when it comes to queries on null value.

12.3.2. Entities

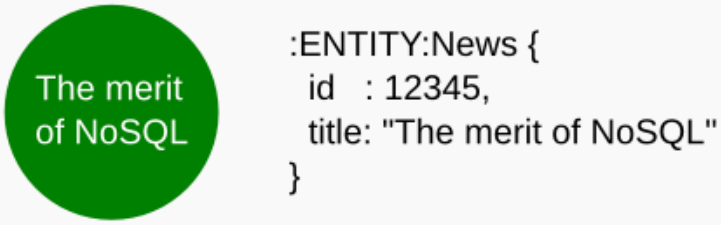
Entities are stored as Neo4j nodes, which means each entity property will be translated into a property of the node. The name of the table mapping the entity is used as label.

You can use the name property of the `@Table` and `@Column` annotations to rename the label and the node's properties.

An additional label `ENTITY` is added to the node.

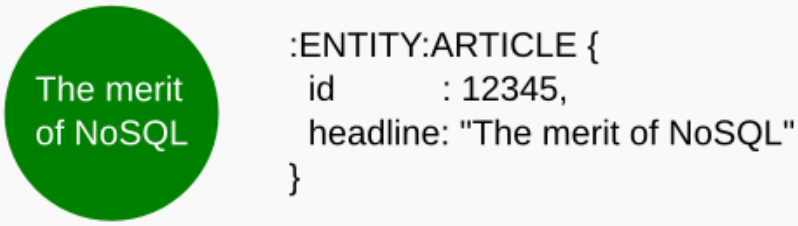
Example 133. Default JPA mapping for an entity

```
@Entity
public class News {

    @Id
    private String id;
    private String title;

    // getters, setters ...
}
```



Example 134. Rename node label and properties using @Table and @Column

```
@Entity
@Table(name="ARTICLE")
public class News {

    @Id
    private String id;

    @Column(name = "headline")
    private String title;

    // getters, setters ...
}
```



Identifiers and unique constraints

Neo4j does not support constraints on more than one property. For this reason, Hibernate OGM will create a unique constraint ONLY when it spans a single property and it will ignore the ones spanning multiple properties.

The lack of unique constraints on node properties might result in the creation of multiple nodes with the same identifier.

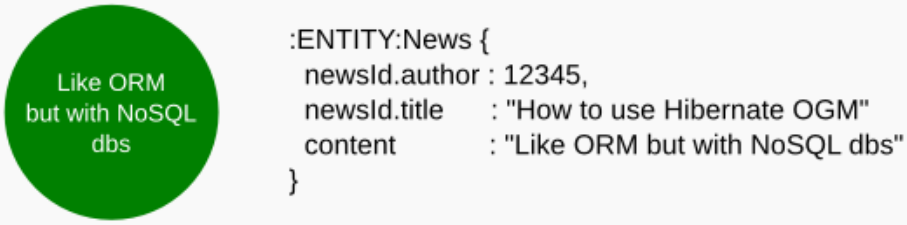
Hibernate OGM will create unique constraints for the identifier of entities and for the properties annotated with:

- `@Id`
- `@EmbeddedId`
- `@NaturalId`
- `@Column( unique = true )`
- `@Table( uniqueConstraints = @UniqueConstraint(columnNames = { "column_name" } ) )`

Embedded identifiers are currently stored as dot separated properties.

Example 135. Entity with @EmbeddedId

```
@Entity
public class News {

    @EmbeddedId
    private NewsID newsId;

    private String content

    // getters, setters ...
}

@Embeddable
public class NewsID implements Serializable {

    private String title;
    private String author;

    // getters, setters ...
}
```



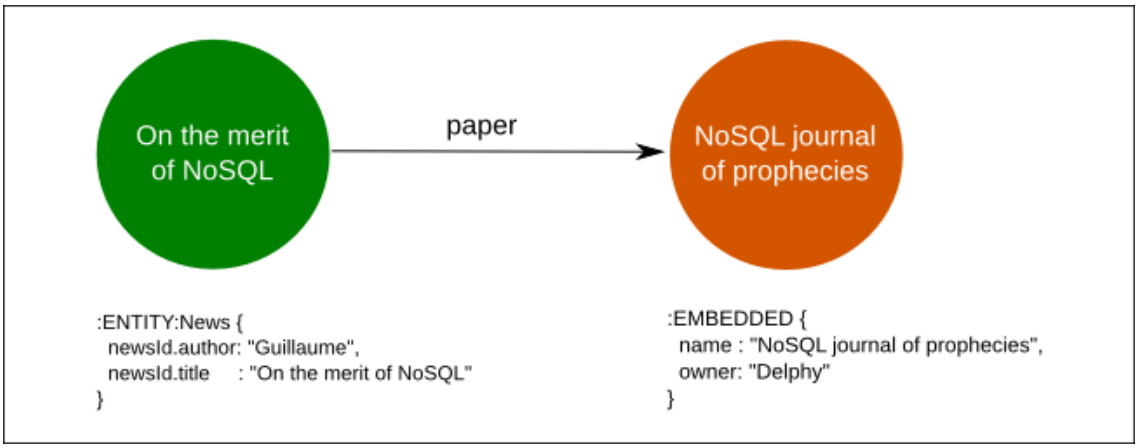
Embedded objects and collections

Embedded elements are stored as separate nodes labeled with `EMBEDDED`.

The type of the relationship that connects the entity node to the embedded node is the attribute name representing the embedded in the java class.

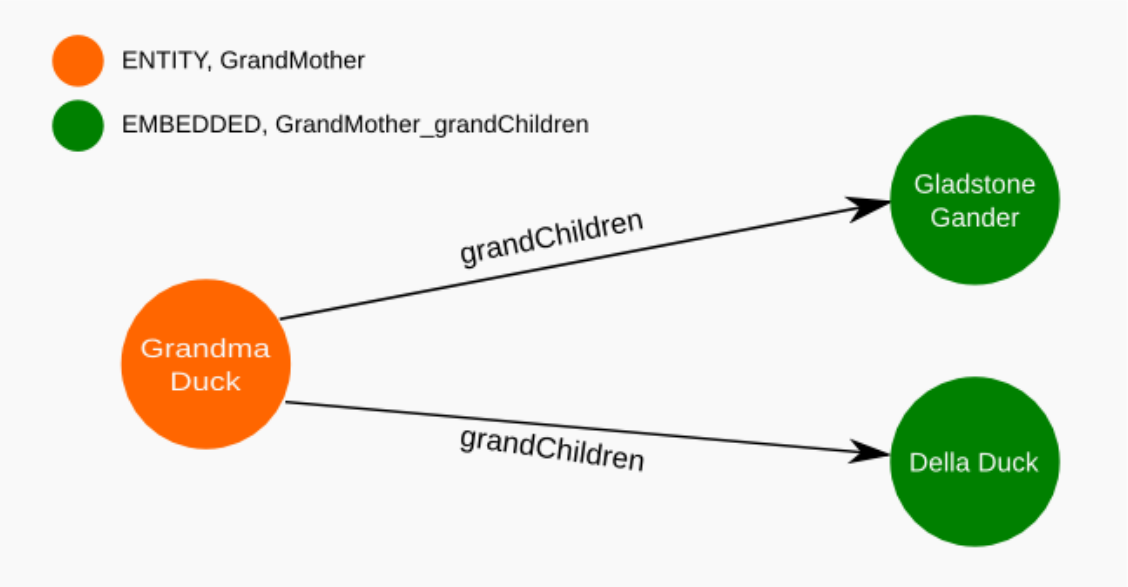
Example 136. Embedded object

```
@Entity
public class News {

    @EmbeddedId
    private NewsID newsId;

    @Embedded
    private NewsPaper paper;

    // getters, setters ...
}

@Embeddable
public class NewsID implements Serializable {

    private String title;
    private String author;

    // getters, setters ...
}

@Embeddable
public class NewsPaper {

    private String name;
    private String owner;

    // getters, setters ...
}
```



Example 137. @ElementCollection

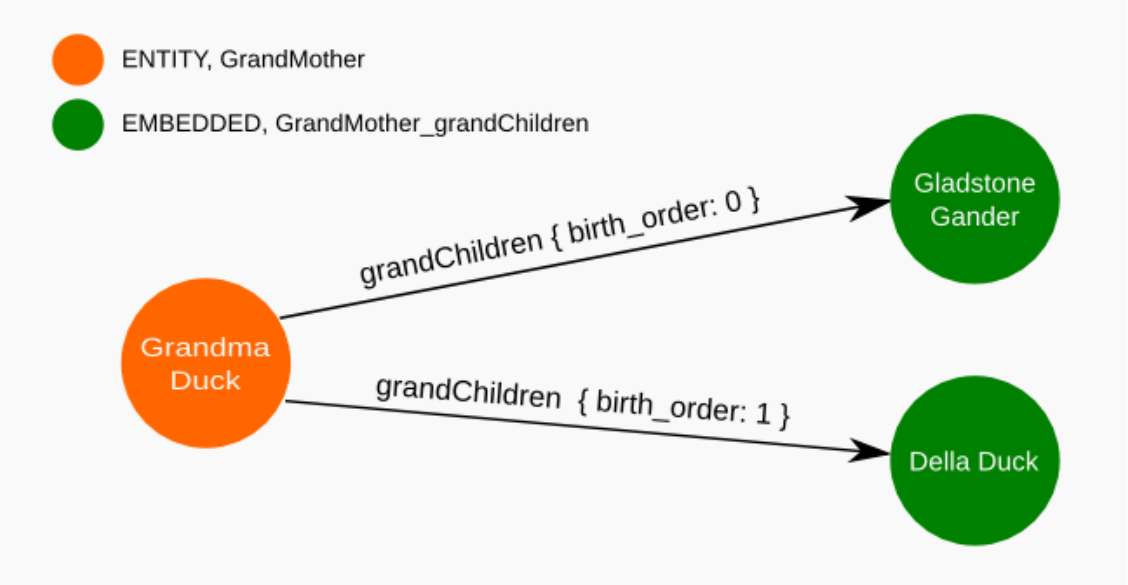
```
@Entity
public class GrandMother {

    @Id
    private String id;

    @ElementCollection
    private List<GrandChild> grandChildren = new ArrayList<GrandChild>();

    // getters, setters ...
}

@Embeddable
public class GrandChild {

    private String name;

    // getters, setters ...
}
```



Note that in the previous examples no property is added to the relationships; in the following one, one property is added to keep track of the order of the elements in the list.

Example 138. @ElementCollection with @OrderColumn

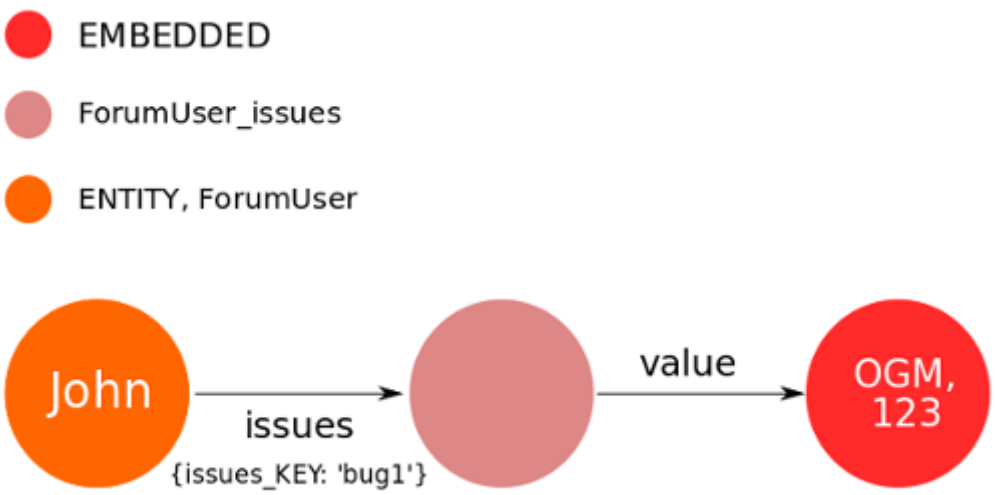
```
@Entity
public class GrandMother {

    @Id
    private String id;

    @ElementCollection
    @OrderColumn( name = "birth_order" )
    private List<GrandChild> grandChildren = new ArrayList<GrandChild>();

    // getters, setters ...
}

@Embeddable
public class GrandChild {

    private String name;

    // getters, setters ...
}
```



It's also possible to use embeddeds in a Map like in the following example:

Example 139. @ElementCollection with Map of Embedded

```
@Entity
public class ForumUser {

    @Id
    private String name;

    @ElementCollection
    private Map<String, JiraIssue> issues = new HashMap<>();

    // getters, setters ...
}

@Embeddable
public class JiraIssue {

    private String project;

    private Integer number;

    // getters, setters ...
}
```



This mapping has some problems, though. It will create an additional node for each element in the map and the embedded values will be stored in a node with only the `EMBEDDED` label. We don't think this is a natural mapping and expect it to change in the upcoming releases.

12.3.3. Associations

An association, bidirectional or unidirectional, is always mapped using one relationship, beginning at the owning side of the association. This is possible because in Neo4j relationships can be navigated in both directions.

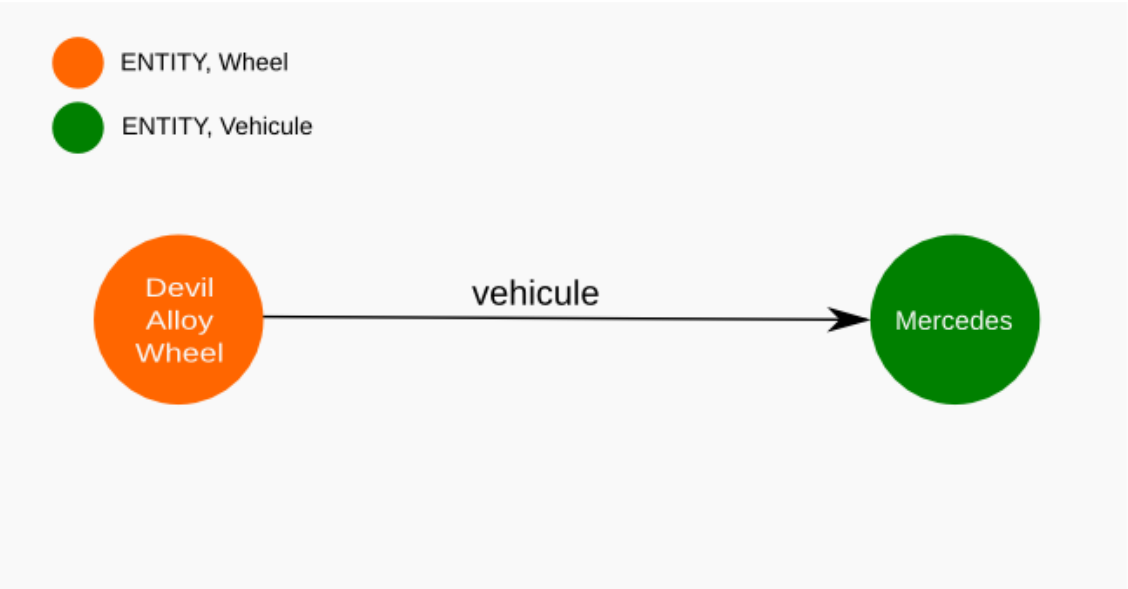
The type of the relationships depends on the type of the association, but in general it is the role

of the association on the main side. The only property stored on the relationship is going to be the index of the association when required, for example when the association is annotated with `@OrderColumn` or when a `java.util.Map` is used.

In Neo4j nodes are connected via relationship, this means that we don't need to create properties which store foreign column keys. This means that annotation like `@JoinColumn` won't have any effect.

