

# Quarkus - Contexts and Dependency Injection

Quarkus DI solution is based on the [Contexts and Dependency Injection for Java 2.0](#) specification. However, it is not a full CDI implementation verified by the TCK. Only a subset of the CDI features is implemented - see also [the list of supported features](#) and [the list of limitations](#).



If you're new to CDI then we recommend you to read the [Introduction to CDI](#) first.



Most of the existing CDI code should work just fine but there are some small differences which follow from the Quarkus architecture and goals.

## 1. Bean Discovery

Bean discovery in CDI is a complex process which involves legacy deployment structures and accessibility requirements of the underlying module architecture. However, Quarkus is using a **simplified bean discovery**. There is only single bean archive with the **bean discovery mode annotated** and no visibility boundaries.

The bean archive is synthesized from:

- the application classes,
- dependencies that contain a **beans.xml** descriptor (content is ignored),
- dependencies that contain a Jandex index - **META-INF/jandex.idx**,
- dependencies referenced by **quarkus.index-dependency** in **application.properties**,
- and Quarkus integration code.

Bean classes that don't have a **bean defining annotation** are not discovered. This behavior is defined by CDI. But producer methods and fields and observer methods are discovered even if the declaring class is not annotated with a bean defining annotation (this behavior is different to what is defined in CDI). In fact, the declaring bean classes are considered annotated with **@Dependent**.



Quarkus extensions may declare additional discovery rules. For example, **@Scheduled** business methods are registered even if the declaring class is not annotated with a bean defining annotation.

### 1.1. How to Generate a Jandex Index

A dependency with a Jandex index is automatically scanned for beans. To generate the index just add the following to your **pom.xml**:

```

<build>
  <plugins>
    <plugin>
      <groupId>org.jboss.jandex</groupId>
      <artifactId>jandex-maven-plugin</artifactId>
      <version>1.0.7</version>
      <executions>
        <execution>
          <id>make-index</id>
          <goals>
            <goal>jandex</goal>
          </goals>
        </execution>
      </executions>
    </plugin>
  </plugins>
</build>

```

If you can't modify the dependency, you can still index it by adding `quarkus.index-dependency` entries to your `application.properties`:

```

quarkus.index-dependency.<name>.group-id=
quarkus.index-dependency.<name>.artifact-id=
quarkus.index-dependency.<name>.classifier=(this one is optional)

```

For example, the following entries ensure that the `org.acme:acme-api` dependency is indexed:

## 1.2. How To Exclude Types and Dependencies from Discovery

It may happen that some beans from third-party libraries do not work correctly in Quarkus. A typical example is a bean injecting a portable extension. In such case, it's possible to exclude types and dependencies from the bean discovery. The `quarkus.arc.exclude-types` property accepts a list of string values that are used to match classes that should be excluded.

Table 1. Value Examples

Value	Description
<code>org.acme.Foo</code>	Match the fully qualified name of the class
<code>org.acme.*</code>	Match classes with package <code>org.acme</code>
<code>org.acme.**</code>	Match classes where the package starts with <code>org.acme</code>
<code>Bar</code>	Match the simple name of the class

Example application.properties

```
quarkus.arc.exclude-types=org.acme.Foo,org.acme.*,Bar ①②③
```

- ① Exclude the type `org.acme.Foo`.
- ② Exclude all types from the `org.acme` package.
- ③ Exclude all types whose simple name is `Bar`

It is also possible to exclude a dependency artifact that would be otherwise scanned for beans. For example, because it contains a `beans.xml` descriptor.

Example application.properties

```
quarkus.arc.exclude-dependency.acme.group-id=org.acme ①  
quarkus.arc.exclude-dependency.acme.artifact-id=acme-services ②
```

- ① Value is a group id for a dependency identified by name `acme`.
- ② Value is an artifact id for a dependency identified by name `acme`.

## 2. Native Executables and Private Members

Quarkus is using GraalVM to build a native executable. One of the limitations of GraalVM is the usage of [Reflection](#). Reflective operations are supported but all relevant members must be registered for reflection explicitly. Those registrations result in a bigger native executable.

And if Quarkus DI needs to access a private member it **has to use reflection**. That's why Quarkus users are encouraged *not to use private members* in their beans. This involves injection fields, constructors and initializers, observer methods, producer methods and fields, disposers and interceptor methods.

How to avoid using private members? You can use package-private modifiers:

```
@ApplicationScoped  
public class CounterBean {  
  
    @Inject  
    CounterService counterService; ①  
  
    void onMessage(@Observes Event msg) { ②  
    }  
}
```

- ① A package-private injection field.
- ② A package-private observer method.

Or constructor injection:

```

@ApplicationScoped
public class CounterBean {

    private CounterService service;

    CounterBean(CounterService service) { ①
        this.service = service;
    }
}

```

① A package-private constructor injection. `@Inject` is optional in this particular case.

