



# OSGi<sup>TM</sup> Alliance

## **RFC 193 - CDI Integration**

Draft

45 Pages

### **Abstract**

While OSGi services are very powerful, some still find it challenging to use them effectively. This RFC looks at how CDI can be used to interact with the OSGi service layer. The intent is to bring the popular CDI programming model to OSGi as a way to interact with OSGi services. It will provide the convenience of CDI and allows developers familiar with the CDI technology to reuse their skills in an OSGi context.

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## 0.3 Feedback

This document can be downloaded from the OSGi Alliance design repository at <https://github.com/osgi/design> The public can provide feedback about this document by opening a bug at <https://www.osgi.org/bugzilla/>.

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## 0.5 Terminology and Document Conventions

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "NOT RECOMMENDED", "MAY" and "OPTIONAL" in this document are to be interpreted as described in 1.

Source code is shown in this typeface.

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## 0.6 Revision History

The last named individual in this history is currently responsible for this document.

Revision	Date	Comments
Initial	16/10/12	Initial version of the draf. David Bosschaert <david@redhat.com>

Revision	Date	Comments
2 <sup>nd</sup> draft	26/10/12	First draft of chapter 5 Paul Bakker <paul.bakker@luminis.eu>
3 <sup>rd</sup> draft	30/10/12	Life-cycle callbacks Paul Bakker < <a href="mailto:paul.bakker@luminis.eu">paul.bakker@luminis.eu</a> >
4 <sup>th</sup> draft	27/01/13	Details on service dynamics Paul Bakker <paul.bakker@luminis.eu>
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7th draft	09.04.13	New sections Entities, CDI container lifecycle, Requirements and Capabilities. A number of comments on existing sections. Harald Wellmann/ Rebaze < <a href="mailto:harald.wellmann@rebaze.com">harald.wellmann@rebaze.com</a> >
8 <sup>th</sup> draft	October, 2013	David Bosschaert, some cleanup and additions: <ul style="list-style-type: none"><li>• Removed OSGi prefix from classnames</li><li>• Replaced API described in the text with actual Javadoc generated from classes in OSGi git</li><li>• Tentatively added sections about support for scopes and support for 'bare' @Inject injection points</li><li>• Added section on the CdiContainer service</li><li>• Added section on osgi.capability portable Java contracts</li></ul>

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# 1 Introduction

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While OSGi services are very powerful, consuming them has been a challenge for many OSGi users. There have been a number of solutions to this problem both in OSGi specifications as well as in non-standardized technologies. OSGi Declarative Services and Blueprint are popular specifications in this area, however they provide new programming models that users need to learn. As of JavaEE 6, CDI (JSR 299) is included as a standard injection technology for JavaEE components. The CDI programming model seems suitable for interaction with the OSGi service layer as well and has the benefit that developers who are familiar with CDI don't need to learn a new technology in order to interact with the OSGi service registry.

This document proposes that OSGi will support CDI with the goal of creating a specification that describes how the CDI programming model can be used to interact with OSGi services.

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## 2 Application Domain

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Software developers often need to build loosely coupled applications. The need for this stems from a number of factors:

- Developing reusable services for consumption outside of the team
- Allowing those services to be easily consumed
- Unit testing of applications and services
- Allowing larger teams to work effectively together by isolating areas of development

Software developers also wish to using a standardized programming model. This promotes:

- Transferability of skill sets
- Ease of sourcing new developers and low initial overhead
- Clear understanding of correct behavior when unexpected behavior is encountered
- Consistency of programming model across the technological strata to provide a uniformity of approach to aid understanding

Finally, software developers require an environment in which the focus can be on solving business issues rather than technological issues. This allows a more responsive development process.

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### 2.1 CDI

CDI, Contexts and Dependency Injection is specified by JSR 299. It defines a clean, mostly annotations-based injection model which has recently become very popular. CDI is part of JavaEE 6 but can also be used standalone in a JavaSE context.

Weld (<http://seamframework.org/Weld>) is the Reference Implementation of JSR 299.