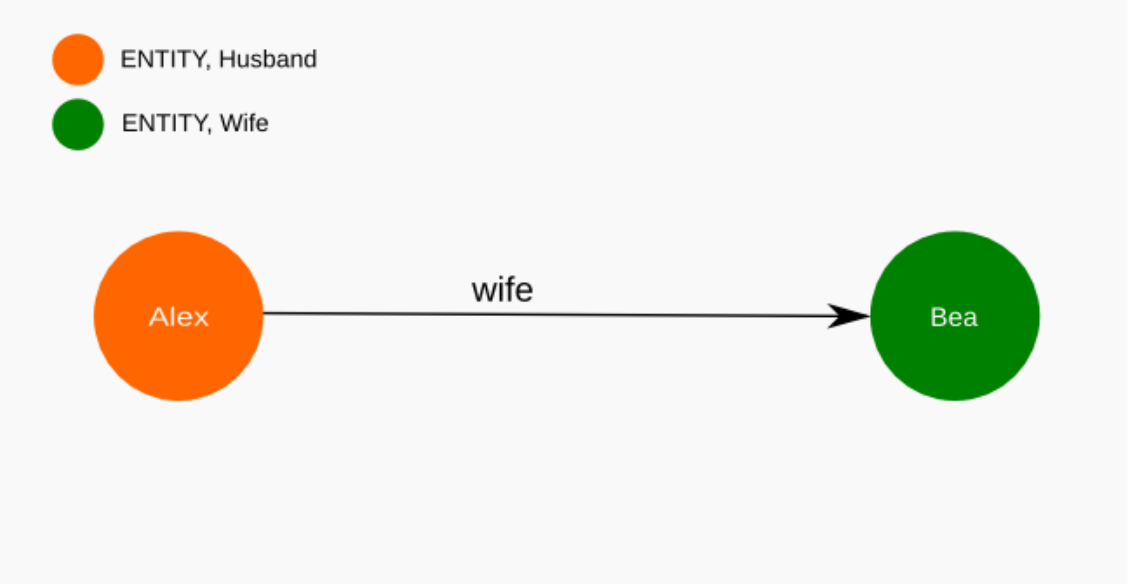
Example 140. Unidirectional one-to-one

```
@Entity
public class Vehicule {

    @Id
    private String id;
    private String brand;

    // getters, setters ...
}


@Entity
public class Wheel {

    @Id
    private String id;
    private String company;
    private double diameter;

    @OneToOne
    private Vehicule vehicule;

    // getters, setters ...
}
```



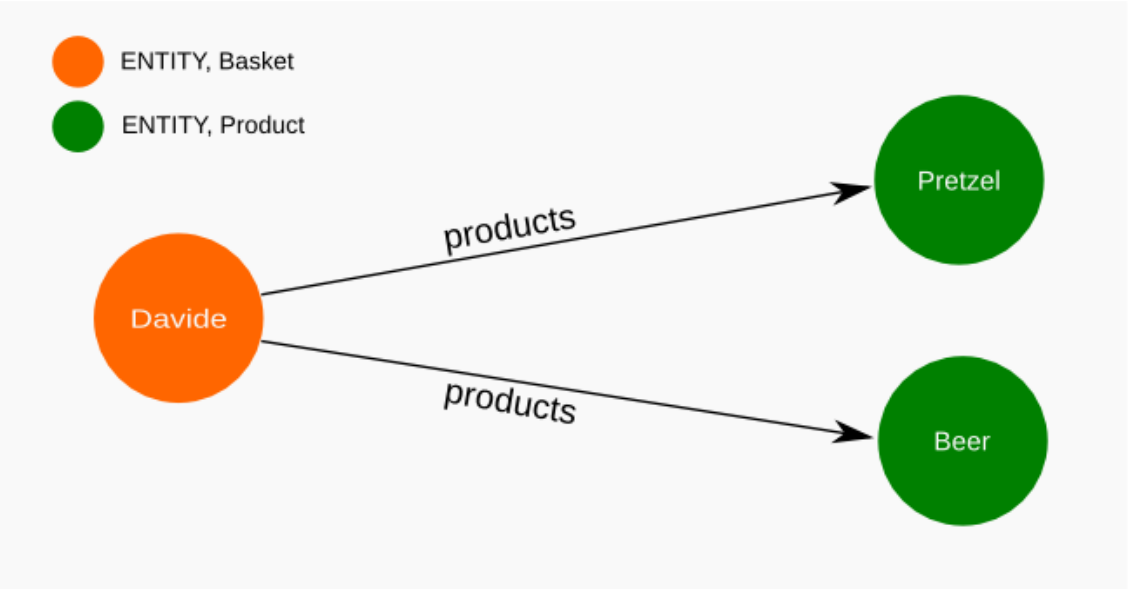
Example 141. Bidirectional one-to-one

```
@Entity
public class Husband {

    @Id
    private String id;
    private String name;

    @OneToOne
    private Wife wife;

    // getters, setters ...
}

@Entity
public class Wife {

    @Id
    private String id;
    private String name;

    @OneToOne(mappedBy = "wife")
    private Husband husband;

    // getters, setters ...
}
```



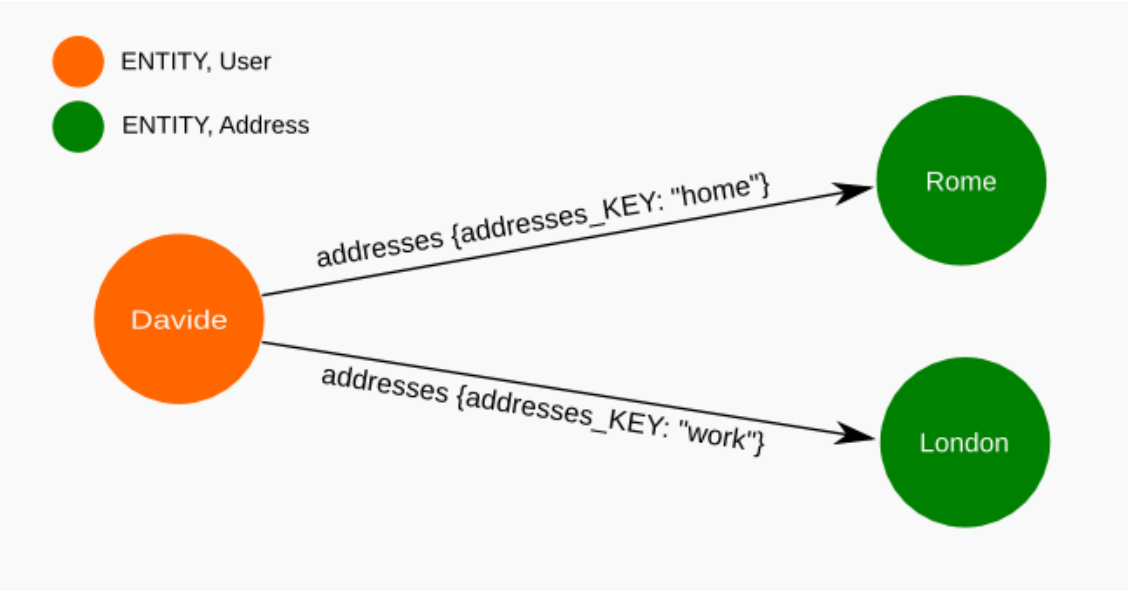
Example 142. Unidirectional one-to-many

```
@Entity
public class Basket {

    @Id
    private String id;

    private String owner;

    @OneToMany
    private List<Product> products = new ArrayList<Product>();

    // getters, setters ...
}

@Entity
public class Product {

    @Id
    private String name;

    private String description;

    // getters, setters ...
}
```



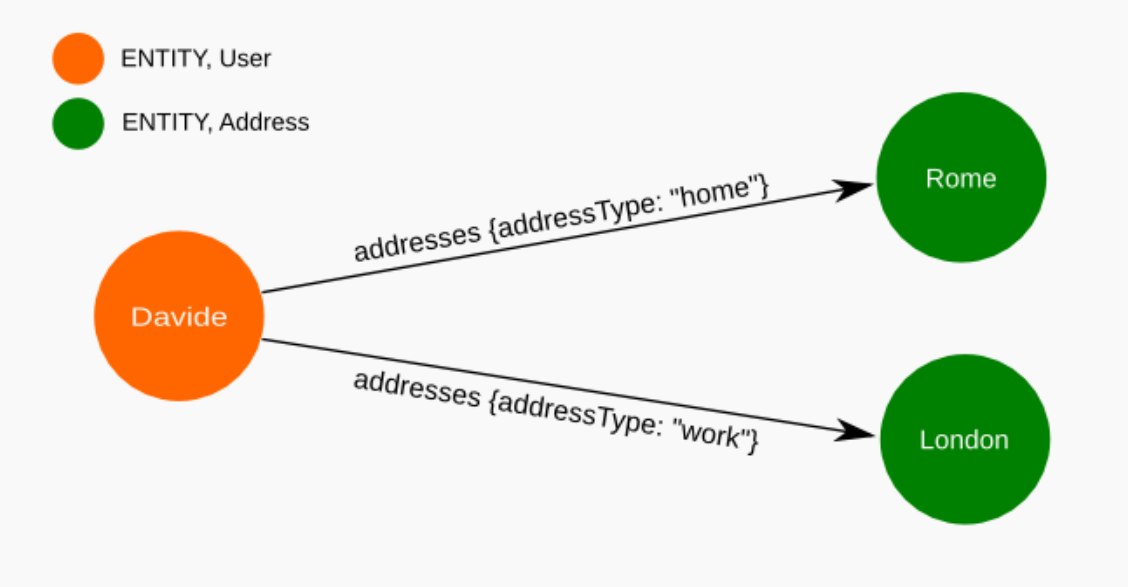
Example 143. Unidirectional one-to-many using maps with defaults

```
@Entity
public class User {

    @Id
    private String id;

    @OneToMany
    private Map<String, Address> addresses = new HashMap<String, Address
>();

    // getters, setters ...
}

@Entity
public class Address {

    @Id
    private String id;
    private String city;

    // getters, setters ...
}
```



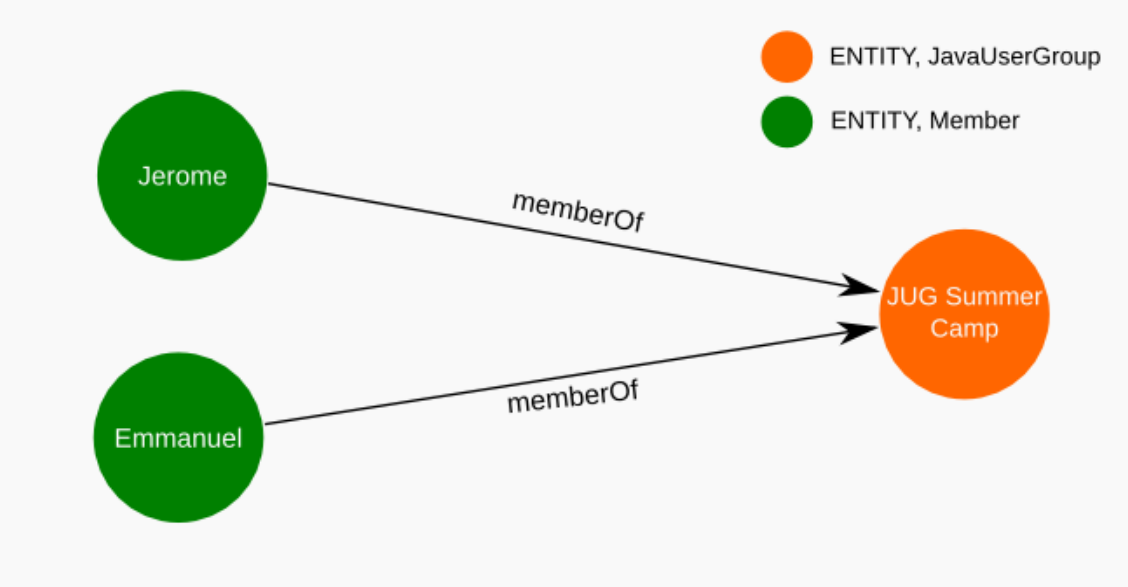
Example 144. Unidirectional one-to-many using maps with @MapKeyColumn

```
@Entity
public class User {

    @Id
    private String id;

    @OneToMany
    @MapKeyColumn(name = "addressType")
    private Map<String, Address> addresses = new HashMap<String, Address
>();

    // getters, setters ...
}

@Entity
public class Address {

    @Id
    private String id;
    private String city;

    // getters, setters ...
}
```



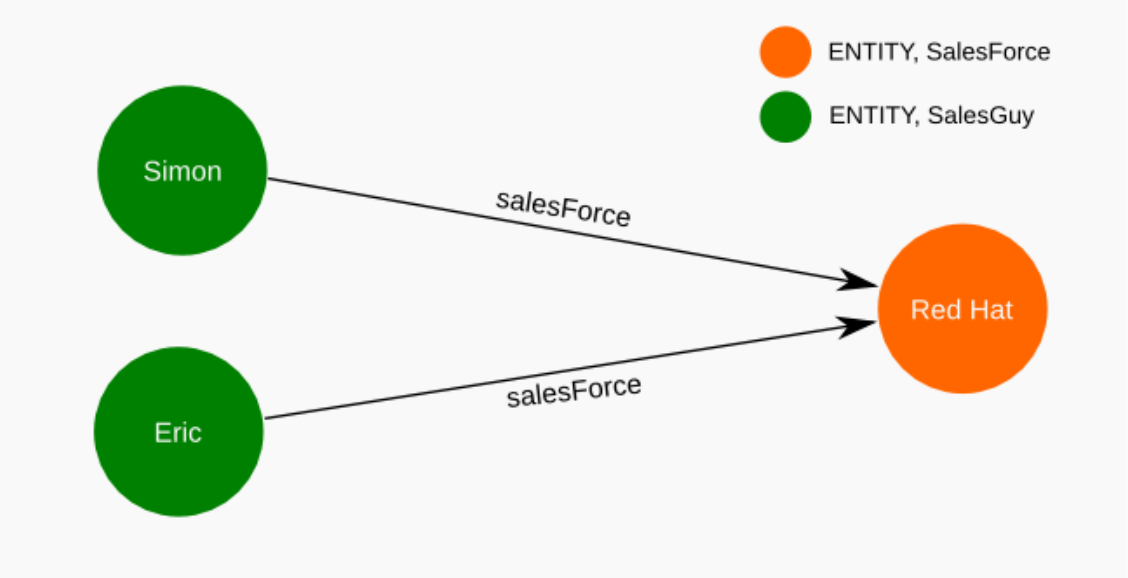
Example 145. Unidirectional many-to-one

```
@Entity
public class JavaUserGroup {

    @Id
    private String jug_id;
    private String name;

    // getters, setters ...
}

@Entity
public class Member {

    @Id
    private String id;
    private String name;

    @ManyToOne
    private JavaUserGroup memberOf;

    // getters, setters ...
}
```



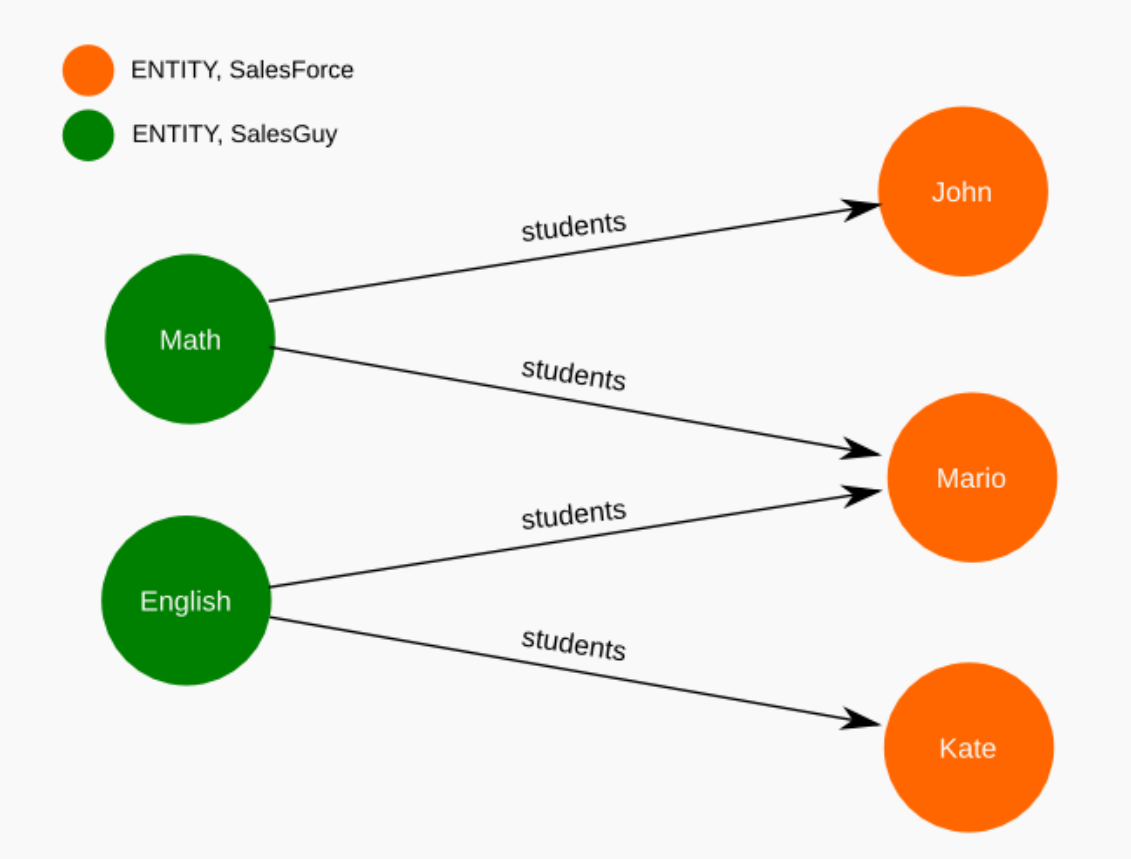
Example 146. Bidirectional many-to-one

```
@Entity
public class SalesForce {

    @Id
    private String id;
    private String corporation;

    @OneToMany(mappedBy = "salesForce")
    private Set<SalesGuy> salesGuys = new HashSet<SalesGuy>();

    // getters, setters ...
}

@Entity
public class SalesGuy {
    private String id;
    private String name;

    @ManyToOne
    private SalesForce salesForce;

    // getters, setters ...
}
```



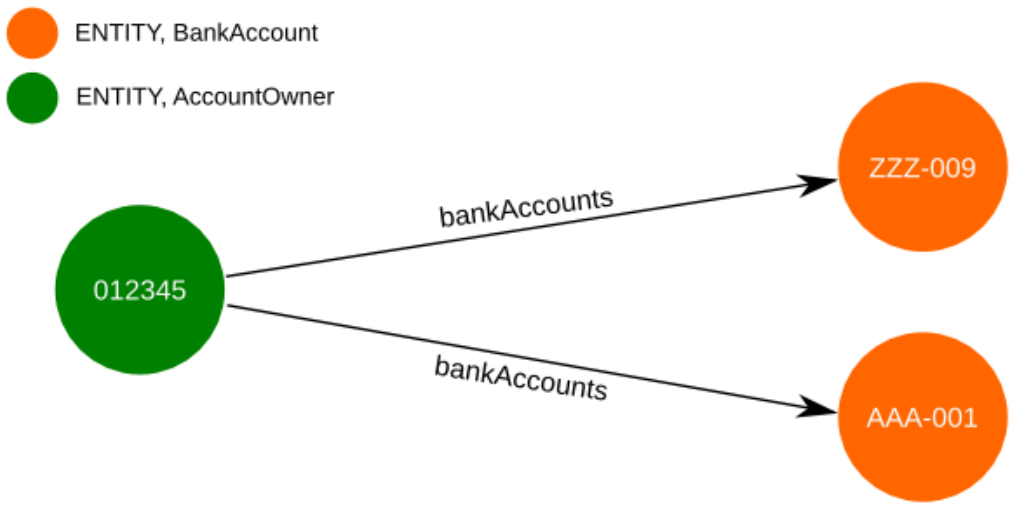
Example 147. Unidirectional many-to-many

```
@Entity
public class Student {

    @Id
    private String id;
    private String name;

    // getters, setters ...
}

@Entity
public class ClassRoom {

    @Id
    private long id;
    private String lesson;

    @ManyToMany
    private List<Student> students = new ArrayList<Student>();

    // getters, setters ...
}
```



Example 148. Bidirectional many-to-many

```
@Entity
public class AccountOwner {

    @Id
    private String id;

    private String SSN;

    @ManyToMany
    private Set<BankAccount> bankAccounts;

    // getters, setters ...
}

@Entity
public class BankAccount {

    @Id
    private String id;

    private String accountNumber;

    @ManyToMany( mappedBy = "bankAccounts" )
    private Set<AccountOwner> owners = new HashSet<AccountOwner>();

    // getters, setters ...
}
```



12.3.4. Auto-generated Values

Hibernate OGM supports the table generation strategy as well as the sequence generation strategy with Neo4j. It is generally recommended to work with the latter, as it allows a slightly more efficient querying for the next sequence value.