## 3. Supported Features

- Programming model
  - Managed beans implemented by a Java class
    - `@PostConstruct` and `@PreDestroy` lifecycle callbacks
  - Producer methods and fields, disposers
  - Qualifiers
  - Alternatives
  - Stereotypes
- Dependency injection and lookup
  - Field, constructor and initializer/setter injection
  - Type-safe resolution
  - Programmatic lookup via `javax.enterprise.inject.Instance`
  - Client proxies
  - Injection point metadata
- Scopes and contexts
  - `@Dependent`, `@ApplicationScoped`, `@Singleton`, `@RequestScoped` and `@SessionScoped`
  - Custom scopes and contexts
- Interceptors
  - Business method interceptors: `@AroundInvoke`
  - Interceptors for lifecycle event callbacks: `@PostConstruct`, `@PreDestroy`, `@AroundConstruct`
- Events and observer methods, including asynchronous events and transactional observer methods

## 4. Limitations

- `@ConversationScoped` is not supported
- Decorators are not supported
- Portable Extensions are not supported
- `BeanManager` - only the following methods are implemented: `getBeans()`, `createCreationalContext()`, `getReference()`, `getInjectableReference()`, `resolve()`, `getContext()`, `fireEvent()`, `getEvent()` and `createInstance()`
- Specialization is not supported
- `beans.xml` descriptor content is ignored
- Passivation and passivating scopes are not supported
- Interceptor methods on superclasses are not implemented yet
- `@Interceptors` is not supported

## 5. Non-standard Features

### 5.1. Eager Instantiation of Beans

#### 5.1.1. Lazy By Default

By default, CDI beans are created lazily, when needed. What exactly "needed" means depends on the scope of a bean.

- A **normal scoped bean** (`@ApplicationScoped`, `@RequestScoped`, etc.) is needed when a method is invoked upon an injected instance (contextual reference per the specification).

In other words, injecting a normal scoped bean will not suffice because a *client proxy* is injected instead of a contextual instance of the bean.

- A **bean with a pseudo-scope** (`@Dependent` and `@Singleton`) is created when injected.

## Lazy Instantiation Example

```
@Singleton // => pseudo-scope
class AmazingService {
    String ping() {
        return "amazing";
    }
}

@ApplicationScoped // => normal scope
class CoolService {
    String ping() {
        return "cool";
    }
}

@Path("/ping")
public class PingResource {

    @Inject
    AmazingService s1; ①

    @Inject
    CoolService s2; ②

    @GET
    public String ping() {
        return s1.ping() + s2.ping(); ③
    }
}
```

- ① Injection triggers the instantiation of **AmazingService**.
- ② Injection itself does not result in the instantiation of **CoolService**. A client proxy is injected.
- ③ The first invocation upon the injected proxy triggers the instantiation of **CoolService**.

### 5.1.2. Startup Event

However, if you really need to instantiate a bean eagerly you can:

- Declare an observer of the **StartupEvent** - the scope of the bean does not matter in this case:

```
@ApplicationScoped
class CoolService {
    void startup(@Observes StartupEvent event) { ①
    }
}
```

① A `CoolService` is created during startup to service the observer method invocation.

- Use the bean in an observer of the `StartupEvent` - normal scoped beans must be used as described in [Lazy By Default](#):

```
@Dependent
class MyBeanStarter {

    void startup(@Observes StartupEvent event, AmazingService
amazing, CoolService cool) { ①
        cool.toString(); ②
    }
}
```

① The `AmazingService` is created during injection.

② The `CoolService` is a normal scoped bean so we have to invoke a method upon the injected proxy to force the instantiation.

- Annotate the bean with `@io.quarkus.runtime.Startup` as described in [Startup annotation](#):

```
@Startup ①
@ApplicationScoped
public class EagerAppBean {

    private final String name;

    EagerAppBean(NameGenerator generator) { ②
        this.name = generator.createName();
    }
}
```

1. For each bean annotated with `@Startup` a synthetic observer of `StartupEvent` is generated. The default priority is used.
2. The bean constructor is called when the application starts and the resulting contextual instance is stored in the application context.



Quarkus users are encouraged to always prefer the `@Observes StartupEvent` to `@Initialized(ApplicationScoped.class)` as explained in the [Application Initialization and Termination](#) guide.

## 5.2. Request Context Lifecycle

The request context is also active:

- during notification of a synchronous observer method.

The request context is destroyed:

- after the observer notification completes for an event, if it was not already active when the notification started.



An event with qualifier `@Initialized(RequestScoped.class)` is fired when the request context is initialized for an observer notification. Moreover, the events with qualifiers `@BeforeDestroyed(RequestScoped.class)` and `@Destroyed(RequestScoped.class)` are fired when the request context is destroyed.

## 5.3. Qualified Injected Fields

In CDI, if you declare a field injection point you need to use `@Inject` and optionally a set of qualifiers.

```
@Inject
@ConfigProperty(name = "cool")
String coolProperty;
```

In Quarkus, you can skip the `@Inject` annotation completely if the injected field declares at least one qualifier.

```
@ConfigProperty(name = "cool")
String coolProperty;
```



With the notable exception of one special case discussed below, `@Inject` is still required for constructor and method injection.

## 5.4. Simplified Constructor Injection

In CDI, a normal scoped bean must always declare a no-args constructor (this constructor is normally generated by the compiler unless you declare any other constructor). However, this requirement complicates constructor injection - you need to provide a dummy no-args constructor to make things work in CDI.

```

@ApplicationScoped
public class MyCoolService {

    private SimpleProcessor processor;

    MyCoolService() { // dummy constructor needed
    }

    @Inject // constructor injection
    MyCoolService(SimpleProcessor processor) {
        this.processor = processor;
    }
}

```

There is no need to declare dummy constructors for normal scoped bean in Quarkus - they are generated automatically. Also if there's only one constructor there is no need for `@Inject`.

```

@ApplicationScoped
public class MyCoolService {

    private SimpleProcessor processor;

    MyCoolService(SimpleProcessor processor) {
        this.processor = processor;
    }
}

```



We don't generate a no-args constructor automatically if a bean class extends a class that does not declare a no-args constructor.