#### 2.1.1 Example

Although many advanced features are available, the most basic annotation used in CDI is `javax.inject.Inject` which declares the injection points for CDI.

For example the following Servlet class uses CDI injection to obtain an implementation of the WeatherBean interface.

```
public class CDIServlet extends HttpServlet {
    @Inject
    WeatherBean weatherBean;

    @Override
    protected void doGet(HttpServletRequest req, HttpServletResponse resp)
        throws ServletException, IOException {
        PrintWriter writer = resp.getWriter();
        writer.print("The Weather in Amsterdam: " +
            weatherBean.getDescription("Amsterdam"));

        writer.flush();
        writer.close();
    }
}
```

While for the most basic use a CDI provider does not need to be annotated, CDI will attempt to find an implementor class and instantiate it using a no-arg constructor. Other mechanisms to publish a bean into CDI can be defined by using the `javax.enterprise.inject.Produces` annotation. Additionally, a number of scopes are defined that can be used to declare the lifecycle of a CDI bean.

For example, the `WeatherBean` above can be scoped to the application lifecycle by adding the `javax.enterprise.context.ApplicationScoped` annotation, as in this example:

```
@ApplicationScoped
public class WeatherBeanProducer {
    @Produces @ApplicationScoped
    public WeatherBean newWeatherBean() {
        WeatherBean wb = new WeatherBeanImpl();
        wb.initialize();
        return wb;
    }

    public void disposeWeatherBean(@Disposes WeatherBean wb) {
        wb.cleanup();
    }
}
```

For more information see the CDI specification at JSR 299 Error: Reference source not found

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## 2.2 Weld-OSGi

The Weld-OSGi project (<http://mathieuancelin.github.com/weld-osgi/>) has created an integration between CDI and OSGi. It allows CDI beans to be exposed as OSGi services and CDI injections to be satisfied by OSGi services. Weld-OSGi takes additional OSGi features into account such as service registration properties and the dynamic aspects of the Service Registry.

Furthermore, Weld-OSGi provides annotation based injection for the Bundle, BundleContext, Bundle Headers and the private bundle storage facility.

Additionally Weld-OSGi provides annotations-based integration with Service and Bundle events.

### 2.2.1 Weld-OSGi example

Many examples can be found in the weld-osgi documentation Error: Reference source not found

Weld-OSGi typically uses additional annotations to interact with the OSGi service Registry. For example, the `org.osgi.cdi.api.extension.annotation.Publish` annotation publishes the CDI bean in the OSGi Service Registry:

```
@Publish
@ApplicationScoped
public class MyServiceImpl implements MyService {
    @Overrides
    public void doSomething() { ... }
}
```

To have a CDI injection come from the OSGi Service Registry, use the `OSGiService` annotation:

```
@Inject @OSGiService MyService service;
```

OSGi Services can also be selected by using LDAP filters:

```
@Inject @OSGiService @Filter("&(lang=EN) (country=US)") MyService service;
```

For more examples, see the weld-osgi documentation.

---

## 2.3 Declarative Services, Blueprint and CDI

In Java EE, the EJB and CDI containers are able to collaborate such that EJB manages an EJB component's life-cycle, whilst CDI manages its runtime dependencies. For example, when a new EJB is created it can be handed over to the CDI container for it to process the injections (`@Inject`) before finally being made available for use. This relationship helps ensure a complementary positioning between the different component models and reduces runtime duplication (EJB is not required to handle `@Inject` processing itself).

OSGi has two existing component models in the form of Declarative Services and Blueprint. Each has its own mechanism for injection of services and Blueprint also supports bean injection within a bundle. Neither has standards support for runtime annotations for injection, although there is some Blueprint prototype work in Apache Aries. In addressing any requirements for runtime annotations support, serious consideration should be given to the use of existing annotations, such as `@Inject`. It also makes sense to consider creating similar complementary relationship between their containers and the CDI container for runtime injection processing, thus reducing duplication between various component model containers.

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## 2.4 Terminology + Abbreviations

CDI – Context and Dependency Injection for JavaEE. Specified in JSR 299.