Sequence-based generators are represented by nodes in the following form:

Example 149. GenerationType.SEQUENCE

```
@Entity
public class Song {

    ...

    @Id
    @GeneratedValue( strategy = GenerationType.SEQUENCE, generator =
"songSequenceGenerator" )
    @SequenceGenerator(
            name = "songSequenceGenerator",
            sequenceName = "song_sequence",
            initialValue = INITIAL_VALUE,
            allocationSize = 10)
    public Long getId() {
        return id;
    }

    ...
```

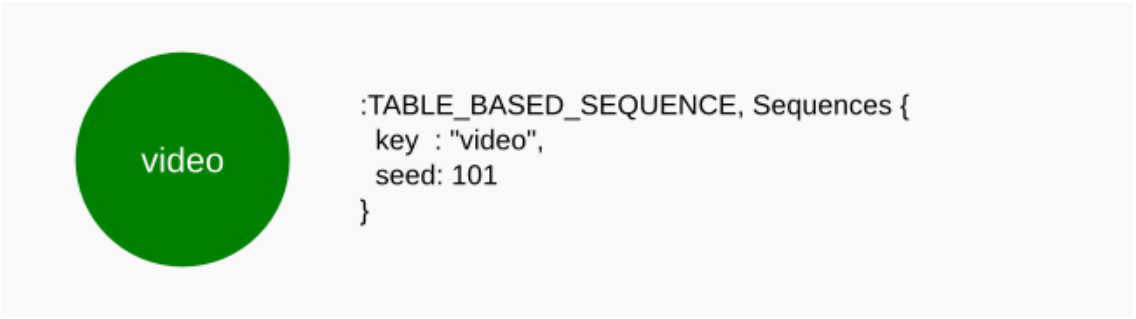
Each sequence generator node is labelled with `SEQUENCE`. The sequence name can be specified via `@SequenceGenerator#sequenceName()`. A unique constraint is applied to the property `sequence_name` in order to ensure uniqueness of sequences.

If required, you can set the initial value of a sequence and the increment size via `@SequenceGenerator#initialValue()` and `@SequenceGenerator#allocationSize()`, respectively. The options `@SequenceGenerator#catalog()` and `@SequenceGenerator#schema()` are not supported.

Table-based generators are represented by nodes in the following form:

Example 150. GenerationType.TABLE

```
@Entity
public class Video {

    ...

    @Id
    @GeneratedValue( strategy = GenerationType.TABLE, generator = "video"
)
    @TableGenerator(
         name = "video",
         table = "Sequences",
         pkColumnName = "key",
         pkColumnValue = "video",
         valueColumnName = "seed"
    )
    public Integer getId() {
        return id;
    }

    ...
```



Each table generator node is labelled with `TABLE_BASED_SEQUENCE` and the table name as specified via `@TableGenerator#table()`. The sequence name is to be given via `@TableGenerator#pkColumnValue()`. The node properties holding the sequence name and value can be configured via `@TableGenerator#pkColumnName()` and `@TableGenerator#valueColumnName()`, respectively. A unique constraint is applied to the property `sequence_name` to avoid the same sequence name is used twice within the same "table".

If required, you can set the initial value of a sequence and the increment size via `@TableGenerator#initialValue()` and `@TableGenerator#allocationSize()`, respectively. The options `@TableGenerator#catalog()`, `@TableGenerator#schema()`, `@TableGenerator#uniqueConstraints()` and `@TableGenerator#indexes()` are not supported.

12.3.5. Labels summary

The maximum number of labels the database can contain is roughly 2 billion.

The following summary will help you to keep track of the labels assigned to a new node:

Table 108. Summary of the labels assigned to a new node

NODE TYPE	LABELS
Entity	ENTITY, <Entity class name>
Embeddable	EMBEDDED, <Embeddable class name>
GenerationType.SEQUENCE	SEQUENCE
GenerationType.TABLE	TABLE_BASED_SEQUENCE, <Table name>

12.4. Transactions

In Neo4j, operations must be executed inside a transaction. Make sure your interactions with Hibernate OGM are within a transaction when you target Neo4J.

Example 151. Example of starting and committing transactions

```
Session session = factory.openSession();
Transaction tx = session.beginTransaction();

Account account = new Account();
account.setLogin( "myAccount" );
session.persist( account );

tx.commit();

...

tx = session.beginTransaction();
Account savedAccount =  (Account) session.get( Account.class, account
.getId() );
tx.commit();
```

In the case of JTA, Hibernate OGM attaches the Neo4J internal transaction to the JTA transaction lifecycle. That way when the JTA transaction is committed or rollbacked (for example by an EJB CMT or explicitly), the Neo4J transaction is also committed or rollbacked. This makes for a nice integration in a Java EE container.

This is NOT a true JTA/XA integration but more a lifecycle alignment: changes on more than one datasource won't be executed as a single atomic transaction.

In particular, if the JTA transaction involves multiple resources, Neo4j might commit before a failure of another resource. In this case, Neo4j won't be able to rollback even if the JTA transaction will.

12.5. Queries

You can express queries in a few different ways:

- using JP-QL
- using the Cypher query language

While you can use JP-QL for simple queries, you might hit limitations. The current recommended approach is to use native Cypher queries if your query involves nested (list of) elements.

You don't need Hibernate Search on the classpath to run queries.

12.5.1. JP-QL queries

Hibernate OGM is a work in progress, so only a sub-set of JP-QL constructs is available when using the JP-QL query support. This includes:

- simple comparisons using "<", "<=", "=", ">=" and ">"
- `IS NULL` and `IS NOT NULL`
- the boolean operators `AND`, `OR`, `NOT`
- `LIKE`, `IN` and `BETWEEN`
- `ORDER BY`
- inner `JOIN` on embedded collections
- projections of regular and embedded properties

Queries using these constructs will be transformed into equivalent Cypher queries.

Let us know by opening an issue or sending an email what query you wish to execute. Expanding our support in this area is high on our priority list.

12.5.2. Cypher queries

Hibernate OGM also supports Cypher queries for Neo4j. You can execute Cypher queries as shown in the following example:

Example 152. Using the JPA API

```
@Entity
public class Poem {

    @Id
    private Long id;

    private String name;

    private String author;

   // getters, setters ...

}

...

javax.persistence.EntityManager em = ...

// a single result query
String query1 = "MATCH ( n:Poem { name:'Portia', author:'Oscar Wilde' } )
RETURN n";
Poem poem = (Poem) em.createNativeQuery( query1, Poem.class )
.getSingleResult();

// query with order by
String query2 = "MATCH ( n:Poem { name:'Portia', author:'Oscar Wilde' } )
" +
                "RETURN n ORDER BY n.name";
List<Poem> poems = em.createNativeQuery( query2, Poem.class )
.getResultList();

// query with projections
String query3 = MATCH ( n:Poem ) RETURN n.name, n.author ORDER BY n.name
";
List<Object[]> poemNames = (List<Object[]>) em.createNativeQuery( query3
)
                                .getResultList();
```

The result of a query is a managed entity (or a list thereof) or a projection of attributes in form of an object array, just like you would get from a JP-QL query.

Example 153. Using the Hibernate native API

```
OgmSession session = ...

String query1 = "MATCH ( n:Poem { name:'Portia', author:'Oscar Wilde' } )
" +
                "RETURN n";
Poem poem = session.createNativeQuery( query1 )
                      .addEntity( "Poem", Poem.class )
                      .uniqueResult();

String query2 = "MATCH ( n:Poem { name:'Portia', author:'Oscar Wilde' } )
" +
                "RETURN n ORDER BY n.name";
List<Poem> poems = session.createNativeQuery( query2 )
                      .addEntity( "Poem", Poem.class )
                      .list();
```

Native queries can also be created using the `@NamedNativeQuery` annotation:

Example 154. Using @NamedNativeQuery

```
@Entity
@NamedNativeQuery(
   name = "AthanasiaPoem",
   query = "MATCH ( n:Poem { name:'Athanasia', author:'Oscar Wilde' } )
RETURN n",
   resultClass = Poem.class )
public class Poem { ... }

...

// Using the EntityManager
Poem poem1 = (Poem) em.createNamedQuery( "AthanasiaPoem" )
                      .getSingleResult();

// Using the Session
Poem poem2 = (Poem) session.getNamedQuery( "AthanasiaPoem" )
                      .uniqueResult();
```

Hibernate OGM stores data in a natural way so you can still execute queries using your favorite tool, the main drawback is that the results are going to be raw Neo4j elements and not managed entities.

Chapter 13. CouchDB (Experimental)

CouchDB is a document-oriented datastore which stores your data in form of JSON documents and exposes its API via HTTP based on REST principles. It is thus very easy to access from a wide range of languages and applications.

Support for CouchDB is considered an EXPERIMENTAL feature as of this release. In particular you should be prepared for possible changes to the persistent representation of mapped objects in future releases.

Also be aware that partial updates are unsupported at the moment (OGM-388). The entire document will be replaced during any updates. This means that fields possibly written by other applications but not mapped to properties in your domain model will get lost.

The `ASSOCIATION_DOCUMENT` mode for storing associations should be used with care as there is potential for lost updates (OGM-461). It is recommended to use the `IN_ENTITY` mode (which is the default).

Should you find any bugs or have feature requests for this dialect, then please open a ticket in the OGM issue tracker.

13.1. How to add CouchDB integration

1. Add the dependencies to your project

If your project uses Maven you can add this to the pom.xml:

```
<dependency>
    <groupId>org.hibernate.ogm</groupId>
    <artifactId>hibernate-ogm-couchdb</artifactId>
    <version>5.1.0.Final</version>
</dependency>
```

Alternatively you can find the required libraries in the distribution package on SourceForge

Example 155. 2. Use the following properties

```
hibernate.ogm.datastore.provider = couchdb_experimental
```

13.2. Configuring CouchDB

Hibernate OGM uses the excellent RESTEasy library to talk to CouchDB stores, so there is no need to include any of the Java client libraries for CouchDB in your classpath.

The following properties are available to configure CouchDB support in Hibernate OGM:

CouchDB datastore configuration properties

hibernate.ogm.datastore.provider

To use CouchDB as a datastore provider, this property must be set to `couchdb_experimental`

hibernate.ogm.option.configurator

The fully-qualified class name or an instance of a programmatic option configurator (see Programmatic configuration)

hibernate.ogm.datastore.host

The hostname and port of the CouchDB instance. The optional port is concatenated to the host and separated by a colon. Let's see a few valid examples:

- `couchdb.example.com`
- `couchdb.example.com:5985`
- `2001:db8::ff00:42:8329` (IPv6)
- `[2001:db8::ff00:42:8329]:5985` (IPv6 with port requires the IPv6 to be surrounded by square brackets)

Listing multiple initial hosts for fault tolerance is not supported. The default value is `127.0.0.1:5984`. If left undefined, the default port is `5984`.

hibernate.ogm.datastore.port

Deprecated: use `hibernate.ogm.datastore.host`. The port used by the CouchDB instance. The default value is `5984`.

hibernate.ogm.datastore.database

The database to connect to. This property has no default value.

hibernate.ogm.datastore.create_database

Whether to create the specified database in case it does not exist or not. Can be `true` or `false` (default). Note that the specified user must have the right to create databases if set to `true`.

hibernate.ogm.datastore.username

The username used when connecting to the CouchDB server. Note that this user must have the right to create design documents in the chosen database. This property has no default value. Hibernate OGM currently does not support accessing CouchDB via HTTPS; if you're interested in such functionality, let us know.

hibernate.ogm.datastore.password

The password used to connect to the CouchDB server. This property has no default value. This property is ignored if the username isn't specified.

hibernate.ogm.error_handler

The fully-qualified class name, class object or an instance of `ErrorHandler` to get notified upon errors during flushes (see Acting upon errors during application of changes)

hibernate.ogm.datastore.document.association_storage

Defines the way OGM stores association information in CouchDB.

The following two strategies exist (values of the `org.hibernate.ogm.datastore.document.options.AssociationStorageType` enum): `IN_ENTITY` (store association information within the entity) and `ASSOCIATION_DOCUMENT` (store association information in a dedicated document per association).

`IN_ENTITY` is the default and recommended option unless the association navigation data is much bigger than the core of the document and leads to performance degradation.

hibernate.ogm.datastore.document.map_storage

Defines the way OGM stores the contents of map-typed associations in CouchDB. The following two strategies exist (values of the `org.hibernate.ogm.datastore.document.options.MapStorageType` enum):

- `BY_KEY`: map-typed associations with a single key column which is of type `String` will be stored as a sub-document, organized by the given key; Not applicable for other types of key columns, in which case always `AS_LIST` will be used
- `AS_LIST`: map-typed associations will be stored as an array containing a sub-document for each map entry. All key and value columns will be contained within the array elements

When bootstrapping a session factory or entity manager factory programmatically, you should use the constants accessible via `CouchDBProperties` when specifying the configuration properties listed above. Common properties shared between (document) stores are declared on `OgmProperties` and `DocumentStoreProperties`, respectively. To ease migration between stores, it is recommended to reference these constants directly from there.

13.2.1. Annotation based configuration

Hibernate OGM allows to configure store-specific options via Java annotations.

When working with the CouchDB backend, you can specify the following settings:

- a strategy for storing associations using the `@AssociationStorage` and `@AssociationDocumentStorage` annotations
- a strategy for storing the contents of map-typed associations using the `@MapStorage` annotation

Refer to <<ogm-couchdb-storage-principles> to learn more about the options related to storing associations.

The following shows an example:

Example 156. Configuring the association storage strategy using annotations

```
@Entity
@AssociationStorage(AssociationStorageType.ASSOCIATION_DOCUMENT)
@MapStorage(MapStorageType.AS_LIST)
public class Zoo {

    @OneToMany
    private Set<Animal> animals;

    @OneToMany
    private Set<Person> employees;

    @OneToMany
    @AssociationStorage(AssociationStorageType.IN_ENTITY)
    private Set<Person> visitors;

    //...
}
```

The annotation on the entity level expresses that all associations of the `Zoo` class should be stored in separate assocation documents. This setting applies to the `animals` and `employees` associations. Only the elements of the `visitors` association will be stored in the document of

the corresponding `Zoo` entity as per the configuration of that specific property which takes precedence over the entity-level configuration.

13.2.2. Programmatic configuration

In addition to the annotation mechanism, Hibernate OGM also provides a programmatic API for applying store-specific configuration options. This can be useful if you can't modify certain entity types or don't want to add store-specific configuration annotations to them. The API allows set options in a type-safe fashion on the global, entity and property levels.