## 5.5. Removing Unused Beans

The container attempts to remove all unused beans during build by default. This optimization can be disabled by setting `quarkus.arc.remove-unused-beans` to `none` or `false`.

An unused bean:

- is not a built-in bean or an interceptor,
- is not eligible for injection to any injection point,
- is not excluded by any extension,
- does not have a name,
- does not declare an observer,
- does not declare any producer which is eligible for injection to any injection point,

- is not directly eligible for injection into any `javax.enterprise.inject.Instance` or `javax.inject.Provider` injection point

This optimization applies to all forms of bean declarations: bean class, producer method, producer field.

Users can instruct the container to not remove any of their specific beans (even if they satisfy all the rules specified above) by annotating them with `io.quarkus.arc.Unremovable`. This annotation can be placed on the types, producer methods, and producer fields.

Since this is not always possible, there is an option to achieve the same via `application.properties`. The `quarkus.arc.unremovable-types` property accepts a list of string values that are used to match beans based on their name or package.

Table 2. Value Examples

Value	Description
<code>org.acme.Foo</code>	Match the fully qualified name of the bean class
<code>org.acme.*</code>	Match beans where the package of the bean class is <code>org.acme</code>
<code>org.acme.**</code>	Match beans where the package of the bean class starts with <code>org.acme</code>
<code>Bar</code>	Match the simple name of the bean class

Example `application.properties`

```
quarkus.arc.unremovable-types=org.acme.Foo,org.acme.*,Bar
```

Furthermore, extensions can eliminate possible false positives by producing `UnremovableBeanBuildItem`.

Finally, Quarkus provides a middle ground for the bean removal optimization where application beans are never removed whether or not they are unused, while the optimization proceeds normally for non application classes. To use this mode, set `quarkus.arc.remove-unused-beans` to `fwk` or `framework`.

When using the dev mode (running `./mvnw clean compile quarkus:dev`), you can see more information about which beans are being removed by enabling additional logging via the following line in your `application.properties`.

```
quarkus.log.category."io.quarkus.arc.processor".level=DEBUG
```

## 5.6. Default Beans

Quarkus adds a capability that CDI currently does not support which is to conditionally declare a bean if no other bean with equal types and qualifiers was declared by any available means (bean class,

producer, synthetic bean, ...) This is done using the `@io.quarkus.arc.DefaultBean` annotation and is best explained with an example.

Say there is a Quarkus extension that among other things declares a few CDI beans like the following code does:

```
@Dependent
public class TracerConfiguration {

    @Produces
    public Tracer tracer(Reporter reporter, Configuration
configuration) {
        return new Tracer(reporter, configuration);
    }

    @Produces
    @DefaultBean
    public Configuration configuration() {
        // create a Configuration
    }

    @Produces
    @DefaultBean
    public Reporter reporter(){
        // create a Reporter
    }
}
```

The idea is that the extension auto-configures things for the user, eliminating a lot of boilerplate - we can just `@Inject` a `Tracer` wherever it is needed. Now imagine that in our application we would like to utilize the configured `Tracer`, but we need to customize it a little, for example by providing a custom `Reporter`. The only thing that would be needed in our application would be something like the following:

```
@Dependent
public class CustomTracerConfiguration {

    @Produces
    public Reporter reporter(){
        // create a custom Reporter
    }
}
```

`@DefaultBean` allows extensions (or any other code for that matter) to provide defaults while backing off if beans of that type are supplied in any way Quarkus supports.

## 5.7. Enabling Beans for Quarkus Build Profile

Quarkus adds a capability that CDI currently does not support which is to conditionally enable a bean when a Quarkus build time profile is enabled, via the `@io.quarkus.arc.profile.IfBuildProfile` and `@io.quarkus.arc.profile.UnlessBuildProfile` annotations. When used in conjunction with `@io.quarkus.arc.DefaultBean`, these annotations allow for the creation of different bean configurations for different build profiles.

Imagine for instance that an application contains a bean named `Tracer`, which needs to be do nothing when in tests or dev-mode, but works in its normal capacity for the production artifact. An elegant way to create such beans is the following:

```
@Dependent
public class TracerConfiguration {

    @Produces
    @IfBuildProfile("prod")
    public Tracer realTracer(Reporter reporter, Configuration
configuration) {
        return new RealTracer(reporter, configuration);
    }

    @Produces
    @DefaultBean
    public Tracer noopTracer() {
        return new NoopTracer();
    }
}
```

If instead, it is required that the `Tracer` bean also works in dev-mode and only default to doing nothing for tests, then `@UnlessBuildProfile` would be ideal. The code would look like:

```

@Dependent
public class TracerConfiguration {

    @Produces
    @UnlessBuildProfile("test") // this will be enabled for both
    prod and dev build time profiles
    public Tracer realTracer(Reporter reporter, Configuration
    configuration) {
        return new RealTracer(reporter, configuration);
    }

    @Produces
    @DefaultBean
    public Tracer noopTracer() {
        return new NoopTracer();
    }
}

```



The runtime profile has absolutely no effect on the bean resolution using `@IfBuildProfile` and `@UnlessBuildProfile`.

## 5.8. Enabling Beans for Quarkus Build Properties

Quarkus adds a capability that CDI currently does not support which is to conditionally enable a bean when a Quarkus build time property has a specific value, via the `@io.quarkus.arc.properties.IfBuildProperty` annotation. When used in conjunction with `@io.quarkus.arc.DefaultBean`, this annotation allow for the creation of different bean configurations for different build properties.