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# 3 Problem Description

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CDI provides a standardized, type-safe, loosely coupled programming model for Java EE 6 and above. Furthermore, it introduces powerful extensibility into the Java EE programming model, and promotes an ecosystem of “portable extensions”.



CDI is declarative, with metadata provided via annotations. This allows developers to locate all logic and metadata in a single location, allowing easier comprehension of the application.

CDI does not specify any modularity or inter-application communication, relying instead on the Java EE platform to provide this.

OSGi provides the de facto standard within Java for modular, service orientated programming.

Use of CDI in the context of OSGi provides a very compelling programming model. However, today there is no standard way to achieve this. A standard for leveraging CDI in OSGi will provide a migration path between JavaEE and OSGi where developers familiar with CDI can reuse their skills in both contexts without being locked in to a particular implementation.

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## 4 Requirements

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### 4.1 Functional Requirements

CDI001 – The specification **MUST** make it possible to use the CDI annotations and XML descriptor in an OSGi bundle to expose and consume CDI beans.

CDI003 – The specification **MUST** make it possible to consume OSGi services in CDI @Inject injection points in an OSGi bundle.

CDI004 – The specification **MUST** make it possible to select OSGi services used in CDI beans based on OSGi filters.

CDI005 – The specification **MUST** make it possible to consider CDI qualifiers when looking up CDI beans in the OSGi Service Registry.

CDI014 – The specification **MUST** provide a mechanism to specify additional OSGi service registration properties for CDI beans.

CDI006 – The specification **MUST** make it possible to write a portable CDI jar that runs both in JavaEE as well as in OSGi.

CDI007 – The specification **MUST** consider the thread-safety issues that can arise when migrating CDI beans from JavaEE to OSGi.

CDI008 – The specification **MUST** consider the issues that can arise in relation to the dynamic bundle lifecycle in OSGi.

CDI015 – The specification **MUST** consider the issues that can arise with OSGi service dynamism when these services are injected into a CDI bean.

CDI009 – The specification **MUST** make it possible to take advantage of the dynamic service capabilities of OSGi.

CDI016 – The specification **MUST** extend the life-cycle dependency model as provided in CDI, to support the dynamic life-cycle provided by OSGi. For example, it **MUST NOT** be fatal to deploy a CDI bean that does not have all its dependencies initially satisfied and it **MUST** be possible to change bean dependencies without requiring the CDI application to be redeployed or restarted.

CDI031 – The specification **MUST** extend the life-cycle dependency model of CDI to include dynamic OSGi service dependencies.

CDI017 – The specification **MUST** make it possible to declare a CDI injection point to an OSGi service as optional.

CDI018 – The specification **MUST** provide a mechanism to consume multiple matching services/beans of a given type in an injection point. For example via the `@Inject Instance<T>` mechanism.

CDI019 – The specification **MUST** support CDI events as defined by the CDI specification.

CDI021 – The specification **MAY** provide a deep integration between CDI events and OSGi events or other OSGi mechanism.

CDI020 – The specification **MUST** support CDI extensions as defined by the CDI specification.

CDI022 – the specification **MAY** provide a deep integration between CDI extensions and OSGi services or other OSGi mechanism.

CDI010 – The specification **MAY** introduce additional annotations.

CDI011 – The specification **MUST** define the behavior in case of incorrect CDI metadata.

CDI012 – The specification **MUST NOT** prevent the use of `@Inject` (and other common java annotations) in other component models/technologies present in the OSGi Framework.

CDI013 – The specification **MUST** define an opt-in mechanism. Bundles not opting in **MUST** not be considered by the CDI-OSGi integration layer.

CDI023 – All the inter-bundle interaction between CDI beans **MUST** go through the OSGi Service Registry.

CDI024 – The specification **MUST** make it possible to access the `BundleContext` from inside a CDI bean in an OSGi Framework.

CDI025 – The specification **MUST** provide support for `@PostConstruct` and `@PreDestroy` activation and de-activation callbacks.

CDI026 – The specification **SHOULD** consider defining behavior for relevant CDI scopes.

CDI027 – The solution **MAY** define new scopes for use with CDI inside an OSGi Framework.