When working with CouchDB, you can currently configure the following options using the API:

- association storage strategy (on the global, entity and property level)
- strategy for storing the contents of map-typed associations

To set this option via the API, you need to create an `OptionConfigurator` implementation as shown in the following example:

Example 157. Example of an option configurator

```
public class MyOptionConfigurator extends OptionConfigurator {

    @Override
    public void configure(Configurable configurable) {
        configurable.configureOptionsFor( CouchDB.class )
            .associationStorage( AssociationStorageType
.ASSOCIATION_DOCUMENT )
            .entity( Zoo.class )
                .property( "visitors", ElementType.FIELD )
                    .associationStorage( AssociationStorageType.IN_ENTITY
)
                    .mapStorage( MapStorageType.ASLIST )
            .entity( Animal.class )
                .associationStorage( AssociationStorageType
.ASSOCIATION_DOCUMENT );
    }
}
```

The call to `configureOptionsFor()`, passing the store-specific identifier type `CouchDB`, provides the entry point into the API. Following the fluent API pattern, you then can configure global options and navigate to single entities or properties to apply options specific to these.

Options given on the property level precede entity-level options. So e.g. the `visitors` association of the `Zoo` class would be stored using the in entity strategy, while all other associations of the `Zoo` entity would be stored using separate association documents.

Similarly, entity-level options take precedence over options given on the global level. Global-

level options specified via the API complement the settings given via configuration properties. In case a setting is given via a configuration property and the API at the same time, the latter takes precedence.

Note that for a given level (property, entity, global), an option set via annotations is overridden by the same option set programmatically. This allows you to change settings in a more flexible way if required.

To register an option configurator, specify its class name using the `hibernate.ogm.option.configurator` property. When bootstrapping a session factory or entity manager factory programmatically, you also can pass in an `OptionConfigurator` instance or the class object representing the configurator type.

13.3. Storage principles

Hibernate OGM tries to make the mapping to the underlying datastore as natural as possible so that third party applications not using Hibernate OGM can still read and update the same datastore. The following describe how entities and associations are mapped to CouchDB documents by Hibernate OGM.

13.3.1. Properties and built-in types

Hibernate OGM doesn't store null values in CouchDB, setting a value to null will be the same as removing the field in the corresponding object in the db.

Hibernate OGM support by default the following types:

- `java.lang.String`

```
{ "text" : "Hello world!" }
```

- `java.lang.Character` (or char primitive)

```
{ "delimiter" : "/" }
```

- `java.lang.Boolean` (or boolean primitive)

```
{ "favorite" : true } # default mapping
{ "favorite" : "T" } # if @Type(type = "true_false") is given
{ "favorite" : "Y" } # if @Type(type = "yes_no") is given
{ "favorite" : 1 } # if @Type(type = "numeric_boolean") is given
```

- `java.lang.Byte` (or byte primitive)

```
{ "display_mask" : "70" }
```

- `java.lang.Short` (or short primitive)

```
{ "urlPort" : 80 }
```

- `java.lang.Integer` (or int primitive)

```
{ "stockCount" : 12309 }
```

- `java.lang.Long` (or long primitive)

```
{ "userId" : "-6718902786625749549" }
```

- `java.lang.Float` (or float primitive)

```
{ "visitRatio" : 10.4 }
```

- `java.lang.Double` (or double primitive)

```
{ "tax_percentage" : 12.34 }
```

- `java.math.BigDecimal`

```
{ "site_weight" : "21.77" }
```

- `java.math.BigInteger`

```
{ "site_weight" : "444" }
```

- `java.util.Calendar`

```
{ "creation" : "2014-11-18T15:51:26.252Z" }
```

- `java.util.Date`

```
{ "last_update" : "2014-11-18T15:51:26.252Z" }
```

- `java.util.UUID`

```
{ "serialNumber" : "71f5713d-69c4-4b62-ad15-aed8ce8d10e0" }
```

- `java.util.URL`

```
{ "url" : "http://www.hibernate.org/" }
```

13.3.2. Entities

Entities are stored as CouchDB documents and not as BLOBs which means each entity property will be translated into a document field. You can use the name property of the `@Table` and `@Column` annotations to rename the collections and the document's fields if you need to.

CouchDB provides a built-in mechanism for detecting concurrent updates to one and the same document. For that purpose each document has an attribute named `_rev` (for "revision") which is to be passed back to the store when doing an update. So when writing back a document and the document's revision has been altered by another writer in parallel, CouchDB will raise an optimistic locking error (you could then e.g. re-read the current document version and try another update).

For this mechanism to work, you need to declare a property for the `_rev` attribute in all your entity types and mark it with the `@Version` and `@Generated` annotations. The first marks it as a property used for optimistic locking, while the latter advices Hibernate OGM to refresh that property after writes since its value is managed by the datastore.

Not mapping the `_rev` attribute may cause lost updates, as Hibernate OGM needs to re-read the current revision before doing an update in this case. Thus a warning will be issued during initialization for each entity type which fails to map that property.

The following shows an example of an entity and its persistent representation in CouchDB.

Example 158. Example of an entity and its representation in CouchDB

```
@Entity
public class News {

    @Id
    private String id;

    @Version
    @Generated
    @Column(name="_rev")
    private String revision;

    private String title;

    private String description;

    //getters, setters ...
}
```

```
{
    "_id": "News:id_:news-1_",
    "_rev": "1-d1cd3b00a677a2e31cd0480a796e8480",
    "$type": "entity",
    "$table": "News",
    "title": "On the merits of NoSQL",
    "description": "This paper discuss why NoSQL will save the world for
good"
}
```

Note that CouchDB doesn't have a concept of "tables" or "collections" as e.g. MongoDB does; Instead all documents are stored in one large bucket. Thus Hibernate OGM needs to add two additional attributes: `$type` which contains the type of a document (entity vs. association documents) and `$table` which specifies the entity name as derived from the type or given via the `@Table` annotation.

Attributes whose name starts with the "$" character are managed by Hibernate OGM and thus should not be modified manually. Also it is not recommended to start the names of your attributes with the "$" character to avoid collisions with attributes possibly introduced by Hibernate OGM in future releases.

Example 159. Rename field and collection using @Table and @Column

```
@Entity
@Table(name="Article")
public class News {

    @Id
    @Column(name="code")
    private String id;

    @Version
    @Generated
    @Column(name="_rev")
    private String revision;

    private String title;

    @Column(name="desc")
    private String description;

    //getters, setters ...
}
```

```
{
    "_id": "Article:code_:news-1_",
    "_rev": "1-d1cd3b00a677a2e31cd0480a796e8480",
    "$type": "entity",
    "$table": "Article",
    "title": "On the merits of NoSQL",
    "desc": "This paper discuss why NoSQL will save the world for good"
}
```

Identifiers

The `_id` field of a CouchDB document is directly used to store the identifier columns mapped in the entities. You can use any persistable Java type as identifier type, e.g. `String` or `long`.

Hibernate OGM will convert the `@Id` property into a `_id` document field so you can name the entity id like you want, it will always be stored into `_id`.

Note that you also can work with embedded ids (via `@EmbeddedId`), but be aware of the fact that CouchDB doesn't support storing embedded structures in the `_id` attribute. Hibernate OGM thus will create a concatenated representation of the embedded id's properties in this case.

Example 160. Entity with @EmbeddedId

```
@Entity
public class News {

    @EmbeddedId
    private NewsID newsId;

    // getters, setters ...
}

@Embeddable
public class NewsID implements Serializable {

    private String title;
    private String author;

    // getters, setters ...
}
```

```
{
    "_id": "News:newsId.author_newsId.title_:Guillaume_How to use
Hibernate OGM ?_",
    "_rev": "2-1f02af4fabba7b4fa7394f1167244226",
    "$type": "entity",
    "$table": "News",
    "newsId": {
        "author": "Guillaume",
        "title": "How to use Hibernate OGM ?"
    }
}
```

Identifier generation strategies

You can assign id values yourself or let Hibernate OGM generate the value using the `@GeneratedValue` annotation.

Two main strategies are supported:

1. TABLE
2. SEQUENCE

Both strategy will create a new document containg the next value to use for the id, the difference between the two strategies is the name of the field containing the values.

Hibernate OGM goes not support the `IDENTITY` strategy and an exception is thrown at startup when it is used. The `AUTO` strategy is the same as the `SEQUENCE` one.

1) TABLE generation strategy

Example 161. Id generation strategy TABLE using default values

```
@Entity
public class Video {

    @Id
    @GeneratedValue(strategy = GenerationType.TABLE)
    private Integer id;
    private String name

    // getters, setters, ...
}
```

```
{
   "_id": "Video:id_:1_",
   "_rev": "1-b4c16b6cd8a083f2173f8df19bd24750",
   "$type": "entity",
   "$table": "Video",
   "id": 1,
   "name": "Scream",
   "director": "Wes Craven"
}
```

```
{
   "_id": "hibernate_sequences:sequence_name:default",
   "_rev": "1-ebb82f1cea26d57f47a290fb0c1cc58f",
   "$type": "sequence",
   "next_val": "2"
}
```

Example 162. Id generation strategy TABLE using a custom table

```
@Entity
public class Video {

    @Id
    @GeneratedValue(strategy = GenerationType.TABLE, generator = "video")
    @TableGenerator(
            name = "video",
            table = "sequences",
            pkColumnName = "key",
            pkColumnValue = "video",
            valueColumnName = "seed"
    )
    private Integer id;

    private String name;

    // getter, setters, ...
}
```

```
@Entity
public class Video {

    @Id
    @GeneratedValue(strategy = GenerationType.TABLE, generator = "video")
    @TableGenerator(
            name = "video",
            table = "sequences",
            pkColumnName = "key",
            pkColumnValue = "video",
            valueColumnName = "seed"
    )
    private Integer id;
    private String name

    // getters, setters, ...
}
```

```
{
   "_id": "sequences:key:video",
   "_rev": "2-78b3450e0658743164828c4076e06a49",
   "$type": "sequence",
   "seed": "101"
}
```

2) SEQUENCE generation strategy

Example 163. SEQUENCE id generation strategy using default values

```
@Entity
public class Song {

  @Id
  @GeneratedValue(strategy = GenerationType.SEQUENCE)
  private Long id;

  private String title;

  // getters, setters ...
}
```

```
{
   "_id": "Song:id_:2_",
   "_rev": "1-63bc100449fb2840067028c3825ed784",
   "$type": "entity",
   "$table": "Song",
   "id": "2",
   "title": "Ave Maria",
   "singer": "Charlotte Church"
}
```

```
{
   "_id": "hibernate_sequences:sequence_name:hibernate_sequence",
   "_rev": "2-dcc622bcb1389ad18829dcfc8b812c87",
   "$type": "sequence",
   "next_val": "3"
}
```

Example 164. SEQUENCE id generation strategy using custom values

```
@Entity
public class Song {

  @Id
  @GeneratedValue(strategy = GenerationType.SEQUENCE, generator =
"songSequenceGenerator")
  @SequenceGenerator(
       name = "songSequenceGenerator",
       sequenceName = "song_sequence",
       initialValue = 2,
       allocationSize = 20
  )
  private Long id;

  private String title;

  // getters, setters ...
}
```

```
{
   "_id": "Song:id_:2_",
   "_rev": "1-63bc100449fb2840067028c3825ed784",
   "$type": "entity",
   "$table": "Song",
   "id": "2",
   "title": "Ave Maria",
   "singer": "Charlotte Church"
}
```

```
{
   "_id": "hibernate_sequences:sequence_name:song_sequence",
   "_rev": "2-df47883f076c84cb953f9184de7aa82a",
   "$type": "sequence",
   "next_val": "21"
}
```

Embedded objects and collections

Hibernate OGM stores elements annotated with `@Embedded` or `@ElementCollection` as nested documents of the owning entity.

Example 165. Embedded object

```
@Entity
public class News {

    @Id
    private String id;
    private String title;

    @Embedded
    private NewsPaper paper;

    // getters, setters ...
}

@Embeddable
public class NewsPaper {

    private String name;
    private String owner;

    // getters, setters ...
}
```

```
{
    "_id": "News:id_:939c892d-1129-4aff-abf8-e6c26e59dcb_",
    "_rev": "2-1f02af4fabba7b4fa7394f1167244226",
    "$type": "entity",
    "$table": "News",
    "id": "939c892d-1129-4aff-abf8-e6c26e59dcb",
    "paper": {
        "name": "NoSQL journal of prophecies",
        "owner": "Delphy"
    }
}
```

Example 166. @ElementCollection with primitive types

```
@Entity
public class AccountWithPhone {

    @Id
    private String id;

    @ElementCollection
    private List<String> mobileNumbers;

    // getters, setters ...
}
```

AccountWithPhone collection

```
{
   "_id": "AccountWithPhone:id_:2_",
   "_rev": "2-a71f7c0d621a08232568f9840bff05ce",
   "$type": "entity",
   "$table": "AccountWithPhone",
   "id": "2",
   "mobileNumbers": [
       "+1-222-555-0222",
       "+1-202-555-0333"
   ]
}
```

Example 167. @ElementCollection with one attribute

```
@Entity
public class GrandMother {

    @Id
    private String id;

    @ElementCollection
    private List<GrandChild> grandChildren = new ArrayList<GrandChild>();

    // getters, setters ...
}

@Embeddable
public class GrandChild {

    private String name;

    // getters, setters ...
}
```

```
{
    "_id": "grandmother:id_:86ada718-f2a2-4299-b6ac-3d90b1ef2331_",
    "_rev": "2-1f02af4fabba7b4fa7394f1167244226",
    "$type": "entity",
    "$table": "grandmother",
    "id": "86ada718-f2a2-4299-b6ac-3d90b1ef2331",
    "grandChildren" : [ "Luke", "Leia" ]
}
```

The class `GrandChild` has only one attribute `name`, this means that Hibernate OGM doesn't need to store the name of the attribute.

If the nested document has two or more fields, like in the following example, Hibernate OGM will store the name of the fields as well.

Example 168. @ElementCollection with @OrderColumn

```
@Entity
public class GrandMother {

    @Id
    private String id;

    @ElementCollection
    @OrderColumn( name = "birth_order" )
    private List<GrandChild> grandChildren = new ArrayList<GrandChild>();

    // getters, setters ...
}

@Embeddable
public class GrandChild {

    private String name;

    // getters, setters ...
}
```

```
{
    "_id": "GrandMother:id_:86ada718-f2a2-4299-b6ac-3d90b1ef2331_",
    "_rev": "2-1f02af4fabba7b4fa7394f1167244226",
    "$type": "entity",
    "$table": "GrandMother",
    "grandChildren" : [
            {
                "name" : "luke",
                "birth_order" : 0
            },
            {
                "name" : "leia",
                "birthorder" : 1
            }
    ]
}
```

Example 169. @ElementCollection with Map of @Embeddable

```
@Entity
public class ForumUser {

    @Id
    private String name;

    @ElementCollection
    private Map<String, JiraIssue> issues = new HashMap<>();

    // getters, setters ...
}

@Embeddable
public class JiraIssue {

    private Integer number;
    private String project;

    // getters, setters ...
}
```

```
{
   "_id": "ForumUser:id_:Jane Doe",
   "_rev": "1-34bd62af46eebaf0550fd968ad7819f5",
   "$type": "entity",
   "$table": "ForumUser",
   "id": "Jane Doe",
   "issues": {
       "issue2": {
           "number" : 2000,
           "project" : "OGM"
       },
       "issue1": {
           "number" : 1253,
           "project" : "HSEARCH"
       }
   }
}
```

13.3.3. Associations

Hibernate OGM CouchDB provides two strategies to store navigation information for associations:

- `IN_ENTITY` (default)
- `ASSOCIATION_DOCUMENT`

You can switch between the two strategies using:

- the `@AssociationStorage` annotation (see Annotation based configuration)
- the API for programmatic configuration (see Programmatic configuration)
- specifying a gloabl default strategy via the `hibernate.ogm.datastore.document.association_storage` configuration property

In Entity strategy

With this strategy, Hibernate OGM directly stores the id(s) of the other side of the association into a field or an embedded document depending if the mapping concerns a single object or a collection. The field that stores the relationship information is named like the entity property.

When using this strategy the annotations `@JoinTable` will be ignored because no collection is created for associations.

You can use `@JoinColumn` to change the name of the field that stores the foreign key (as an example, see [couchdb-in-entity-one-to-one-join-column]).