The scenario we mentioned above with `Tracer` could also be implemented in the following way:

```

@Dependent
public class TracerConfiguration {

    @Produces
    @IfBuildProperty(name = "some.tracer.enabled", stringValue =
"true")
    public Tracer realTracer(Reporter reporter, Configuration
configuration) {
        return new RealTracer(reporter, configuration);
    }

    @Produces
    @DefaultBean
    public Tracer noopTracer() {
        return new NoopTracer();
    }
}

```



Properties set at runtime have absolutely no effect on the bean resolution using `@IfBuildProperty`.

## 5.9. Declaring Selected Alternatives

In CDI, an alternative bean may be selected either globally for an application by means of `@Priority`, or for a bean archive using a `beans.xml` descriptor. Quarkus has a simplified bean discovery and the content of `beans.xml` is ignored.

The disadvantage of `@Priority` is that it has `@Target({ TYPE, PARAMETER })` and so it cannot be used for producer methods and fields. To address this problem and to simplify the code Quarkus provides the `io.quarkus.arc.AlternativePriority` annotation. It's basically a shortcut for `@Alternative` plus `@Priority`. Additionally, it can be used for producers.

However, it is also possible to select alternatives for an application using the unified configuration. The `quarkus.arc.selected-alternatives` property accepts a list of string values that are used to match alternative beans. If any value matches then the priority of `Integer#MAX_VALUE` is used for the relevant bean. The priority declared via `@Priority` or `@AlternativePriority` is overridden.

Table 3. Value Examples

Value	Description
<code>org.acme.Foo</code>	Match the fully qualified name of the bean class or the bean class of the bean that declares the producer
<code>org.acme.*</code>	Match beans where the package of the bean class is <code>org.acme</code>

<code>org.acme.**</code>	Match beans where the package of the bean class starts with <code>org.acme</code>
<code>Bar</code>	Match the simple name of the bean class or the bean class of the bean that declares the producer

Example `application.properties`

```
quarkus.arc.selected-alternatives=org.acme.Foo,org.acme.*,Bar
```

## 5.10. Simplified Producer Method Declaration

In CDI, a producer method must be always annotated with `@Produces`.

```
class Producers {
    @Inject
    @ConfigProperty(name = "cool")
    String coolProperty;

    @Produces
    @ApplicationScoped
    MyService produceService() {
        return new MyService(coolProperty);
    }
}
```

In Quarkus, you can skip the `@Produces` annotation completely if the producer method is annotated with a scope annotation, a stereotype or a qualifier.

```
class Producers {
    @ConfigProperty(name = "cool")
    String coolProperty;

    @ApplicationScoped
    MyService produceService() {
        return new MyService(coolProperty);
    }
}
```

## 5.11. Interception of Static Methods

The Interceptors specification is clear that *around-invoke* methods must not be declared static. However, this restriction was driven mostly by technical limitations. And since Quarkus is a build-time

oriented stack that allows for additional class transformations, those limitations don't apply anymore. It's possible to annotate a non-private static method with an interceptor binding:

```
class Services {  
  
    @Logged ①  
    static BigDecimal computePrice(long amount) { ②  
        BigDecimal price;  
        // Perform computations...  
        return price;  
    }  
}
```

① **Logged** is an interceptor binding.

② Each method invocation is intercepted if there is an interceptor associated with **Logged**.

### 5.11.1. Limitations

- Only **method-level bindings** are considered for backward compatibility reasons (otherwise static methods of bean classes that declare class-level bindings would be suddenly intercepted)
- Private static methods are never intercepted
- **InvocationContext#getTarget()** returns **null** for obvious reasons; therefore not all existing interceptors may behave correctly when intercepting static methods



Interceptors can use **InvocationContext.getMethod()** to detect static methods and adjust the behavior accordingly.

## 5.12. Ability to handle 'final' classes and methods

In normal CDI, classes that are marked as **final** and / or have **final** methods are not eligible for proxy creation, which in turn means that interceptors and normal scoped beans don't work properly. This situation is very common when trying to use CDI with alternative JVM languages like Kotlin where classes and methods are **final** by default.

Quarkus however, can overcome these limitations when **quarkus.arc.transform-unproxyable-classes** is set to **true** (which is the default value).

## 5.13. Container-managed Concurrency

There is no standard concurrency control mechanism for CDI beans. Nevertheless, a bean instance can be shared and accessed concurrently from multiple threads. In that case it should be thread-safe. You can use standard Java constructs (**volatile**, **synchronized**, **ReadWriteLock**, etc.) or let the container control the concurrent access. Quarkus provides **@io.quarkus.arc.Lock** and a built-in interceptor for this interceptor binding. Each interceptor instance associated with a contextual instance of an intercepted bean holds a separate **ReadWriteLock** with non-fair ordering policy.



`io.quarkus.arc.Lock` is a regular interceptor binding and as such can be used for any bean with any scope. However, it is especially useful for "shared" scopes, e.g. `@Singleton` and `@ApplicationScoped`.

### Container-managed Concurrency Example

```
import io.quarkus.arc.Lock;

@Lock ①
@ApplicationScoped
class SharedService {

    void addAmount(BigDecimal amount) {
        // ...changes some internal state of the bean
    }

    @Lock(value = Lock.Type.READ, time = 1, unit = TimeUnit.SECONDS)
    ② ③
    BigDecimal getAmount() {
        // ...it is safe to read the value concurrently
    }
}
```

- ① `@Lock` (which maps to `@Lock(Lock.Type.WRITE)`) declared on the class instructs the container to lock the bean instance for any invocation of any business method, i.e. the client has "exclusive access" and no concurrent invocations will be allowed.
- ② `@Lock(Lock.Type.READ)` overrides the value specified at class level. It means that any number of clients can invoke the method concurrently, unless the bean instance is locked by `@Lock(Lock.Type.WRITE)`.
- ③ You can also specify the "wait time". If it's not possible to acquire the lock in the given time a `LockException` is thrown.