CDI028 – The specification **MUST** define an opt-in mechanism for CDI extensions.

CDI029 – The specification **MUST** consider the issues that arise from dynamically adding CDI extensions to the system.

CDI030 – The specification **MUST** support the inclusion of CDI beans and descriptors in a Web Application Bundle in the same way they can be included in a WAR (e.g. including `beans.xml` in `WEB-INF/`).

CDI032 – The specification **MUST** support the OSGi Service Permission security model when publishing OSGi services from CDI beans and injecting services into CDI beans. It needs to take into account that the CDI extender acts on behalf of other bundles and uses the permissions associated with those.

---

## 4.2 Non-functional Requirements

CDI050 – The specification **MUST NOT** prevent an implementation from injecting OSGi services into CDI beans which are not deployed as OSGi bundles.



CDI052 – The specification **MUST NOT** prevent an implementation from injecting OSGi services into CDI beans which are not deployed as OSGi bundles.

CDI051 – The specification **SHOULD** adhere to the current CDI programming model as much as possible.

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## 4.3 Requirements from RFP 98 (OSGi/Java EE umbrella RFP)

JEE001 – A Java EE/OSGi system **SHOULD** enable the standard Java EE application artifacts (e.g. web application) to remain installed when a supporting Java EE runtime element (e.g. web container) is dynamically replaced.

JEE002 – RFCs that refer to one or more Java EE technologies **MUST NOT** impede the ability of an OSGi-compliant implementation to also be compliant with the Java EE specification.

JEE003 – RFCs that refer to one or more Java EE technologies **MAY** define the additional aspects of the technology that are required for the technology to be properly integrated in an OSGi framework but **MUST NOT** make any syntactic changes to the Java interfaces defined by those Java EE specifications.

JEE004 – RFCs whose primary purpose is integration with Java EE technologies **MUST NOT** require an OSGi Execution Environment greater than that which satisfies only the signatures of those Java EE technologies.

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# 5 Technical Solution

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## 5.1 Entities

- CDI – Contexts and Dependency Injection 1.0 (JSR-299).
- CDI Provider – An implementation of the CDI 1.0 specification.
- CDI OSGi adapter – Adapts a given CDI Provider to the OSGi environment. This entity is implementation dependent and may or may not be separate from the CDI provider.
- CDI Bundle – A CDI-enabled OSGi bundle.

- CDI Container – A container for managed beans in a CDI Bundle. Each CDI Bundle has its own CDI container.
- CDI Extender – An application of the extender pattern to discover CDI Bundles and to manage the CDI container life-cycle on behalf of CDI Bundles.
- CDI Extension – A portable extension as defined in CDI 1.0.
- Extension Bundle – A bundle providing one or more CDI extensions. An extension bundle may or may not be a CDI Bundle at the same time.
- OSGi CDI Extension – A specific CDI extension for publishing and consuming OSGi services to or from managed beans by means of annotations. This is a mandatory part of this specification.

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## 5.2 CDI Container Life-Cycle

The CDI Extender tracks all bundles becoming ACTIVE. When a tracked bundle is identified as a CDI Bundle, the CDI Extender creates a CDI Container for this bundle. When a tracked CDI Bundle is stopped, the CDI Extender stops the CDI Container for the given bundle.

Starting a CDI container requires scanning the CDI Bundle for managed bean candidate classes. Class loading scenarios are far more complex in OSGi than in Java EE or Java SE, due to the modular and dynamic nature of the OSGi environment.

The bean scanner needs to consider

- All classes on the bundle classpath of the CDI Bundle, including any embedded archives or directories.
- All classes contained in packages imported by the CDI Bundle from other bundles wired to the given bundle.
- All classes exported by required bundles wired to the CDI Bundle.
- TODO: What about dynamic package imports?

The set of candidate bean classes determined by the bean scanner is *not* equal to the set of managed beans in the bean container: The CDI Provider discards all candidate classes that do not satisfy the requirements for managed beans. The set of managed beans may be further extended or modified by CDI extensions.