Example 170. Java entity

```
@Entity
public class AccountOwner {

    @Id
    private String id;

    @ManyToMany
    public Set<BankAccount> bankAccounts;

    // getters, setters, ...
```

Example 171. JSON representation

```
{
    "_id": "AccountOwner:id_:owner0001_",
    "_rev": "1-d1cd3b00a677a2e31cd0480a796e8480",
    "$type": "entity",
    "$table": "AccountOwner",
    "bankAccounts" : [
        "accountABC",
        "accountXYZ"
    ]
}
```

Example 172. Unidirectional one-to-one

```
@Entity
public class Vehicule {

    @Id
    private String id;
    private String brand;

    // getters, setters ...
}


@Entity
public class Wheel {

    @Id
    private String id;
    private double diameter;

    @OneToOne
    private Vehicule vehicule;

    // getters, setters ...
}
```

```
{
    "_id": "Vehicule:id_:V001_",
    "_rev": "1-41dc2d2fd68ce2fc683241a60e59a676",
    "$type": "entity",
    "$table": "Vehicule",
    "id": "V001",
    "brand": "Mercedes",
}
```

```
{
  "_id": "Wheel:id_:W1_",
  "_rev": "1-30430d67174484f6b647480dbf781f55",
  "$type": "entity",
  "$table": "Wheel",
  "id": "W1",
  "diameter" : 0,
  "vehicule_id" : "V001"
}
```

Example 173. Unidirectional one-to-one with @JoinColumn

```
@Entity
public class Vehicule {

    @Id
    private String id;
    private String brand;

    // getters, setters ...
}


@Entity
public class Wheel {

    @Id
    private String id;
    private double diameter;

    @OneToOne
    @JoinColumn( name = "part_of" )
    private Vehicule vehicule;

    // getters, setters ...
}
```

```
{
    "_id": "Vehicule:id_:V001_",
    "_rev": "1-41dc2d2fd68ce2fc683241a60e59a676",
    "$type": "entity",
    "$table": "Vehicule",
    "id": "V001",
    "brand": "Mercedes",
}
```

```
{
  "_id": "Wheel:id_:W1_",
  "_rev": "1-30430d67174484f6b647480dbf781f55",
  "$type": "entity",
  "$table": "Wheel",
  "id": "W1",
  "diameter" : 0,
  "part_of" : "V001"
}
```

In a true one-to-one association, it is possible to share the same id between the two entities and therefore a foreign key is not required. You can see how to map this type of association in the following example:

Example 174. Unidirectional one-to-one with @MapsId and @PrimaryKeyJoinColumn

```
@Entity
public class Vehicule {

    @Id
    private String id;
    private String brand;

    // getters, setters ...
}

@Entity
public class Wheel {

    @Id
    private String id;
    private double diameter;

    @OneToOne
    @PrimaryKeyJoinColumn
    @MapsId
    private Vehicule vehicule;

    // getters, setters ...
}
```

```
{
    "_id": "Vehicule:id_:V001_",
    "_rev": "1-41dc2d2fd68ce2fc683241a60e59a676",
    "$type": "entity",
    "$table": "Vehicule",
    "id": "V001",
    "brand": "Mercedes",
}
```

```
{
  "_id": "Wheel:vehicule/_id_:V001_",
  "_rev": "1-30430d67174484f6b647480dbf781f55",
  "$type": "entity",
  "$table": "Wheel",
  "diameter" : 0,
  "vehicule_id" : "V001"
}
```

Example 175. Bidirectional one-to-one

```
@Entity
public class Husband {

    @Id
    private String id;
    private String name;

    @OneToOne
    private Wife wife;

    // getters, setters ...
}

@Entity
public class Wife {

    @Id
    private String id;
    private String name;

    @OneToOne
    private Husband husband;

    // getters, setters ...
}
```

```
{
  "_id": "Husband:id_:alex_",
  "_rev": "2-8f976fc216130fb40144b000910b9c1d",
  "$type": "entity",
  "$table": "Husband",
  "id" : "alex",
  "name" : "Alex",
  "wife" : "bea"
}
```

```
{
  "_id": "Wife:id_:bea_",
  "_rev": "2-69130cc082958becbdf4154a3d19c2e6",
  "$type": "entity",
  "$table": "Wife",
  "id" : "bea",
  "name" : "Bea",
  "husband" : "alex"
}
```

Example 176. Unidirectional one-to-many

```java
@Entity
public class Basket {

    @Id
    private String id;

    private String owner;

    @OneToMany
    private List<Product> products = new ArrayList<Product>();

    // getters, setters ...
}

@Entity
public class Product {

    @Id
    private String name;

    private String description;

    // getters, setters ...
}
```

Basket collection

```json
{
  "_id": "Basket:id_:davide/_basket_",
  "_rev": "2-8f976fc216130fb40144b000910b9c1d",
  "$type": "entity",
  "$table": "Basket",
  "id" : "davide_basket",
  "owner" : "Davide",
  "products" : [ "Beer", "Pretzel" ]
}
```

Product collection

```
{
  "_id": "Product:name_:Beer_",
  "_rev": "1-e2a51de970f3e5a0e1118989eef1cf7b",
  "$type": "entity",
  "$table": "Product",
  "name" : "Beer",
  "description" : "Tactical nuclear penguin"
}
{
  "_id": "Product:name_:Pretzel_",
  "_rev": "1-b78ce2687db2fb550d9e8753423db3f3",
  "$type": "entity",
  "$table": "Product",
  "name" : "Pretzel",
  "description" : "Glutino Pretzel Sticks"
}
```

Example 177. Unidirectional one-to-many using one collection per strategy with @OrderColumn

```
@Entity
public class Basket {

    @Id
    private String id;

    private String owner;

    @OneToMany
    private List<Product> products = new ArrayList<Product>();

    // getters, setters ...
}

@Entity
public class Product {

    @Id
    private String name;

    private String description;

    // getters, setters ...
}
```

Basket collection

```
{
  "_id" : "davide_basket",
  "owner" : "Davide"
}
```

Product collection

```
{
  "_id" : "Pretzel",
  "description" : "Glutino Pretzel Sticks"
}
{
  "_id" : "Beer",
  "description" : "Tactical nuclear penguin"
}
```

associations_Basket_Product collection

```
{
  "_id" : { "Basket_id" : "davide_basket" },
  "rows" : [
    {
      "products_name" : "Pretzel",
      "products_ORDER" : 1
    },
    {
      "products_name" : "Beer",
      "products_ORDER" : 0
    }
  ]
}
```

A map can be used to represents an association, in this case Hibernate OGM will store the key of the map and the associated id.

Example 178. Unidirectional one-to-many using maps with defaults

```
@Entity
public class User {

    @Id
    private String id;

    @OneToMany
    private Map<String, Address> addresses = new HashMap<String, Address
>();

    // getters, setters ...
}

@Entity
public class Address {

    @Id
    private String id;
    private String city;

    // getters, setters ...
}
```

```
{
  "_id": "User:id_:user/_001",
  "_rev": "3-77de96250380a79a20a38e78826bf4f7",
  "$type": "entity",
  "$table": "User",
  "id" : "user_001",
  "addresses" : {
    "work" : "address_001",
    "home" : "address_002"
  }
}
```

```
{
  "_id": "Address:id_:address/_001",
  "_rev": "1-dd366cd017f87548956dc55d3b12fefd",
  "$type": "entity",
  "$table": "Address",
  "id" : "address_001",
  "city" : "Rome"
}
```

```
{
  "_id": "Address:id_:address/_002",
  "_rev": "1-04f13666a62473ac951dd039c7cdc780",
  "$type": "entity",
  "$table": "Address",
  "id" : "address_002",
  "city" : "Paris"
}
```

If the map value cannot be represented by a single field (e.g. when referencing a type with a composite id or using an embeddable type as map value type), a sub-document containing all the required fields will be stored as value.

If the map key either is not of type `String` or it is made up of several columns (composite map key), the optimized structure shown in the example above cannot be used. In that case the association will be represented by a list of sub-documents, also containing the map key column(s). You can use `@MapKeyColumn` to rename the field containing the key of the map, otherwise it will default to "<%COLLECTION_ROLE%>_KEY", e.g. "addresses_KEY".

In case you want to enforce the list-style represention also for maps with a single key column of type `String` you can use the option `hibernate.ogm.datastore.document.map_storage` to do so.

Example 179. Unidirectional one-to-many using maps with @MapKeyColumn

```java
@Entity
public class User {

    @Id
    private String id;

    @OneToMany
    @MapKeyColumn(name = "addressType")
    private Map<String, Address> addresses = new HashMap<String, Address
>();

    // getters, setters ...
}

@Entity
public class Address {

    @Id
    private String id;
    private String city;

    // getters, setters ...
}
```

```json
{
  "_id": "User:id_:user/_001",
  "_rev": "3-77de96250380a79a20a38e78826bf4f7",
  "$type": "entity",
  "$table": "User",
  "id" : "user_001",
  "addresses" : [
    {
      "addressType" : "work",
      "addresses_id" : "address_001"
    },
    {
      "addressType" : "home",
      "addresses_id" : "address_002"
    }
  ]
}
```

```json
{
  "_id": "Address:id_:address/_001",
  "_rev": "1-dd366cd017f87548956dc55d3b12fefd",
  "$type": "entity",
  "$table": "Address",
  "id" : "address_001",
  "city" : "Rome"
}
```

```
{
  "_id": "Address:id_:address/_002",
  "_rev": "1-04f13666a62473ac951dd039c7cdc780",
  "$type": "entity",
  "$table": "Address",
  "id" : "address_002",
  "city" : "Paris"
}
```

Example 180. Unidirectional many-to-one

```
@Entity
public class JavaUserGroup {

    @Id
    private String jugId;
    private String name;

    // getters, setters ...
}

@Entity
public class Member {

    @Id
    private String id;
    private String name;

    @ManyToOne
    private JavaUserGroup memberOf;

    // getters, setters ...
}
```

```
{
  "_id": "JavaUserGroups:id_:summer/_camp",
  "_rev": "1-04f13666a62473ac951dd039c7cdc780",
  "$type": "entity",
  "$table": "JavaUserGroup",
  "id" : "summer_camp",
  "name" : "JUG Summer Camp"
}
```

```
{
  "_id": "Member:id_:jerome",
  "_rev": "1-880bf595c39a965dec0216d9d990ebd1",
  "$type": "entity",
  "$table": "Member",
  "id" : "jerome",
  "name" : "Jerome"
  "memberOf_jugId" : "summer_camp"
}
```

```
{
  "_id": "Member:id_:emmanuel",
  "_rev": "1-18e83ce9774a769814c401c49a5afcf3",
  "$type": "entity",
  "$table": "Member",
  "id" : "emmanuel",
  "name" : "Emmanuel Bernard"
  "memberOf_jugId" : "summer_camp"
}
```

Example 181. Bidirectional many-to-one

```
@Entity
public class SalesForce {

    @Id
    private String id;
    private String corporation;

    @OneToMany(mappedBy = "salesForce")
    private Set<SalesGuy> salesGuys = new HashSet<SalesGuy>();

    // getters, setters ...
}

@Entity
public class SalesGuy {

    private String id;
    private String name;

    @ManyToOne
    private SalesForce salesForce;

    // getters, setters ...
}
```

```
{
  "_id": "SalesForce:id_:red/_hat",
  "_rev": "1-04f13666a62473ac951dd039c7cdc780",
  "$type": "entity",
  "$table": "SalesForce",
  "_id": "red_hat",
  "corporation": "Red Hat",
  "salesGuys": [ "eric", "simon" ]
}
```

```
{
  "_id": "SalesGuy:id_:eric",
  "_rev": "1-18e83ce9774a769814c401c49a5afcf3",
  "$type": "entity",
  "$table": "SalesGuy",
  "id": "eric",
  "name": "Eric"
  "salesForce_id": "red_hat",
}
```

```
{
  "_id": "SalesGuy:id_:eric",
  "_rev": "1-18e83ce9774a769814c401c49a5afcf3",
  "$type": "entity",
  "$table": "SalesGuy",
  "id": "simon",
  "name": "Simon",
  "salesForce_id": "red_hat"
}
```

Example 182. Unidirectional many-to-many using in entity strategy

```
@Entity
public class Student {

    @Id
    private String id;
    private String name;

    // getters, setters ...
}

@Entity
public class ClassRoom {

    @Id
    private Long id;
    private String lesson;

    @ManyToMany
    private List<Student> students = new ArrayList<Student>();

    // getters, setters ...
}
```

```
{
   "_id": "ClassRoom:id_:1_",
   "_rev": "2-ae1d9748a84af991615fa842a7e796ea",
   "$type": "entity",
   "$table": "ClassRoom",
   "id": "1",
   "students": [
       "mario",
       "john"
   ],
   "name": "Math"
}
```

```
{
   "_id": "ClassRoom:id_:2_",
   "_rev": "2-0e58f03f518c5c1982bb7936308604e4",
   "$type": "entity",
   "$table": "ClassRoom",
   "id": "2",
   "students": [
       "kate",
       "mario"
   ],
   "name": "English"
}
```

```
{
   "_id": "Student:id_:john_",
   "_rev": "1-60b642619f0e62e079da8a6521ea9750",
   "$type": "entity",
   "$table": "Student",
   "id": "john",
   "name": "John Doe"
}
```

```
{
   "_id": "Student:id_:kate_",
   "_rev": "1-911bb5cbc9b16c6d90f1e91e856a9224",
   "$type": "entity",
   "$table": "Student",
   "id": "kate",
   "name": "Kate Doe"
}
```

```
{
   "_id": "Student:id_:mario_",
   "_rev": "1-7dc611e3c627a837033e7eb5e244f7f8",
   "$type": "entity",
   "$table": "Student",
   "id": "mario",
   "name": "Mario Rossi"
}
```


Example 183. Bidirectional many-to-many

```java
@Entity
public class AccountOwner {

    @Id
    private String id;

    private String SSN;

    @ManyToMany
    private Set<BankAccount> bankAccounts;

    // getters, setters ...
}

@Entity
public class BankAccount {

    @Id
    private String id;

    private String accountNumber;

    @ManyToMany( mappedBy = "bankAccounts" )
    private Set<AccountOwner> owners = new HashSet<AccountOwner>();

    // getters, setters ...
}
```

```json
{
   "_id": "AccountOwner:id_:owner/_1_",
   "_rev": "3-07eb9959eac966afedd0547aa74a59a7",
   "$type": "entity",
   "$table": "AccountOwner",
   "id": "owner_1",
   "SSN": "0123456",
   "bankAccounts": [
       "account_1",
       "account_2"
   ]
}
```

```json
{
   "_id": "BankAccount:id_:account/_1_",
   "_rev": "2-87252fffa4ab443485f55504215fbed3",
   "$type": "entity",
   "$table": "BankAccount",
   "id": "account_1",
   "accountNumber": "X2345000",
   "owners": [
       "owner_1"
   ]
}
```

```
{
   "_id": "BankAccount:id_:account/_2_",
   "_rev": "2-15bdfeda927dd10fa10aa19ceee4ea34",
   "$type": "entity",
   "$table": "BankAccount",
   "id": "account_2",
   "accountNumber": "ZZZ-009",
   "owners": [
       "owner_1"
   ]
}
```

Association document strategy

With this strategy, Hibernate OGM uses separate association documents (with `$type` set to "association") to store all navigation information. Each assocation document is structured in 2 parts. The first is the `_id` field which contains the identifier information of the association owner and the name of the association table. The second part is the `rows` field which stores (into an embedded collection) all ids that the current instance is related to.

Example 184. Unidirectional relationship

```
{
   "_id": "AccountOwner_BankAccount:owners/_id_:4f5b48ad-f074-4a64-8cf4-
1f9c54a33f76_",
   "_rev": "1-18ef25ec73c1942c45c868aa92f24f2c",
   "$type": "association",
   "rows": [
        "7873a2a7-c77c-447c-b000-890f0a4dfa9a"
   ]
}
```

For a bidirectional relationship, another document is created where ids are reversed. Don't worry, Hibernate OGM takes care of keeping them in sync:

Example 185. Bidirectional relationship

```
{
   "_id": "AccountOwner_BankAccount:owners/_id_:4f5b48ad-f074-4a64-8cf4-
1f9c54a33f76_",
   "_rev": "1-18ef25ec73c1942c45c868aa92f24f2c",
   "$type": "association",
   "rows": [
        "7873a2a7-c77c-447c-b000-890f0a4dfa9a"
   ]
}
{
   "_id": "AccountOwner_BankAccount:bankAccounts/_id_:7873a2a7-c77c-447c-
b000-890f0a4dfa9a_",
   "_rev": "1-78e92f980745941a779abb914da65a6c",
   "$type": "association",
   "rows": [
        "4f5b48ad-f074-4a64-8cf4-1f9c54a33f76"
   ]
}
```

This strategy won't affect *-to-one associations or embedded collections.

Example 186. Unidirectional one-to-many using document strategy

```
@Entity
public class Basket {

    @Id
    private String id;

    private String owner;

    @OneToMany
    private List<Product> products = new ArrayList<Product>();

    // getters, setters ...
}

@Entity
public class Product {

    @Id
    private String name;

    private String description;

    // getters, setters ...
}
```

```
{
   "_id": "Basket:id_:davide/_basket_",
   "_rev": "1-ba920ac3d1ed5544a71d6c6c5f2ee286",
   "$type": "entity",
   "$table": "Basket",
   "id": "davide_basket",
   "owner": "Davide"
}
```

```
{
   "_id": "Basket:id_:davide/_basket_",
   "_rev": "1-ba920ac3d1ed5544a71d6c6c5f2ee286",
   "$type": "entity",
   "$table": "Basket",
   "id": "davide_basket",
   "owner": "Davide"
}
```

```
{
   "_id": "Product:name_:Pretzel_",
   "_rev": "1-b78ce2687db2fb550d9e8753423db3f3",
   "$type": "entity",
   "$table": "Product",
   "description": "Glutino Pretzel Sticks",
   "name": "Pretzel"
}
```

```
{
   "_id": "Basket_Product:Basket/_id_:davide/_basket_",
   "_rev": "1-f6d9aa44a7ca4f01b68c94b1f5599956",
   "$type": "association",
   "rows": [
       "Beer",
       "Pretzel"
   ]
}
```

Using the annotation `@JoinTable` it is possible to change the value of the document containing the association.