## 6. Build Time Extension Points

### 6.1. Portable Extensions

Quarkus incorporates build-time optimizations in order to provide instant startup and low memory footprint. The downside of this approach is that CDI Portable Extensions cannot be supported. Nevertheless, most of the functionality can be achieved using Quarkus [extensions](#).

### 6.2. Additional Bean Defining Annotations

As described in [Bean Discovery](#) bean classes that don't have a bean defining annotation are not discovered. However, `BeanDefiningAnnotationBuildItem` can be used to extend the set of default bean defining annotations (`@Dependent`, `@Singleton`, `@ApplicationScoped`, `@RequestScoped` and `@Stereotype` annotations):

```

@BuildStep
BeanDefiningAnnotationBuildItem additionalBeanDefiningAnnotation()
{
    return new
    BeanDefiningAnnotationBuildItem(DotName.createSimple("javax.ws.rs.P
ath"));
}

```



Bean registrations that are result of a `BeanDefiningAnnotationBuildItem` are unremovable by default. See also [Removing Unused Beans](#).

## 6.3. Resource Annotations

`ResourceAnnotationBuildItem` is used to specify resource annotations that make it possible to resolve non-CDI injection points, such as Java EE resources.



An integrator must also provide a corresponding `io.quarkus.arc.ResourceReferenceProvider` implementation.

```

@BuildStep
void
setupResourceInjection(BuildProducer<ResourceAnnotationBuildItem>
resourceAnnotations, BuildProducer<GeneratedResourceBuildItem>
resources) {
    resources.produce(new GeneratedResourceBuildItem("META-
INF/services/io.quarkus.arc.ResourceReferenceProvider",
        JPAResourceReferenceProvider.class.getName().getBytes()));
    resourceAnnotations.produce(new
    ResourceAnnotationBuildItem(DotName.createSimple(PersistenceContext
.class.getName())));
}

```

## 6.4. Additional Beans

`AdditionalBeanBuildItem` is used to specify additional bean classes to be analyzed during discovery. Additional bean classes are transparently added to the application index processed by the container.

```

@BuildStep
List<AdditionalBeanBuildItem> additionalBeans() {
    return Arrays.asList(
        new
AdditionalBeanBuildItem(SmallRyeHealthReporter.class),
        new AdditionalBeanBuildItem(HealthServlet.class));
}

```



A bean registration that is a result of an `AdditionalBeanBuildItem` is removable by default. See also [Removing Unused Beans](#).

## 6.5. Synthetic Beans

Sometimes it is very useful to be able to register a synthetic bean. Bean attributes of a synthetic bean are not derived from a java class, method or field. Instead, the attributes are specified by an extension. In CDI, this could be achieved using the `AfterBeanDiscovery.addBean()` methods. In Quarkus, there are three ways to register a synthetic bean.

### 6.5.1. BeanRegistrarBuildItem

A build step can produce a `BeanRegistrarBuildItem` and leverage the `io.quarkus.arc.processor.BeanConfigurator` API to build a synthetic bean definition.

*BeanRegistrarBuildItem Example*

```

@BuildStep
BeanRegistrarBuildItem syntheticBean() {
    return new BeanRegistrarBuildItem(new BeanRegistrar() {

        @Override
        public void register(RegistrationContext
registrationContext) {

registrationContext.configure(String.class).types(String.class).qua
lifiers(new MyQualifierLiteral()).creator(mc ->
mc.returnValue(mc.load("foo"))).done();
        }
    });
}

```



The output of a `BeanConfigurator` is recorded as bytecode. Therefore there are some limitations in how a synthetic bean instance is created. See also `BeanConfigurator.creator()` methods.



You can easily filter all class-based beans via the convenient `BeanStream` returned from the `RegistrationContext.beans()` method.

## 6.5.2. BeanRegistrationPhaseBuildItem

If a build step needs to produce other build items during the registration it should use the `BeanRegistrationPhaseBuildItem`. The reason is that injected objects are only valid during a `@BuildStep` method invocation.

*BeanRegistrationPhaseBuildItem Example*

```
@BuildStep
void syntheticBean(BeanRegistrationPhaseBuildItem
beanRegistrationPhase,
                  BuildProducer<MyBuildItem> myBuildItem,
                  BuildProducer<BeanConfiguratorBuildItem>
beanConfigurators) {
    beanConfigurators.produce(new
BeanConfiguratorBuildItem(beanRegistrationPhase.getContext().config
ure(String.class).types(String.class).qualifiers(new
MyQualifierLiteral()).creator(mc ->
mc.returnValue(mc.load("foo"))));
    myBuildItem.produce(new MyBuildItem());
}
```



See the `BeanRegistrationPhaseBuildItem` javadoc for more information.

## 6.5.3. SyntheticBeanBuildItem

Finally, a build step can produce a `SyntheticBeanBuildItem` to register a synthetic bean whose instance can be easily produced through a recorder. The extended `BeanConfigurator` accepts either a `io.quarkus.runtime.RuntimeValue` or a `java.util.function.Supplier`.