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## 5.3 Requirements and Capabilities

Bean deployment archives according to CDI 1.0 are required to opt in to OSGi enrichment by the CDI Extender. However, opting in may have no effect at all if a would-be CDI Bundle is installed and started in a system where no CDI Extender is available.

This kind of dependency can be made explicit using capabilities (introduced in OSGi Core 4.3). Capabilities are also useful to express a loose dependency on a given CDI extension. This covers the following use case:

CDI Bundle A works with a CDI extension with an annotation API defined in bundle B and an extension implementation in bundle C. A has a package dependency on B, but not on C. There is only an implicit runtime dependency on C. C needs to be resolved when the CDI container for A is constructed, so that the extension can modify the set of managed beans, but C may not be available at all.

Extension capabilities are a means to declare a dependency on a given extension *by name* and not by implementation.

For these reasons, this specification defines the following capabilities.

- An OSGi extender capability named `osgi.cdi`.
- A capability `osgi.cdi.extension` with a mandatory attribute `extension = <name>`, where `<name>` is a logical name for the given extension. The name `osgi.cdi` is reserved for the OSGi CDI extension defined in this specification.

A CDI Bundle MUST require the OSGi extender capability named `osgi.cdi`, e.g.

```
Require-Capability = osgi.extender; filter:="(osgi.extender=osgi.cdi)"
```

(Note that this is not a *sufficient* condition for a bundle to be a CDI Bundle. A CDI Bundle must also be a bean deployment archive as defined in CDI 1.0, i.e. it must have a `beans.xml` descriptor in one of the defined locations.)

A CDI Bundle MAY require additional `osgi.cdi.extension` capabilities with other filter attributes for other CDI extensions.

A CDI Extender implementation MUST provide the `osgi.extender` capability named `osgi.cdi` with version 1.0, e.g.

```
Provide-Capability = osgi.extender; osgi.extender=osgi.cdi; version=1.0
```

Future versions of this specification will require higher version numbers.

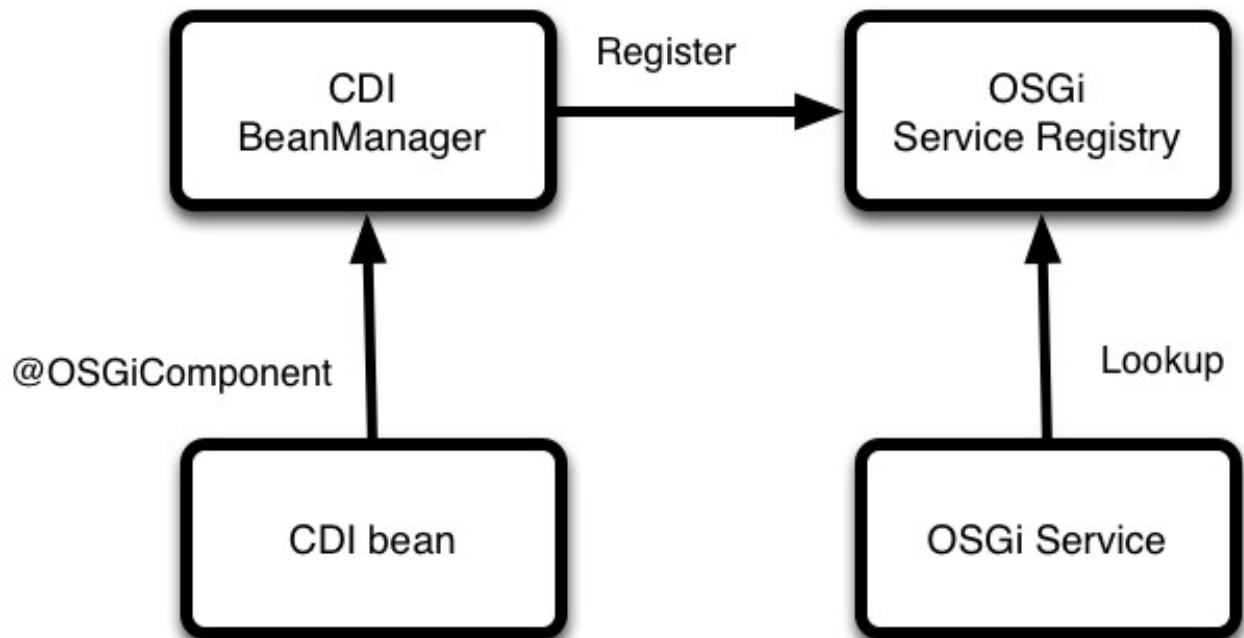
An OSGi-enabled CDI extension MUST provide an `osgi.cdi.extension` capability with a distinctive name, e.g.

```
Provide-Capability = osgi.cdi.extension; extension=frobnicator
```