Example 187. Unidirectional one-to-many using document strategy with `@JoinTable`

```java
@Entity
public class Basket {

    @Id
    private String id;

    private String owner;

    @OneToMany
    @JoinTable( name = "BasketContent" )
    private List<Product> products = new ArrayList<Product>();

    // getters, setters ...
}

@Entity
public class Product {

    @Id
    private String name;

    private String description;

    // getters, setters ...
}
```

```json
{
   "_id": "Basket:id_:davide/_basket_",
   "_rev": "1-ba920ac3d1ed5544a71d6c6c5f2ee286",
   "$type": "entity",
   "$table": "Basket",
   "id": "davide_basket",
   "owner": "Davide"
}
```

```json
{
   "_id": "Basket:id_:davide/_basket_",
   "_rev": "1-ba920ac3d1ed5544a71d6c6c5f2ee286",
   "$type": "entity",
   "$table": "Basket",
   "id": "davide_basket",
   "owner": "Davide"
}
```

```json
{
   "_id": "Product:name_:Pretzel_",
   "_rev": "1-b78ce2687db2fb550d9e8753423db3f3",
   "$type": "entity",
   "$table": "Product",
   "description": "Glutino Pretzel Sticks",
   "name": "Pretzel"
}
```

```
{
   "_id": "BasketContent:Basket/_id_:davide/_basket_",
   "_rev": "1-f6d9aa44a7ca4f01b68c94b1f5599956",
   "$type": "association",
   "rows": [
       "Beer",
       "Pretzel"
   ]
}
```

Example 188. Unidirectional many-to-many using document strategy

```
@Entity
public class Student {

    @Id
    private String id;
    private String name;

    // getters, setters ...
}

@Entity
public class ClassRoom {

    @Id
    private Long id;
    private String lesson;

    @ManyToMany
    private List<Student> students = new ArrayList<Student>();

    // getters, setters ...
}
```

```
{
   "_id": "ClassRoom:id_:1_",
   "_rev": "2-ae1d9748a84af991615fa842a7e796ea",
   "$type": "entity",
   "$table": "ClassRoom",
   "id": "1",
   "name": "Math"
}
```

```
{
   "_id": "ClassRoom:id_:2_",
   "_rev": "2-0e58f03f518c5c1982bb7936308604e4",
   "$type": "entity",
   "$table": "ClassRoom",
   "id": "2",
   "name": "English"
}
```

```
{
   "_id": "Student:id_:john_",
   "_rev": "1-60b642619f0e62e079da8a6521ea9750",
   "$type": "entity",
   "$table": "Student",
   "id": "john",
   "name": "John Doe"
}
```

```
{
   "_id": "Student:id_:kate_",
   "_rev": "1-911bb5cbc9b16c6d90f1e91e856a9224",
   "$type": "entity",
   "$table": "Student",
   "id": "kate",
   "name": "Kate Doe"
}
```

```
{
   "_id": "Student:id_:mario_",
   "_rev": "1-7dc611e3c627a837033e7eb5e244f7f8",
   "$type": "entity",
   "$table": "Student",
   "id": "mario",
   "name": "Mario Rossi"
}
```

```
{
   "_id": "ClassRoom_Student:ClassRoom/_id_:1_",
   "_rev": "1-351e470a8c134a084d9ad282796a7464",
   "$type": "association",
   "rows": [
       "mario",
       "john"
   ]
}
```

```
{
   "_id": "ClassRoom_Student:ClassRoom/_id_:2_",
   "_rev": "1-825d1900ec216dc73e0152564de8e975",
   "$type": "association",
   "rows": [
       "kate"
   ]
}
```


Example 189. Bidirectional many-to-many using document strategy

```java
@Entity
public class AccountOwner {

    @Id
    private String id;

    private String SSN;

    @ManyToMany
    private Set<BankAccount> bankAccounts;

    // getters, setters ...
}

@Entity
public class BankAccount {

    @Id
    private String id;

    private String accountNumber;

    @ManyToMany(mappedBy = "bankAccounts")
    private Set<AccountOwner> owners = new HashSet<AccountOwner>();

    // getters, setters ...
}
```

```json
{
   "_id": "AccountOwner:id_:owner/_1_",
   "_rev": "3-07eb9959eac966afedd0547aa74a59a7",
   "$type": "entity",
   "$table": "AccountOwner",
   "id": "owner_1",
   "SSN": "0123456",
}
```

```json
{
   "_id": "BankAccount:id_:account/_1_",
   "_rev": "2-87252fffa4ab443485f55504215fbed3",
   "$type": "entity",
   "$table": "BankAccount",
   "id": "account_1",
   "accountNumber": "X2345000",
}
```

```json
{
   "_id": "BankAccount:id_:account/_2_",
   "_rev": "2-15bdfeda927dd10fa10aa19ceee4ea34",
   "$type": "entity",
   "$table": "BankAccount",
   "id": "account_2",
   "accountNumber": "ZZZ-009",
}
```

```
{
    "_id": "AccountOwner_BankAccount:bankAccounts/_id_:account/_1_",
    "_rev": "1-34ecb6bcadae6e51112de0cf50387521",
    "$type": "association",
    "rows": [
        "owner_1"
    ]
}
```

```
{
    "_id": "AccountOwner_BankAccount:bankAccounts/_id_:account/_2_",
    "_rev": "1-34ecb6bcadae6e51112de0cf50387521",
    "$type": "association",
    "rows": [
        "owner_1"
    ]
}
```

```
{
    "_id": "AccountOwner_BankAccount:owners/_id_:owner/_1_",
    "_rev": "2-d2cc7816eae5498a0829a3cdae0b208e",
    "$type": "association",
    "rows": [
        "account_1",
        "account_2"
    ]
}
```

13.4. Transactions

CouchDB does not support transactions. Only changes applied to the same document are done atomically. A change applied to more than one document will not be applied atomically. This problem is slightly mitigated by the fact that Hibernate OGM queues all changes before applying them during flush time. So the window of time used to write to CouchDB is smaller than what you would have done manually.

We recommend that you still use transaction demarcations with Hibernate OGM to trigger the flush operation transparently (on commit). But consider that rolling back the transaction isn't an option: operations already flushed will not be undone.

13.5. Queries

Hibernate OGM is a work in progress and we are actively working on JP-QL query support.

In the mean time, you have two strategies to query entities stored by Hibernate OGM:

- use native CouchDB queries
- use Hibernate Search

Because Hibernate OGM stores data in CouchDB in a natural way, you can the HTTP client or REST library of your choice and execute queries (using CouchDB views) on the datastore directly without involving Hibernate OGM. The benefit of this approach is to use the query capabilities of CouchDB. The drawback is that raw CouchDB documents will be returned and not managed entities.

The alternative approach is to index your entities with Hibernate Search. That way, a set of secondary indexes independent of CouchDB is maintained by Hibernate Search and you can write queries on top of them. The benefit of this approach is a nice integration at the JPA / Hibernate API level (managed entities are returned by the queries). The drawback is that you need to store the Lucene indexes somewhere (file system, Infinispan grid etc). Have a look at the paragraph Using Hibernate Search to have more details about it.

Chapter 14. Cassandra (Experimental)

Cassandra is a distributed column family database.

This implementation uses CQL3 over the native wire protocol with java-driver. The currently supported versions are Cassandra 2.2.x and Cassandra 3.0.x.

Support for Cassandra is considered an EXPERIMENTAL feature of this release.

Should you find any bugs or have feature requests for this dialect, then please open a ticket in the OGM issue tracker.

14.1. Configuring Cassandra

Configuring Hibernate OGM to use Cassandra is easy:

- add the Cassandra module and driver to the classpath
- provide the Cassandra connection information to Hibernate OGM
- if you need to run JPQL or HQL queries, add Hibernate Search (Using Hibernate Search)

14.1.1. Adding Cassandra dependencies

To add the dependencies via Maven, add the following module:

```
<dependency>
    <groupId>org.hibernate.ogm</groupId>
    <artifactId>hibernate-ogm-cassandra</artifactId>
    <version>5.1.0.Final</version>
</dependency>
```

This will pull the Cassandra Java driver transparently.

If you're not using a dependency management tool, copy all the dependencies from the distribution in the directories:

- `/lib/required`
- `/lib/cassandra`
- Optionally - depending on your container - you might need some of the jars from `/lib/provided`

14.1.2. Cassandra specific configuration properties

To get started you will need to configure the following properties:

- `hibernate.ogm.datastore.provider`
- `hibernate.ogm.datastore.host`
- `hibernate.ogm.datastore.database`

Cassandra datastore configuration properties

hibernate.ogm.datastore.provider

To use Cassandra as a datastore provider, this property must be set to `cassandra_experimental`

hibernate.ogm.datastore.host

The hostname and port of the Cassandra instance. The optional port is concatenated to the host and separated by a colon. Let's see a few valid examples:

- `cassandra.example.com`
- `cassandra.example.com:9043`
- `2001:db8::ff00:42:8329` (IPv6)
- `[2001:db8::ff00:42:8329]:9043` (IPv6 with port requires the IPv6 to be surrounded by square brackets)

Listing multiple initial hosts for fault tolerance is not currently supported. The default value is `127.0.0.1:9042`. If left undefined, the default port is `9042`.

hibernate.ogm.datastore.port

Deprecated: use `hibernate.ogm.datastore.host`. The port used by the Cassandra instance. Ignored when multiple hosts are defined. The default value is `9042`.

hibernate.ogm.datastore.database

The database to connect to. This property has no default value.

hibernate.ogm.datastore.username

The username used when connecting to the Cassandra server. This property has no default value.

hibernate.ogm.datastore.password

The password used to connect to the Cassandra server. This property has no default value.

14.2. Storage principles

Each Entity type maps to one Cassandra table. Each Entity instance maps to one CQL3 row of the table, each property of the Entity being one CQL3 column.

CQL3 table and column names are always quoted to preserve case consistency with the Java layer, with the table name matching the Entity class and the column names matching the Entity's properties. The @Table and @Column annotations can be used to override identifier names in the usual manner.

Embedded objects are stored as additional columns in the owning Entitie's table. The columns are named as `EmbeddedTypeName.FieldOfEmbeddedType` The type and field names can be overridden by annotations, but concatenation token delimiter cannot.

14.2.1. Properties and built-in types

CQL3 types

CQL3 supports a smaller selection of numeric data types than Hibernate, so the missing types are automatically converted. `byte` and `short` values are promoted to `integer`. `java.math.BigDecimal` is converted to `decimal`.

CQL3 has no character type, so character is promoted to varchar i.e. String. Strings are UTF-8, not ascii.

CQL3 does not distinguish between byte[] and BLOB types for binary storage. These are handled equivalently.

CQL3 does not have a Calendar type, so these are converted to Dates, which are stores as time offset from the unix epoch.

Identifier generation strategies

You can assign id values yourself or let Hibernate OGM generate the value using the `@GeneratedValue` annotation.

The preferred identifier approach in Cassandra is to use UUIDs.

Cassandra does not natively support sequences (auto increment identifiers) at present. This approach is supported though use of an additional table to store sequence state, but incurs additional access overheads that make it undesirable for tables with frequent inserts.

14.3. Transactions and Concurrency

Cassandra does not support transactions. Changes to a single Entity are atomic. Changes to more than one entity are neither atomic nor isolated.

Cassandra does not distinguish between update and insert operations and will not prevent creation of an Entity with duplicate Id, instead treating it as modification of the existing Entity.

14.4. Native queries

Native queries are supported: you can execute native CQL queries using the `EntityManager` infrastructure.

Currently, only ordinal parameters are supported, named parameters do not work.

Example 190. Using native CQL queries

```
Query query = em.createNativeQuery( "SELECT * FROM \"WILDE_POEM\" WHERE
name = ?" );
query.setParameter( 1, "Portia" ); // CQL parameters positions start at 1
List<OscarWildePoem> results = query.getResultList();
```

Unlike in JPQL, in CQL, parameters positions start at 1, not 0.

Chapter 15. Redis (Experimental)

Redis is a key-value datastore which stores your data in a variety of data structures. Although there is no one-and-only style how to map data between data structures and Redis, two major styles are are most common:

- Storing entities using keys as JSON documents
- Storing entities using hashes as key-value pairs

Support for Redis is considered an EXPERIMENTAL feature as of this release. In particular you should be prepared for possible changes to the persistent representation of mapped objects in future releases.

Also be aware of the fact that partial updates using the JSON dialect are unsupported at the moment Instead always the entire document will be replaced during updates. This means that fields possibly written by other applications but not mapped to properties in your domain model will get lost.

The JSON dialect supports two modes for storing associations: The `ASSOCIATION_DOCUMENT` mode should be used with care as there is potential for lost updates (OGM-461). It is recommended to use the `IN_ENTITY` mode (which is the default).

Should you find any bugs or have feature requests for this dialect, then please open a ticket in the OGM issue tracker.

15.1. Configuring Redis

Hibernate OGM uses the lettuce library to talk to Redis, so you need the client libraries to use Hibernate OGM Redis.

The following properties are available to configure Redis support in Hibernate OGM:

Redis datastore configuration properties

hibernate.ogm.datastore.provider

To use Redis as a datastore provider, this property must be set to `redis_experimental`

hibernate.ogm.datastore.grid_dialect

The dialect type how Hibernate OGM Redis maps entities and associations within Redis. The following two dialects exist: `org.hibernate.ogm.datastore.redis.RedisJsonDialect` (store entities as JSON

documents within Redis keys. Associations are mapped to Redis lists/sets) and `org.hibernate.ogm.datastore.redis.RedisHashDialect` (store entities as key-value pairs within Redis hashes. Associations are mapped as JSON documents to Redis lists/sets)

hibernate.ogm.datastore.host

The hostname and port of the Redis instance. The optional port is concatenated to the host and separated by a colon. Let's see a few valid examples:

- `redis.example.com`
- `redis.example.com:6379`

Listing multiple initial hosts for fault tolerance is not supported. The default value is `127.0.0.1:6379`. If left undefined, the default port is `6379`.

hibernate.ogm.datastore.database

The database number to connect to. If left undefined, the default number is `0`. Note that Redis databases are identified with a number from `0` to `16`.

hibernate.ogm.datastore.password

The password used to connect to the Redis server. This property has no default value.

hibernate.ogm.redis.ssl

Boolean flag to enable SSL connections to Redis. Note that Redis does not support native SSL and SSL is provided by tools like stunnel

hibernate.ogm.redis.connection_timeout

Defines the timeout used by the driver when the connection to the Redis instance is initiated. This configuration is expressed in milliseconds. The default value is `5000`.

hibernate.ogm.redis.cluster

Boolean flag to enable Redis Cluster mode. It's strongly recommended to use simple primary and association keys as composite keys are serialized as JSON which may interfere the slot distribution. Curly braces within keys are used to denote hash tags to group keys within one slot.

hibernate.ogm.redis.ttl

Defines the TTL for entities and associations. TTL can be configured on entity and association level (see Annotation based configuration This property has no default value.

hibernate.ogm.error_handler

The fully-qualified class name, class object or an instance of `ErrorHandler` to get notified upon errors during flushes (see Acting upon errors during application of changes)

hibernate.ogm.datastore.redis.association_storage

Defines the way OGM stores association information in Redis. The following two strategies exist for the JSON dialect (values of the `org.hibernate.ogm.datastore.document.options.AssociationStorageType` enum): `IN_ENTITY` (store association information within the entity) and `ASSOCIATION_DOCUMENT` (store association information in a dedicated document per association). `IN_ENTITY` is the default and recommended option unless the association navigation data is much bigger than the core of the document and leads to performance degradation. The Redis hash dialect supports only the `ASSOCIATION_DOCUMENT` strategy.

hibernate.ogm.datastore.document.map_storage

Defines the way OGM stores the contents of map-typed associations in Redis. The following two strategies exist (values of the `org.hibernate.ogm.datastore.document.options.MapStorageType` enum):

- `BY_KEY`: map-typed associations with a single key column which is of type `String` will be stored as a sub-document, organized by the given key; Not applicable for other types of key columns, in which case always `AS_LIST` will be used
- `AS_LIST`: map-typed associations will be stored as an array containing a sub-document for each map entry. All key and value columns will be contained within the array elements The default value is `BY_KEY`.

When bootstrapping a session factory or entity manager factory programmatically, you should use the constants accessible via `RedisProperties` when specifying the configuration properties listed above. Common properties shared between stores are declared on `OgmProperties`. To ease migration between stores, it is recommended to reference these constants directly from there.

15.1.1. Annotation based configuration

Hibernate OGM allows to configure store-specific options via Java annotations. When working with the Redis backend, you can specify how associations should be stored using the `AssociationStorage` annotation. A strategy for storing the contents of map-typed associations can be defined using the `@MapStorage` annotation.

(refer to Storage principles to learn more about association storage strategies in general).

The following shows an example:

Example 191. Configuring the association storage strategy using annotations

```
@Entity
@AssociationStorage(AssociationStorageType.ASSOCIATION_DOCUMENT)
public class Zoo {

    @OneToMany
    private Set<Animal> animals;

    @OneToMany
    private Set<Person> employees;

    @OneToMany
    @AssociationStorage(AssociationStorageType.IN_ENTITY)
    private Set<Person> visitors;

    //...
}
```

The annotation on the entity level expresses that all associations of the `Zoo` class should be stored in separate association documents. This setting applies to the `animals` and `employees` associations. Only the elements of the `visitors` association will be stored in the document of the corresponding `Zoo` entity as per the configuration of that specific property which takes precedence over the entity-level configuration.