*SyntheticBeanBuildItem Example*

```
@BuildStep
@Record(STATIC_INIT) ①
SyntheticBeanBuildItem syntheticBean(TestRecorder recorder) {
    return
SyntheticBeanBuildItem.configure(Foo.class).scope(Singleton.class)
                        .runtimeValue(recorder.createFoo()) ②
                        .done();
}
```

① By default, a synthetic bean is initialized during `STATIC_INIT`.

② The bean instance is supplied by a value returned from a recorder method.

It is possible to mark a synthetic bean to be initialized during `RUNTIME_INIT`:

#### `RUNTIME_INIT SyntheticBeanBuildItem` Example

```
@BuildStep
@Record(RUNTIME_INIT) ①
SyntheticBeanBuildItem syntheticBean(TestRecorder recorder) {
    return
    SyntheticBeanBuildItem.configure(Foo.class).scope(Singleton.class)
        .setRuntimeInit() ②
        .runtimeValue(recorder.createFoo())
        .done();
}
```

- ① The recorder must be executed in the `ExecutionTime.RUNTIME_INIT` phase.
- ② The bean instance is initialized during `RUNTIME_INIT`.

Synthetic bean initialized during `RUNTIME_INIT` must not be accessed during `STATIC_INIT`. `RUNTIME_INIT` build steps that access a runtime-init synthetic bean should consume the `SyntheticBeansRuntimeInitBuildItem`:



```
@BuildStep
@Record(RUNTIME_INIT)
@Consume(SyntheticBeansRuntimeInitBuildItem.class) ①
void accessFoo(TestRecorder recorder) {
    recorder.foo(); ②
}
```

- ① This build step must be executed after `syntheticBean()` completes.
- ② This recorder method results in an invocation of the `Foo` bean instance.

## 6.6. Annotation Transformations

A very common task is to override the annotations found on the bean classes. For example you might want to add an interceptor binding to a specific bean class. Here is how to do it - use the `AnnotationsTransformerBuildItem`:

```

@BuildStep
AnnotationsTransformerBuildItem transform() {
    return new AnnotationsTransformerBuildItem(new
AnnotationsTransformer() {

        public boolean
appliesTo(org.jboss.jandex.AnnotationTarget.Kind kind) {
            return kind ==
org.jboss.jandex.AnnotationTarget.Kind.CLASS;
        }

        public void transform(TransformationContext context) {
            if
(context.getTarget().asClass().name().toString().equals("com.foo.Bar")) {

context.transform().add(MyInterceptorBinding.class).done();
            }
        }
    });
}

```

## 6.7. Additional Interceptor Bindings

In rare cases it might be handy to programmatically register an existing annotation as interceptor binding. This is similar to what pure CDI achieves through `BeforeBeanDiscovery#addInterceptorBinding()`. Though here we are going to use `InterceptorBindingRegistrarBuildItem` to get it done. Note that you can register multiple annotations in one go:

```

@BuildStep
InterceptorBindingRegistrarBuildItem addInterceptorBindings() {
    InterceptorBindingRegistrarBuildItem
    additionalBindingsRegistrar = new
    InterceptorBindingRegistrarBuildItem(new
    InterceptorBindingRegistrar() {
        @Override
        public Collection<DotName> registerAdditionalBindings() {
            Collection<DotName> result = new HashSet<>();

            result.add(DotName.createSimple(MyAnnotation.class.getName()));

            result.add(DotName.createSimple(MyOtherAnnotation.class.getName()));
        };
        return result;
    });
    return additionalBindingsRegistrar;
}

```

## 6.8. Injection Point Transformation

Every now and then it is handy to be able to change qualifiers of an injection point programmatically. You can do just that with `InjectionPointTransformerBuildItem`. The following sample shows how to apply transformation to injection points with type `Foo` that contain qualifier `MyQualifier`:

```

@BuildStep
InjectionPointTransformerBuildItem transformer() {
    return new InjectionPointTransformerBuildItem(new
InjectionPointsTransformer() {

        public boolean appliesTo(Type requiredType) {
            return
requiredType.name().equals(DotName.createSimple(Foo.class.getName()
));
        }

        public void transform(TransformationContext context) {
            if (context.getQualifiers().stream()
                .anyMatch(a ->
a.name().equals(DotName.createSimple(MyQualifier.class.getName()))
) {
                context.transform()
                    .removeAll()

                .add(DotName.createSimple(MyOtherQualifier.class.getName()))
                    .done();
            }
        }
    });
}

```

## 6.9. Observer Transformation

Any [observer method](#) definition can be vetoed or transformed using an [ObserverTransformerBuildItem](#). The attributes that can be transformed include:

- [qualifiers](#)
- [reception](#)
- [priority](#)
- [transaction phase](#)
- [asynchronous](#)

```

@BuildStep
ObserverTransformerBuildItem transformer() {
    return new ObserverTransformerBuildItem(new
ObserverTransformer() {

        public boolean appliesTo(Type observedType,
Set<AnnotationInstance> qualifiers) {
            return
observedType.name.equals(DotName.createSimple(MyEvent.class.getName
()));
        }

        public void transform(TransformationContext context) {
            // Veto all observers of MyEvent
            context.veto();
        }
    });
}

```

## 6.10. Bean Deployment Validation

Once the bean deployment is ready an extension can perform additional validations and inspect the found beans, observers and injection points. Register a `BeanDeploymentValidatorBuildItem`:

```

@BuildStep
BeanDeploymentValidatorBuildItem beanDeploymentValidator() {
    return new BeanDeploymentValidatorBuildItem(new
BeanDeploymentValidator() {
        public void validate(ValidationContext validationContext)
{
            for (InjectionPointInfo injectionPoint :
validationContext.get(Key.INJECTION_POINTS)) {
                System.out.println("Injection point: " +
injectionPoint);
            }
        }
    });
}

```



You can easily filter all registered beans via the convenient `BeanStream` returned from the `ValidationContext.beans()` method.