---

## 5.4 Managed Beans and OSGi Services




## Publish CDI bean as OSGi Service



A class can be published to the OSGi service registry using the `@org.osgi.service.cdi.Component` annotation. Note that classes that are already CDI beans, are not automatically published to the service registry; the `@Component` annotation is always required for this. The requirement to explicitly annotate a bean to be an OSGi component is necessary for the following reasons:


1. In CDI 1.0 every class is a potential CDI bean, no annotations are required for this. The container scans injection points at container startup time to calculate which classes should be registered as beans. A CDI container in OSGi is scoped to a single bundle, and will only know about injection points in that bundle. OSGi services however can be used by other bundles as well. Although it is technically possible to find injection points in all bundles, this would be very hard to reason about for end users.
2. Not each CDI bean should be registered to the service registry. CDI is often used to inject tightly coupled classes into each other. This is fine for internal bundle usage, but should not be reflected in the service registry.
3. Not all CDI beans might be exported. It's useless to publish services of types that other bundles can't have access to.

This behavior is different than the behavior described in the EJB integration specification, where all EJBs are published as OSGi services by default. Although technically EJBs and CDI beans are very similar, their usage in practice is often very different. EJBs tend to be used in a similar granularity as OSGi services, while CDI beans are not.


 class doesn't have to have an interface defined. If no interface is defined the service will be registered with `Object.class` as the service interface which is sometimes useful for whiteboard style registrations. The bean's type itself might not be exported and is therefore not published. If an interface is defined, the service is registered using this interface. If multiple  interfaces are defined the developer can optionally explicitly define the list of registered interfaces using the  `@Component` annotation. By default all interfaces will be published.

```

@Component(interfaces={A.class})
public class MyComponent implements A,B {}
  
```

Service properties can be defined in the `@Component` annotation using the "properties" argument. The properties argument takes an array of `@ComponentProperty` annotations. The `@ComponentProperty` annotations requires a key and value to be set, both of type `String`. 

```

@Component(properties = {@ServiceProperty(key = "key", value = "value"), @ServiceProperty(key = "key2", value = "value2")})
public class ExampleComponent {}
  
```

## 5.5 Scopes

The following table outlines the CDI scopes and their support by this specification. 

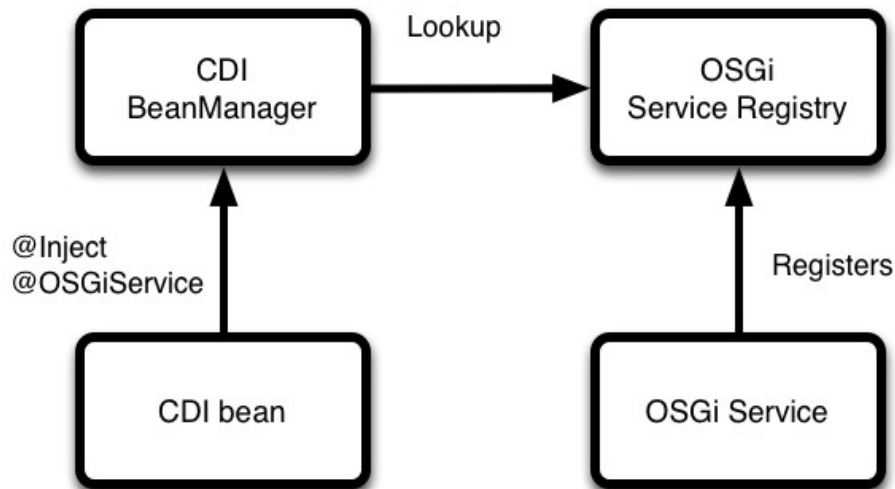
<code>@ApplicationScoped</code>	Supported in the context of Subsystem applications
<code>@ConversationScoped</code>	This seems JSF-specific. Do we need to support???
<code>@Dependent</code>	Default same as <code>@Singleton</code> below
<code>@SessionScoped</code>	Supported in the context of Web Applications
<code>@RequestScoped</code>	Map to prototype service scope?