Example 192. Configuring the TTL/expiry using annotations

```
@Entity
@TTL(value = 7, unit = TimeUnit.DAYS)
public class Zoo {

    @OneToMany
    private Set<Animal> animals;

    @OneToMany
    @TTL(value = 3, unit = TimeUnit.DAYS)
    private Set<Person> employees;

    @OneToMany
    @AssociationStorage(AssociationStorageType.IN_ENTITY)
    private Set<Person> visitors;

    //...
}
```

Redis supports a native TTL/expiry mechanism. Keys can expire at a date or after a certain period. Hibernate OGM allows to specify a TTL value on entities and associations. The TTL is set after persisting the entity using the PEXPIRE command. Every write to Redis will set a new TTL.

You can specify a different TTL on associations if they are stored as separate documents. In the

case of `visitors` which is stored in the entity, the TTL of the association will be the one of the entity.

15.2. Storage principles

Hibernate OGM tries to make the mapping to the underlying datastore as natural as possible so that third party applications not using Hibernate OGM can still read and update the same datastore. Hibernate OGM facilitates two styles of data mapping within Redis:

- JSON
- Redis Hash

The following describe how entities and associations are mapped to Redis data structures by Hibernate OGM.

15.2.1. JSON mapping

The JSON mapping dialect maps entities to JSON documents and stores the JSON data within Redis keys. A document is self-contained and does not support partial updates.

Properties and built-in types

Hibernate OGM doesn't store null values in Redis, setting a value to null will be the same as removing the field in the corresponding object in the db.

Hibernate OGM supports by default the following types:

- `java.lang.String`

```
{ "text" : "Hello world!" }
```

- `java.lang.Character` (or char primitive)

```
{ "delimiter" : "/" }
```

- `java.lang.Boolean` (or boolean primitive)

```
{ "favorite" : true } # default mapping
{ "favorite" : "T" } # if @Type(type = "true_false") is given
{ "favorite" : "Y" } # if @Type(type = "yes_no") is given
{ "favorite" : 1 } # if @Type(type = "numeric_boolean") is given
```

- `java.lang.Byte` (or byte primitive)

```
{ "display_mask" : "70" }
```

- `java.lang.Short` (or short primitive)

```
{ "urlPort" : 80 }
```

- `java.lang.Integer` (or int primitive)

```
{ "stockCount" : 12309 }
```

- `java.lang.Long` (or long primitive)

```
{ "userId" : -6718902786625749549 }
```

- `java.lang.Float` (or float primitive)

```
{ "visitRatio" : 10.4 }
```

- `java.lang.Double` (or double primitive)

```
{ "tax_percentage" : 12.34 }
```

- `java.math.BigDecimal`

```
{ "site_weight" : "21.77" }
```

- `java.math.BigInteger`

```
{ "site_weight" : "444" }
```

- `java.util.Calendar`

```
{ "creation" : "2014-11-18T15:51:26.252Z" }
```

- `java.util.Date`

```
{ "last_update" : "2014-11-18T15:51:26.252Z" }
```

- `java.util.UUID`

```
{ "serialNumber" : "71f5713d-69c4-4b62-ad15-aed8ce8d10e0" }
```

- `java.util.URL`

```
{ "url" : "http://www.hibernate.org/" }
```

Entities

Entities are stored as JSON documents and not as BLOBs which means each entity property will be translated into a document field. You can use the name property of the `@Table` and `@Column` annotations to rename the collections and the document's fields if you need to.

Redis has no built-in mechanism for detecting concurrent updates to one and the same document.

The following shows an example of an entity and its persistent representation in Redis.

Example 193. Example of an entity and its representation in Redis

```
@Entity
public class News {

    @Id
    private String id;

    @Version
    @Column(name="version")
    private int version;

    private String title;

    private String description;

    //getters, setters ...
}
```

```
{
    "version": 1,
    "title": "On the merits of NoSQL",
    "description": "This paper discuss why NoSQL will save the world for
good"
}
```

Redis doesn't have a concept of "tables"; Instead all values are stored in a unique key. Thus Hibernate OGM needs to add two additional attributes:

Example 194. Rename field and collection using @Table and @Column

```
@Entity
@Table(name="Article")
public class News {

    @Id
    @Column(name="code")
    private String id;

    @Version
    @Column(name="revision")
    private int revision;

    private String title;

    @Column(name="desc")
    private String description;

    //getters, setters ...
}
```

```
{
    "revision": 1,
    "title": "On the merits of NoSQL",
    "desc": "This paper discuss why NoSQL will save the world for good"
}
```

Embedded objects and collections

Hibernate OGM stores elements annotated with `@Embedded` or `@ElementCollection` as nested documents of the owning entity.

Example 195. Embedded object

```
@Entity
public class News {

    @Id
    private String id;
    private String title;

    @Embedded
    private NewsPaper paper;

    // getters, setters ...
}

@Embeddable
public class NewsPaper {

    private String name;
    private String owner;

    // getters, setters ...
}
```

```
Key: News:939c892d-1129-4aff-abf8-e6c26e59dcb
{
    "title": "On the merits of NoSQL",
    "paper": {
        "name": "NoSQL journal of prophecies",
        "owner": "Delphy"
    }
}
```

Example 196. @ElementCollection with primitive types

```
@Entity
public class AccountWithPhone {

    @Id
    private String id;

    @ElementCollection
    private List<String> mobileNumbers;

    // getters, setters ...
}
```

AccountWithPhone collection

```
Key: AccountWithPhone:2
{
   "mobileNumbers": [
       "+1-222-555-0222",
       "+1-202-555-0333"
   ]
}
```

Example 197. @ElementCollection with one attribute

```
@Entity
public class GrandMother {

    @Id
    private String id;

    @ElementCollection
    private List<GrandChild> grandChildren = new ArrayList<GrandChild>();

    // getters, setters ...
}

@Embeddable
public class GrandChild {

    private String name;

    // getters, setters ...
}
```

```
Key: GrandMother:86ada718-f2a2-4299-b6ac-3d90b1ef2331
{
    "grandChildren" : [ "Luke", "Leia" ]
}
```

The class `GrandChild` has only one attribute `name`, this means that Hibernate OGM doesn't need to store the name of the attribute.

If the nested document has two or more fields, like in the following example, Hibernate OGM will store the name of the fields as well.

Example 198. @ElementCollection with @OrderColumn

```
@Entity
public class GrandMother {

    @Id
    private String id;

    @ElementCollection
    @OrderColumn( name = "birth_order" )
    private List<GrandChild> grandChildren = new ArrayList<GrandChild>();

    // getters, setters ...
}

@Embeddable
public class GrandChild {

    private String name;

    // getters, setters ...
}
```

```
Key: GrandMother:86ada718-f2a2-4299-b6ac-3d90b1ef2331
{
    "grandChildren" : [
            {
                "birthorder" : 0
                "name" : "luke",
            },
            {
                "birthorder" : 1
                "name" : "leia",
            }
    ]
}
```

Example 199. @ElementCollection with Map of @Embeddable

```
@Entity
public class ForumUser {

    @Id
    private String name;

    @ElementCollection
    private Map<String, JiraIssue> issues = new HashMap<>();

    // getters, setters ...
}

@Embeddable
public class JiraIssue {

    private Integer number;
    private String project;

    // getters, setters ...
}
```

```
Key: "ForumUser:Jane Doe"
{
    "issues": {
        "issue2": {
            "number" : 2000,
            "project" : "OGM"
        },
        "issue1": {
            "number" : 1253,
            "project" : "HSEARCH"
        }
    }
}
```

15.2.2. Hash mapping

The Redis Hash mapping dialect maps entities to key-value pairs. It stores the data within Redis hashes. Hashes support partial updates. While the JSON dialect discards not mapped fields in the entity model the hash dialect does not touch fields that are not mapped to the entity model.

Properties and built-in types

Hibernate OGM doesn't store null values in Redis, setting a value to null will be the same as removing the field in the corresponding object in the db.

Hibernate OGM supports by default the following types:

- `java.lang.String`

```
text=Hello world!
```

- `java.lang.Character` (or char primitive)

```
delimiter=/
```

- `java.lang.Boolean` (or boolean primitive)

```
favorite=true  # default mapping
favorite=T     # if @Type(type = "true_false") is given
favorite=Y     # if @Type(type = "yes_no") is given
favorite=1     # if @Type(type = "numeric_boolean") is given
```

- `java.lang.Byte` (or byte primitive)

```
 display_mask=Rg==
```

Redis Hash stores byte data as base64-encoded string

- `java.lang.Short` (or short primitive)

```
urlPort=80
```

- `java.lang.Integer` (or int primitive)

```
stockCount=12309
```

- `java.lang.Long` (or long primitive)

```
userId=-6718902786625749549
```

- `java.lang.Float` (or float primitive)

```
visitRatio=10.4
```

- `java.lang.Double` (or double primitive)

```
tax_percentage=12.34
```

- `java.math.BigDecimal`

```
site_weight=21.77
```

- `java.math.BigInteger`

```
site_weight=444
```

- `java.util.Calendar`

```
creation=2014-11-18T15:51:26.252Z
```

- `java.util.Date`

```
last_update=2014-11-18T15:51:26.252Z
```

- `java.util.UUID`

```
serialNumber=71f5713d-69c4-4b62-ad15-aed8ce8d10e0
```

- `java.util.URL`

```
url=http://www.hibernate.org/
```

Entities

Entities are stored as key-value pairs within Redis hashes. Each entity property will be translated into a hash field and is represented as `java.lang.String`. The Redis hash dialect supports only flat data structures hence nested entities and associations are represented as JSON documents within the association documents in Redis lists/sets. You can use the name property of the `@Table` and `@Column` annotations to rename the collections and the document's fields if you need to.

Redis has no built-in mechanism for detecting concurrent updates to one and the same document.

The following shows an example of an entity and its persistent representation in Redis.

Example 200. Example of an entity and its representation in Redis

```
@Entity
public class News {

    @Id
    private String id;

    @Version
    @Column(name="version")
    private int version;

    private String title;

    private String description;

    //getters, setters ...
}
```

```
version=1
title=On the merits of NoSQL
description=This paper discuss why NoSQL will save the world for good
```

Redis doesn't have a concept of "tables"; Instead all values are stored in a hash as key values. The hash key contains the table name and the primary key of the entity. Thus Hibernate OGM needs to add two additional attributes:

Example 201. Rename field and collection using @Table and @Column

```
@Entity
@Table(name="Article")
public class News {

    @Id
    @Column(name="code")
    private String id;

    @Version
    @Column(name="revision")
    private int revision;

    private String title;

    @Column(name="desc")
    private String description;

    //getters, setters ...
}
```

```
revision=1
title=On the merits of NoSQL
desc=This paper discuss why NoSQL will save the world for good
```

Embedded objects and collections

Hibernate OGM stores elements annotated with `@Embedded` or `@ElementCollection` as nested documents of the owning entity.

Example 202. Embedded object

```
@Entity
public class News {

    @Id
    private String id;
    private String title;

    @Embedded
    private NewsPaper paper;

    // getters, setters ...
}

@Embeddable
public class NewsPaper {

    private String name;
    private String owner;

    // getters, setters ...
}
```

```
Key: News:939c892d-1129-4aff-abf8-e6c26e59dcb
paper.name=NoSQL journal of prophecies
paper.owner=Delphy
```

Example 203. @ElementCollection with primitive types

```
@Entity
public class AccountWithPhone {

    @Id
    private String id;

    @ElementCollection
    private List<String> mobileNumbers;

    // getters, setters ...
}
```

AccountWithPhone collection

```
Key: AccountWithPhone:2
id=2

Key: Associations:AccountWithPhone:2:mobileNumbers
[
   "+1-222-555-0222",
   "+1-202-555-0333"
]
```

Example 204. @ElementCollection with one attribute

```
@Entity
public class GrandMother {

    @Id
    private String id;

    @ElementCollection
    private List<GrandChild> grandChildren = new ArrayList<GrandChild>();

    // getters, setters ...
}

@Embeddable
public class GrandChild {

    private String name;

    // getters, setters ...
}
```

```
Key: Associations:GrandMother_grandChildren:86ada718-f2a2-4299-b6ac-3d90
b1ef2331:grandChildren

[ "Luke", "Leia" ]
```

The class `GrandChild` has only one attribute `name`, this means that Hibernate OGM doesn't need to store the name of the attribute.

If the nested document has two or more fields, like in the following example, Hibernate OGM will store the name of the fields as well.

Example 205. @ElementCollection with @OrderColumn

```
@Entity
public class GrandMother {

    @Id
    private String id;

    @ElementCollection
    @OrderColumn( name = "birth_order" )
    private List<GrandChild> grandChildren = new ArrayList<GrandChild>();

    // getters, setters ...
}

@Embeddable
public class GrandChild {

    private String name;

    // getters, setters ...
}
```

```
Key: Associations:GrandMother_grandChildren:86ada718-f2a2-4299-b6ac-3d90
b1ef2331:grandChildren
[
    "{\"name\":\"Luke\",\"birthorder\":\"0\"}",
    "{\"name\":\"Leia\",\"birthorder\":\"1\"}"
]
```

Example 206. @ElementCollection with Map of @Embeddable

```
@Entity
public class ForumUser {

    @Id
    private String name;

    @ElementCollection
    private Map<String, JiraIssue> issues = new HashMap<>();

    // getters, setters ...
}

@Embeddable
public class JiraIssue {

    private Integer number;
    private String project;

    // getters, setters ...
}
```

```
Key: "ForumUser:Jane Doe"
id = "Jane Doe"

Key: Associations:ForumUser_issues:Jane Doe:issues
[
    {"issues_KEY":\"issueWithNull\"}"
    {"value":{\"number\":\"2000\",\"project\":\"OGM\"},\"issues_KEY\":
\"issue2\"}"
    {"value":{\"number\":\"1253\",\"project\":\"HSEARCH\"},\"issues_KEY
\":\"issue1\"}
]
```

15.2.3. Associations

Hibernate OGM Redis provides two strategies to store navigation information for associations:

- `IN_ENTITY` (default)
- `ASSOCIATION_DOCUMENT`

You can switch between the two strategies using:

- the `@AssociationStorage` annotation (see Annotation based configuration)
- specifying a gloabl default strategy via the `hibernate.ogm.datastore.document.association_storage` configuration property

In Entity strategy

With this strategy, Hibernate OGM directly stores the id(s) of the other side of the association into a field or an embedded document depending if the mapping concerns a single object or a collection. The field that stores the relationship information is named like the entity property.

When using this strategy the annotations `@JoinTable` will be ignored because no collection is created for associations. This strategy is supported only using the JSON dialect.

You can use `@JoinColumn` to change the name of the field that stores the foreign key (as an example, see Unidirectional one-to-one with @JoinColumn).

Example 207. Java entity

```
@Entity
public class AccountOwner {

    @Id
    private String id;

    @ManyToMany
    public Set<BankAccount> bankAccounts;

    // getters, setters, ...
```

Example 208. JSON representation

```
Key: AccountOwner:owner0001
{
    "bankAccounts" : [
        "accountABC",
        "accountXYZ"
    ]
}
```

Example 209. Unidirectional one-to-one

```
@Entity
public class Vehicule {

    @Id
    private String id;
    private String brand;

    // getters, setters ...
}


@Entity
public class Wheel {

    @Id
    private String id;
    private double diameter;

    @OneToOne
    private Vehicule vehicule;

    // getters, setters ...
}
```

```
Key: Vehicule:V001
{
    "brand": "Mercedes"
}
```

```
Key: Wheel:W1
{
  "diameter" : 0.0,
  "vehicule_id" : "V001"
}
```

Example 210. Unidirectional one-to-one with @JoinColumn

```
@Entity
public class Vehicule {

    @Id
    private String id;
    private String brand;

    // getters, setters ...
}


@Entity
public class Wheel {

    @Id
    private String id;
    private double diameter;

    @OneToOne
    @JoinColumn( name = "part_of" )
    private Vehicule vehicule;

    // getters, setters ...
}
```

```
Key: Vehicule:V001
{
    "brand": "Mercedes"
}
```

```
Key: Wheel:W1
{
  "diameter" : 0.0,
  "part_of" : "V001"
}
```

In a true one-to-one association, it is possible to share the same id between the two entities and therefore a foreign key is not required. You can see how to map this type of association in the following example:

Example 211. Unidirectional one-to-one with @MapsId and @PrimaryKeyJoinColumn

```
@Entity
public class Vehicule {

    @Id
    private String id;
    private String brand;

    // getters, setters ...
}

@Entity
public class Wheel {

    @Id
    private String id;
    private double diameter;

    @OneToOne
    @PrimaryKeyJoinColumn
    @MapsId
    private Vehicule vehicule;

    // getters, setters ...
}
```

```
Key: Vehicule:V001
{
    "brand": "Mercedes"
}
```

```
Wheel:vehicule:V001
{
  "diameter" : 0.0,
  "vehicule_id" : "V001"
}
```

Example 212. Bidirectional one-to-one

```
@Entity
public class Husband {

    @Id
    private String id;
    private String name;

    @OneToOne
    private Wife wife;

    // getters, setters ...
}

@Entity
public class Wife {

    @Id
    private String id;
    private String name;

    @OneToOne
    private Husband husband;

    // getters, setters ...
}
```

```
Key: Husband:alex
{
  "name" : "Alex",
  "wife" : "bea"
}
```

```
Key: Wife:bea
{
  "name" : "Bea",
  "husband" : "alex"
}
```

Example 213. Unidirectional one-to-many

```
@Entity
public class Basket {

    @Id
    private String id;

    private String owner;

    @OneToMany
    private List<Product> products = new ArrayList<Product>();

    // getters, setters ...
}

@Entity
public class Product {

    @Id
    private String name;

    private String description;

    // getters, setters ...
}
```

Basket collection

```
Key: Basket:davide_basket
{
  "owner" : "Davide",
  "products" : [ "Beer", "Pretzel" ]
}
```

Product collection

```
Key: Product:Beer
{
  "name" : "Beer",
  "description" : "Tactical nuclear penguin"
}

Key: Product:Pretzel
{
  "name" : "Pretzel",
  "description" : "Glutino Pretzel Sticks"
}
```

Example 214. Unidirectional one-to-many using one collection per strategy with @OrderColumn

```
@Entity
public class Basket {

    @Id
    private String id;

    private String owner;

    @OneToMany
    private List<Product> products = new ArrayList<Product>();

    // getters, setters ...
}

@Entity
public class Product {

    @Id
    private String name;

    private String description;

    // getters, setters ...
}
```

Basket collection

```
Key: Basket:davide_basket
{
  "owner" : "Davide"
}
```

Product collection

```
Key: Product:Pretzel
{
  "description" : "Glutino Pretzel Sticks"
}
Key: Product:Beer
{
  "description" : "Tactical nuclear penguin"
}
```

Redis List Associations:davide_basket:Basket_Product

```
Rows:
[
{
  "products_name" : "Pretzel",
  "products_ORDER" : 1
},
{
  "products_name" : "Beer",
  "products_ORDER" : 0
}
]
```

A map can be used to represents an association, in this case Hibernate OGM will store the key of the map and the associated id.