If an extension needs to produce other build items during the "validation" phase it should use the `ValidationPhaseBuildItem` instead. The reason is that injected objects are only valid during a `@BuildStep` method invocation.

```

@BuildStep
void validate(ValidationPhaseBuildItem validationPhase,
              BuildProducer<MyBuildItem> myBuildItem,
              BuildProducer<ValidationErrorBuildItem> errors) {
    if (someCondition) {
        errors.produce(new ValidationErrorBuildItem(new
IllegalStateException()));
        myBuildItem.produce(new MyBuildItem());
    }
}

```



See [ValidationPhaseBuildItem](#) javadoc for more information.

## 6.11. Custom Contexts

An extension can register a custom [InjectableContext](#) implementation by means of a [ContextRegistrarBuildItem](#):

```

@BuildStep
ContextRegistrarBuildItem customContext() {
    return new ContextRegistrarBuildItem(new ContextRegistrar() {
        public void register(RegistrationContext
registrationContext) {

            registrationContext.configure(CustomScoped.class).normal().contextC
lass(MyCustomContext.class).done();
        }
    });
}

```

If an extension needs to produce other build items during the "context registration" phase it should use the [ContextRegistrationPhaseBuildItem](#) instead. The reason is that injected objects are only valid during a [@BuildStep](#) method invocation.

```

@BuildStep
void addContext(ContextRegistrationPhaseBuildItem
contextRegistrationPhase,
                BuildProducer<MyBuildItem> myBuildItem,
                BuildProducer<ContextConfiguratorBuildItem> contexts) {
    contexts.produce(new
ContextConfiguratorBuildItem(contextRegistrationPhase.getContext().
configure(CustomScoped.class).normal().contextClass(MyCustomContext
.class)));
    myBuildItem.produce(new MyBuildItem());
}

```



See [ContextRegistrationPhaseBuildItem](#) javadoc for more information.

## 6.12. Available Build Time Metadata

Any of the above extensions that operates with `BuildExtension.BuildContext` can leverage certain build time metadata that are generated during build. The built-in keys located in `io.quarkus.arc.processor.BuildExtension.Key` are:

- `ANNOTATION_STORE`
  - Contains an `AnnotationStore` that keeps information about all `AnnotationTarget` annotations after application of annotation transformers
- `INJECTION_POINTS`
  - `Collection<InjectionPointInfo>` containing all injection points
- `BEANS`
  - `Collection<BeanInfo>` containing all beans
- `REMOVED_BEANS`
  - `Collection<BeanInfo>` containing all the removed beans; see [Removing Unused Beans](#) for more information
- `OBSERVERS`
  - `Collection<ObserverInfo>` containing all observers
- `SCOPES`
  - `Collection<ScopeInfo>` containing all scopes, including custom ones
- `QUALIFIERS`
  - `Map<DotName, ClassInfo>` containing all qualifiers
- `INTERCEPTOR_BINDINGS`
  - `Map<DotName, ClassInfo>` containing all interceptor bindings
- `STEREOTYPES`

- `Map<DotName, ClassInfo>` containing all stereotypes

To get hold of these, simply query the extension context object for given key. Note that these metadata are made available as build proceeds which means that extensions can only leverage metadata that were build before they are invoked. If your extension attempts to retrieve metadata that wasn't yet produced, `null` will be returned. Here is a summary of which extensions can access which metadata:

- `AnnotationsTransformer`
  - Shouldn't rely on any metadata as this is one of the first CDI extensions invoked
- `ContextRegistrar`
  - Has access to `ANNOTATION_STORE`
- `InjectionPointsTransformer`
  - Has access to `ANNOTATION_STORE`, `QUALIFIERS`, `INTERCEPTOR_BINDINGS`, `STEREOTYPES`
- `ObserverTransformer`
  - Has access to `ANNOTATION_STORE`, `QUALIFIERS`, `INTERCEPTOR_BINDINGS`, `STEREOTYPES`
- `BeanRegistrar`
  - Has access to `ANNOTATION_STORE`, `QUALIFIERS`, `INTERCEPTOR_BINDINGS`, `STEREOTYPES`, `BEANS`
- `BeanDeploymentValidator`
  - Has access to all build metadata

## 7. Development Mode

In the development mode, two special endpoints are registered automatically to provide some basic debug info in the JSON format:

- HTTP GET `/quarkus/arc/beans` - returns the list of all beans
  - You can use query params to filter the output:
    - `scope` - include beans with scope that ends with the given value, i.e. <http://localhost:8080/quarkus/arc/beans?scope=ApplicationScoped>
    - `beanClass` - include beans with bean class that starts with the given value, i.e. <http://localhost:8080/quarkus/arc/beans?beanClass=org.acme.Foo>
    - `kind` - include beans of the specified kind (`CLASS`, `PRODUCER_FIELD`, `PRODUCER_METHOD`, `INTERCEPTOR` or `SYNTHETIC`), i.e. [http://localhost:8080/quarkus/arc/beans?kind=PRODUCER\\_METHOD](http://localhost:8080/quarkus/arc/beans?kind=PRODUCER_METHOD)
- HTTP GET `/quarkus/arc/observers` - returns the list of all observer methods



These endpoints are only available in the development mode, i.e. when you run your application via `mvn quarkus:dev` (or `./gradlew quarkusDev`).