The following table lists OSGi-defined scopes and associated behavior:

<code>@BundleScoped</code>	Maps to OSGi Service Factory
<code>@PrototypeScoped</code>	Maps to OSGi Prototype Service Factory
<code>@SingletonScoped</code>	Maps to normal OSGi singleton service

## 5.6 Life-Cycle

### Inject OSGi services in CDI beans



The life-cycle of an `@Component` is different from a normal CDI bean, because it has to deal with service dynamics. An `@Component` may have dependencies on other OSGi services which can influence the life-cycle of the `@Component` as described in the next section.

An OSGi service can be injected into another OSGi Service or a CDI bean using the standard `@Inject` annotation. The life-cycle of an OSGi service is different than a plain CDI bean however. By default, a CDI bean has the *Dependent* scope; its life-cycle is bound to the life-cycle of the consuming bean, or alternatively it's scope is defined using annotations. For a mapping of CDI scope to OSGi behaviour, see section 5.5, however not all CDI scopes are supported in an OSGi environment. Another difference is that there may be multiple OSGi services publishing the same interface, a client may or may not choose a specific instance using service properties and ordering.

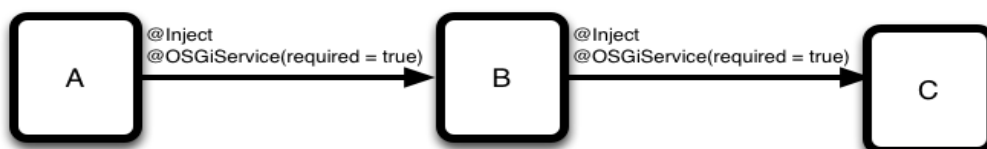
Because of the differences between the CDI BeanManager and OSGi service registry and to remove ambiguity we must always use `@Service` CDI qualifier to instruct the CDI container (and the developer) that we are dealing with a specific type of bean, where different rules may apply. When the `@Service` annotation is used, the CDI container will lookup the OSGi service in the service registry and inject its instance into the CDI bean.

Any OSGi service registered in the service registry can be injected using CDI, even if the service was not registered using CDI but with the low level service API or DS for example.

#### 5.6.1 Required dependencies (@Component only)

Require a dependency; the component will not be registered when a required dependency is not available. When all dependencies becomes available, the component will be registered. If at some point during runtime a required dependency becomes unavailable, the component will be deregistered again. This model handles service dynamics correctly, while the code doesn't have to handle the case where dependencies are not available.


As an example we have the dependency structure:





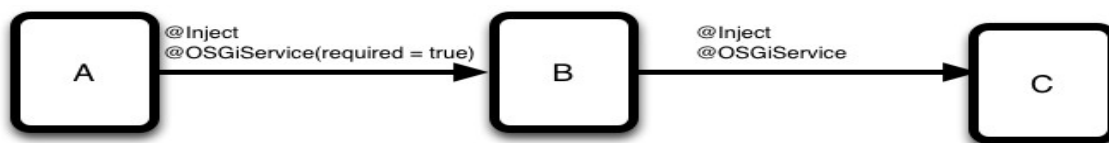
When C becomes unavailable, B will become unavailable as well, and so will A. When C becomes available again, so will be B, and so will A.

### 5.6.2 Optional dependencies

By default dependencies are optional.  To deal with service dynamics a proxy is injected instead of the real reference to the service. The proxy is by default a null-object, every method invocation should return null. The code that uses an optional dependency must deal with the possibility that the service is not available and handle null values properly.