Example 215. Unidirectional one-to-many using maps with defaults

```
@Entity
public class User {

    @Id
    private String id;

    @OneToMany
    private Map<String, Address> addresses = new HashMap<String, Address
>();

    // getters, setters ...
}

@Entity
public class Address {

    @Id
    private String id;
    private String city;

    // getters, setters ...
}
```

```
Key: User:user_001
{
  "addresses" : {
    "work" : "address_001",
    "home" : "address_002"
  }
}
```

```
Key: Address:address_001
{
  "city" : "Rome"
}
```

```
Key: Address:address_002
{
  "city" : "Paris"
}
```

If the map value cannot be represented by a single field (e.g. when referencing a type with a composite id or using an embeddable type as map value type), a sub-document containing all the required fields will be stored as value.

If the map key either is not of type `String` or it is made up of several columns (composite map key), the optimized structure shown in the example above cannot be used. In that case the

association will be represented by a list of sub-documents, also containing the map key column(s). You can use `@MapKeyColumn` to rename the field containing the key of the map, otherwise it will default to "<%COLLECTION_ROLE%>_KEY", e.g. "addresses_KEY".

In case you want to enforce the list-style represention also for maps with a single key column of type `String` you can use the option `hibernate.ogm.datastore.document.map_storage` to do so.

Example 216. Unidirectional one-to-many using maps with @MapKeyColumn

```
@Entity
public class User {

    @Id
    private String id;

    @OneToMany
    @MapKeyColumn(name = "addressType")
    private Map<String, Address> addresses = new HashMap<String, Address
>();

    // getters, setters ...
}

@Entity
public class Address {

    @Id
    private String id;
    private String city;

    // getters, setters ...
}
```

```
Key: User:user_001
{
  "addresses" : [
    {
      "addressType" : "work",
      "addresses_id" : "address_001"
    },
    {
      "addressType" : "home",
      "addresses_id" : "address_002"
    }
  ]
}
```

```
Key: Address:address_001
{
  "city" : "Rome"
}
```

```
Key: Address:address_002
{
  "city" : "Paris"
}
```

Example 217. Unidirectional many-to-one

```
@Entity
public class JavaUserGroup {

    @Id
    private String jugId;
    private String name;

    // getters, setters ...
}

@Entity
public class Member {

    @Id
    private String id;
    private String name;

    @ManyToOne
    private JavaUserGroup memberOf;

    // getters, setters ...
}
```

```
Key: JavaUserGroups:summer_camp
{
  "name" : "JUG Summer Camp"
}
```

```
Key: Member:jerome
{
  "name" : "Jerome"
  "memberOf_jugId" : "summer_camp"
}
```

```
Key: Member:emmanuel
{
  "name" : "Emmanuel Bernard"
  "memberOf_jugId" : "summer_camp"
}
```

Example 218. Bidirectional many-to-one

```
@Entity
public class SalesForce {

    @Id
    private String id;
    private String corporation;

    @OneToMany(mappedBy = "salesForce")
    private Set<SalesGuy> salesGuys = new HashSet<SalesGuy>();

    // getters, setters ...
}

@Entity
public class SalesGuy {

    private String id;
    private String name;

    @ManyToOne
    private SalesForce salesForce;

    // getters, setters ...
}
```

```
Key: SalesForce:red_hat
{
  "corporation": "Red Hat",
  "salesGuys": [ "eric", "simon" ]
}
```

```
Key: SalesGuy:eric
{
  "name": "Eric"
  "salesForce_id": "red_hat",
}
```

```
Key: SalesGuy:simon
{
  "name": "Simon",
  "salesForce_id": "red_hat"
}
```

Example 219. Unidirectional many-to-many using in entity strategy

```java
@Entity
public class Student {

    @Id
    private String id;
    private String name;

    // getters, setters ...
}

@Entity
public class ClassRoom {

    @Id
    private Long id;
    private String lesson;

    @ManyToMany
    private List<Student> students = new ArrayList<Student>();

    // getters, setters ...
}
```

```
Key: ClassRoom:1
{
   "students": [
       "mario",
       "john"
   ],
   "name": "Math"
}
```

```
Key: ClassRoom:2
{
   "students": [
       "kate",
       "mario"
   ],
   "name": "English"
}
```

```
Key: Student:john
{
   "name": "John Doe"
}
```

```
Key: Student:kate
{
   "name": "Kate Doe"
}
```

```
Key: Student:mario
{
   "name": "Mario Rossi"
}
```

Example 220. Bidirectional many-to-many

```
@Entity
public class AccountOwner {

    @Id
    private String id;

    private String SSN;

    @ManyToMany
    private Set<BankAccount> bankAccounts;

    // getters, setters ...
}

@Entity
public class BankAccount {

    @Id
    private String id;

    private String accountNumber;

    @ManyToMany( mappedBy = "bankAccounts" )
    private Set<AccountOwner> owners = new HashSet<AccountOwner>();

    // getters, setters ...
}
```

```
Key: AccountOwner:owner_1
{
   "SSN": "0123456",
   "bankAccounts": [
       "account_1",
       "account_2"
   ]
}
```

```
Key: BankAccount:account_1
{
   "accountNumber": "X2345000",
   "owners": [
       "owner_1"
   ]
}
```

```
Key: BankAccount:account_2
{
   "accountNumber": "ZZZ-009",
   "owners": [
       "owner_1"
   ]
}
```

Association document strategy

With this strategy, Hibernate OGM uses separate association data structures to store all navigation information. The association data structure depends on the type of the association:

- Bag, List, Map, One-to-one: Redis List
- Set: Redis Set

Each association has 2 parts. The first is the key. The key consists of a prefix, the identifier information of the association owner, and the name of the association table.

"Associations:<%ASSOCIATION_TABLE%>:<%ASSOCIATION_ID%>:<%COLLECTION_ROLE%>", e.g. "Associations:AccountOwner:4f5b48ad-f074-4a64-8cf4-1f9c54a33f76:BankAccount".

The second part is the `rows` field which stores (into an embedded collection) all ids that the current instance is related to.

Example 221. Unidirectional relationship

```
Key: Associations:AccountOwner:4f5b48ad-f074-4a64-8cf4-1f9c54a33f76:Bank
Account
[
    "7873a2a7-c77c-447c-b000-890f0a4dfa9a"
]
```

For a bidirectional relationship, another list is created where ids are reversed. Don't worry, Hibernate OGM takes care of keeping them in sync:

Example 222. Bidirectional relationship

```
Key: Associations:AccountOwner:4f5b48ad-f074-4a64-8cf4-1f9c54a33f76:Bank
Account
[
    "7873a2a7-c77c-447c-b000-890f0a4dfa9a"
]

Key: Associations:AccountOwner:bankAccounts:7873a2a7-c77c-447c-b000-890f
0a4dfa9a
[
    "4f5b48ad-f074-4a64-8cf4-1f9c54a33f76"
]
```

This strategy won't affect *-to-one associations or embedded collections.

Example 223. Unidirectional one-to-many using document strategy

```
@Entity
public class Basket {

    @Id
    private String id;

    private String owner;

    @OneToMany
    private List<Product> products = new ArrayList<Product>();

    // getters, setters ...
}

@Entity
public class Product {

    @Id
    private String name;

    private String description;

    // getters, setters ...
}
```

```
Key: Basket:davide_basket
{
   "owner": "Davide"
}
```

```
Key: Basket:davide_basket
{
   "owner": "Davide"
}
```

```
Key: Product:Pretzel
{
   "description": "Glutino Pretzel Sticks",
}
```

```
Key: Associations:Basket_Product:davide_basket:products
[
   "Beer",
   "Pretzel"
]
```

Using the annotation `@JoinTable` it is possible to change the value of the document containing

the association.

Example 224. Unidirectional one-to-many using document strategy with `@JoinTable`

```
@Entity
public class Basket {

    @Id
    private String id;

    private String owner;

    @OneToMany
    @JoinTable( name = "BasketContent" )
    private List<Product> products = new ArrayList<Product>();

    // getters, setters ...
}

@Entity
public class Product {

    @Id
    private String name;

    private String description;

    // getters, setters ...
}
```

```
Key: Basket:davide_basket
{
   "owner": "Davide"
}
```

```
Key: Basket:davide_basket
{
   "owner": "Davide"
}
```

```
Key: Product:Pretzel
{
   "description": "Glutino Pretzel Sticks",
}
```

```
Key: Association:BasketContent:Basket:davide_basket
[
   "Beer",
   "Pretzel"
]
```

Example 225. Unidirectional many-to-many using document strategy

```
@Entity
public class Student {

    @Id
    private String id;
    private String name;

    // getters, setters ...
}

@Entity
public class ClassRoom {

    @Id
    private Long id;
    private String lesson;

    @ManyToMany
    private List<Student> students = new ArrayList<Student>();

    // getters, setters ...
}
```

```
Key: ClassRoom:1
{
   "name": "Math"
}
```

```
Key: ClassRoom:2
{
   "name": "English"
}
```

```
Key: ClassStudent:john
{
   "name": "John Doe"
}
```

```
Key: ClassStudent:kate
{
   "name": "Kate Doe"
}
```

```
Key: ClassStudent:mario
{
   "name": "Mario Rossi"
}
```

```
Key: Association:ClassRoom:Student:ClassRoom:1
[
   "mario",
   "john"
]
```

```
Key: Association:ClassRoom:Student:ClassRoom:2
[
   "kate"
]
```

Example 226. Bidirectional many-to-many using document strategy

```
@Entity
public class AccountOwner {

    @Id
    private String id;

    private String SSN;

    @ManyToMany
    private Set<BankAccount> bankAccounts;

    // getters, setters ...
}

@Entity
public class BankAccount {

    @Id
    private String id;

    private String accountNumber;

    @ManyToMany(mappedBy = "bankAccounts")
    private Set<AccountOwner> owners = new HashSet<AccountOwner>();

    // getters, setters ...
}
```

```
Key: AccountOwner:owner_1
{
   "SSN": "0123456",
}
```

```
Key: BankAccount:account_1
{
   "accountNumber": "X2345000",
}
```

```
Key: BankAccount:account_2
{
   "accountNumber": "ZZZ-009",
}
```

```
Key: Association:AccountOwner:BankAccount:account_1
[
   "owner_1"
]
```

```
Key: Association:AccountOwner:BankAccount:bankAccounts:account_2
[
   "owner_1"
]
```

```
Key: Association:AccountOwner:BankAccount:owners:account_1
[
   "account_1",
   "account_2"
]
```

15.3. Identifiers

Redis keys are derived from the Entity name and its Id separated by a colon (`:`). String-based Id's are used directly within the key, non-string keys are encoded to JSON. You can use any persistable Java type as identifier type, e.g. `String` or `long`. Hibernate OGM will convert the `@Id` property into a part of the key name so you can name the entity id like you want.

```
@Entity
public class News {

    @Id
    @Column
    private long id;

    // fields, getters, setters ...
}
```

Key-Scheme for `News` entity with an Id of `42`

```
  News:42
```

```
@Entity
@Table(name="Article")
public class News {

    @Id
    @Column(name="code")
    private String id;

    // fields, getters, setters ...
}
```

Key-Scheme for `News` entity with an Id of `breaking-news`

```
Article:breaking-news
```

Note that you also can work with embedded ids (via `@EmbeddedId`), Composite Id's are mapped to a JSON object containing keys and values. Hibernate OGM thus will create a concatenated representation of the embedded id's properties in this case. The columns are sorted in alphabetical order to guarantee the same order.

Example 227. Entity with @EmbeddedId

```
@Entity
public class News {

    @EmbeddedId
    private NewsID newsId;

    // getters, setters ...
}

@Embeddable
public class NewsID implements Serializable {

    private String title;
    private String author;

    // getters, setters ...
}
```

Resulting key:

```
News:{"newsId.author": "Guillaume, "newsId.title": "How to use Hibernate
OGM ?"},
```

15.3.1. Identifier generation strategies

You can assign id values yourself or let Hibernate OGM generate the value using the `@GeneratedValue` annotation.

Two main strategies are supported:

1. TABLE
2. SEQUENCE

Both strategies will operate in the keys starting with `Identifiers` containing the last value of the id. The difference between the two strategies is the name of the key containing the values.

The `AUTO` strategy is the same as the SEQUENCE one.

The next value is obtained using Redis' HINCRBY command that guarantees to create atomic updates to the underlying data structure.

1) TABLE generation strategy

Example 228. Id generation strategy TABLE using default values

```
@Entity
public class Video {

    @Id
    @GeneratedValue(strategy = GenerationType.TABLE)
    private Integer id;
    private String name

    // getters, setters, ...
}
```

```
Key: Video:1
{
   "name": "Scream",
   "director": "Wes Craven"
}
```

```
Key: Identifiers:hibernate_sequences:default
Value: 1
```

Example 229. Id generation strategy TABLE using a custom table

```
@Entity
public class Video {

    @Id
    @GeneratedValue(strategy = GenerationType.TABLE, generator = "video")
    @TableGenerator(
            name = "video",
            table = "sequences",
            pkColumnName = "key",
            pkColumnValue = "video",
            valueColumnName = "seed"
    )
    private Integer id;

    private String name;

    // getter, setters, ...
}
```

```
Key: Identifiers:sequences:video
Value: 2
```

2) SEQUENCE generation strategy

Example 230. SEQUENCE id generation strategy using default values

```
@Entity
public class Song {

  @Id
  @GeneratedValue(strategy = GenerationType.SEQUENCE)
  private Long id;

  private String title;

  // getters, setters ...
}
```

```
Key: Song:2
{
   "title": "Ave Maria",
   "singer": "Charlotte Church"
}
```

```
Key: Identifiers:hibernate_sequences
Value: 2
```

Example 231. SEQUENCE id generation strategy using custom values

```
@Entity
public class Song {

  @Id
  @GeneratedValue(strategy = GenerationType.SEQUENCE, generator =
"songSequenceGenerator")
  @SequenceGenerator(
       name = "songSequenceGenerator",
       sequenceName = "song_sequence",
       initialValue = 2,
       allocationSize = 20
  )
  private Long id;

  private String title;

  // getters, setters ...
}
```

```
Key: Song:2
{
   "title": "Ave Maria",
   "singer": "Charlotte Church"
}
```

```
Key: Identifiers:song_sequence
Value: 21
```

The value stored in Redis for the sequence is not the one the dialect will return as next number in the sequence. Instead, Hibernate OGM will use it as seed to generate the correct value in the sequence.

15.4. Transactions

The Redis dialect does not support transactions for now. Only changes applied to the same document are done atomically. A change applied to more than one document will not be applied atomically. This problem is slightly mitigated by the fact that Hibernate OGM queues all changes before applying them during flush time. So the window of time used to write to Redis is smaller than what you would have done manually.

We recommend that you still use transaction demarcations with Hibernate OGM to trigger the flush operation transparently (on commit). But do not consider rollback as a possibility, this won't work.

15.5. Queries

Hibernate OGM is a work in progress and we are actively working on JP-QL query support.

In the mean time, you can use Hibernate Search to query entities stored by Hibernate OGM (Using Hibernate Search).

15.6. Redis Cluster

Using Hibernate OGM with Redis Cluster is a matter of enabling Redis Cluster mode (see Configuring Redis). Data stored with Hibernate OGM Redis is distributed across Redis Cluster nodes according to the Redis key distribution model based on the hash slot of the key of each entity.