## 8. ArC Configuration Reference

Configuration property fixed at build time - All other configuration properties are overridable at runtime

Configuration property	Type	Default
<code>quarkus.arc.remove-unused-beans</code> <ul style="list-style-type: none"><li>• If set to <code>all</code> (or <code>true</code>) the container will attempt to remove all unused beans.</li><li>• If set to <code>none</code> (or <code>false</code>) no beans will ever be removed even if they are unused (according to the criteria set out below)</li><li>• If set to <code>fwk</code>, then all unused beans will be removed, except the unused beans whose classes are declared in the application code An unused bean:<ul style="list-style-type: none"><li>• is not a built-in bean or interceptor,</li><li>• is not eligible for injection to any injection point,</li><li>• is not excluded by any extension,</li><li>• does not have a name,</li><li>• does not declare an observer,</li><li>• does not declare any producer which is eligible for injection to any injection point,</li><li>• is not directly eligible for injection into any <code>javax.enterprise.inject.Instance</code> injection point</li></ul></li></ul>	string	<code>all</code>
<code>quarkus.arc.auto-inject-fields</code> <p>If set to true <code>@Inject</code> is automatically added to all non-static fields that are annotated with one of the annotations defined by <code>AutoInjectAnnotationBuildItem</code>.</p>	boolean	<code>true</code>
<code>quarkus.arc.transform-unproxyable-classes</code> <p>If set to true, the bytecode of unproxyable beans will be transformed. This ensures that a proxy/subclass can be created properly. If the value is set to false, then an exception is thrown at build time indicating that a subclass/proxy could not be created. Quarkus performs the following transformations when this setting is enabled: - Remove 'final' modifier from classes and methods when a proxy is required. - Create a no-args constructor if needed. - Makes private no-args constructors package-private if necessary.</p>	boolean	<code>true</code>

<p> <code>quarkus.arc.config-properties-default-naming-strategy</code></p> <p>The default naming strategy for <code>ConfigProperties.NamingStrategy</code>. The allowed values are determined by that enum</p>	<p>from-config, verbatim, kebab-case</p>	<p>kebab-case</p>
<p> <code>quarkus.arc.selected-alternatives</code></p> <p>The list of selected alternatives for an application. An element value can be: - a fully qualified class name, i.e. <code>org.acme.Foo</code> - a simple class name as defined by <code>Class#getSimpleName()</code>, i.e. <code>Foo</code> - a package name with suffix <code>.*</code>, i.e. <code>org.acme.*</code>, matches a package - a package name with suffix <code>**</code>, i.e. <code>org.acme.**</code>, matches a package that starts with the value Each element value is used to match an alternative bean class, an alternative stereotype annotation type or a bean class that declares an alternative producer. If any value matches then the priority of <code>Integer#MAX_VALUE</code> is used for the relevant bean. The priority declared via <code>javax.annotation.Priority</code> or <code>io.quarkus.arc.AlternativePriority</code> is overridden.</p>	<p>list of string</p>	
<p> <code>quarkus.arc.auto-producer-methods</code></p> <p>If set to true then <code>javax.enterprise.inject.Produces</code> is automatically added to all methods that are annotated with a scope annotation, a stereotype or a qualifier, and are not annotated with <code>Inject</code> or <code>Produces</code>, and no parameter is annotated with <code>Disposes</code>, <code>Observes</code> or <code>ObservesAsync</code>.</p>	<p>boolean</p>	<p>true</p>
<p> <code>quarkus.arc.exclude-types</code></p> <p>The list of types that should be excluded from discovery. An element value can be: - a fully qualified class name, i.e. <code>org.acme.Foo</code> - a simple class name as defined by <code>Class#getSimpleName()</code>, i.e. <code>Foo</code> - a package name with suffix <code>.*</code>, i.e. <code>org.acme.*</code>, matches a package - a package name with suffix <code>**</code>, i.e. <code>org.acme.**</code>, matches a package that starts with the value If any element value matches a discovered type then the type is excluded from discovery, i.e. no beans and observer methods are created from this type.</p>	<p>list of string</p>	
<p> <code>quarkus.arc.unremovable-types</code></p> <p>List of types that should be considered unremovable regardless of whether they are directly used or not. This is a configuration option equivalent to using <code>io.quarkus.arc.Unremovable</code> annotation. An element value can be: - a fully qualified class name, i.e. <code>org.acme.Foo</code> - a simple class name as defined by <code>Class#getSimpleName()</code>, i.e. <code>Foo</code> - a package name with suffix <code>.*</code>, i.e. <code>org.acme.*</code>, matches a package - a package name with suffix <code>**</code>, i.e. <code>org.acme.**</code>, matches a package that starts with the value If any element value matches a discovered bean, then such a bean is considered unremovable.</p>	<p>list of string</p>	

<p> <code>quarkus.arc.exclude-dependency."exclude-dependency".group-id</code></p> <p>The maven groupId of the artifact to index</p>	string	required 
<p> <code>quarkus.arc.exclude-dependency."exclude-dependency".artifact-id</code></p> <p>The maven artifactId of the artifact to index</p>	string	required 
<p> <code>quarkus.arc.exclude-dependency."exclude-dependency".classifier</code></p> <p>The maven classifier of the artifact to index</p>	string	