Alternatively the `@Service` supports a configuration parameter “proxyType” that can be used to configure the proxy to throw a `org.osgi.cdi.ServiceNotAvailableException` when the proxy is invoked while the service is not available. This way clients can handle null values returned by the real service differently than the situation where the service is not available.

Optional and required dependencies can be mixed in a single component and in the dependency graph of a component. Take the following example again, note that the dependency on C is now optional.



When C becomes unavailable, B should still be available, and therefore A as well. When B becomes unavailable, A should still become unavailable as well. Because the dependency on C is now optional, the code of B should be handling the fact that method invocations on C might return null or throw exceptions.

CDI does not support dynamic dependencies. All beans must be registered and all dependencies must be resolved at container startup. For normal CDI beans the container should resolve `@Inject` `@Service` injection points immediately with proxies as described for optional dependencies. Required dependencies are not required to be implemented by the container for normal CDI beans; the container may throw an exception to inform the developer that the required attribute is not supported. A CDI container may implement required dependencies for normal CDI beans as well too however.

For components registered with the `@Component` annotation, required dependencies must be supported. An `@Component` with unavailable dependencies must not be registered to the OSGi service registry, and it's `@PostConstruct` method must not be invoked. If the component was active before the dependency became unavailable, the `@PreDestroy` method must be called and the service must be de-registered from the service registry.

Because OSGi services are dynamic, a developer should make the explicit choice to inject beans using the OSGi service registry by using the `@Service` qualifier. If the `@Service` qualifier is not used, the container should not query the service registry.

### 5.6.3 Allowing Service Injections in vanilla CDI injection points

As described in previous sections, the life-cycle and dynamics of OSGi makes this a fundamentally different environment to the JavaEE container for which CDI was originally designed. This is one of the key reasons for introducing the `@Service` annotation to go with the `@Inject` annotation.

However in certain scenarios it may be desirable allow injections from the OSGi service registry into plain `@Inject` injection points. This is to allow migration paths from pure JavaEE to configurations where unmodified

CDI beans are injected with services from the OSGi service registry. Clearly such a situation introduces risks and analysis of the system is necessary beforehand to ensure that no fatal situations can occur by the introduced dynamics.

Once satisfied that the system can cope in the OSGi environment, injection into pure `@Inject` points can be enabled by setting a directive on the extender requirement in the CDI Bundle:

```
Require-Capability = osgi.extender;  
    filter:="(osgi.extender:=osgi.cdi)";  
    at-service:="optional"
```

#### 5.6.4 Service and bundle registration observers

In most situations service dependencies are injected directly into a field. Sometimes some extra logic needs to be executed however. This can be done using callback methods. There is a callback method for service registration and a callback for service deregistration. The parameters of the observer method should be the type of the service.

Only events fired while the bundle containing the observer methods are delivered. Events fired while the bundle was not active are ignored.

```
void serviceAdded(@Observes @ServiceAdded SomeService) ;  
void serviceRemoved(@Observes @ServiceRemoved SomeService) ;  
void serviceModified(@Observes @ServiceModified SomeService) ;
```

In some cases it's useful to also have access to the `ServiceReference` representing a service. For this case a special event type is introduced:

```
public class ServiceCdiEvent<T> {  
    private ServiceReference<T> reference;  
    private T service;  
    // constructor and getters etc.  
}
```

```
void serviceAdded(@Observes @ServiceAdded ServiceCdiEvent<SomeService> event)  
void serviceRemoved(@Observes @ServiceRemoved ServiceCdiEvent<SomeService> event)
```

The `@ServiceAdded` and `@ServiceRemoved` annotations have the same service filtering semantics as `@Service` described in the following section.

#### 5.6.5 Service Filters

Service filtering can be done using the `@Service` value parameter using the standard OSGi service filter (LDAP like) syntax:

```
@Service("(somekey=somevalue")
```

As a convenience alternatively the same could be done using CDI Qualifiers:

```
@Qualifier
```

```
@ServiceFilter
```

```
public @interface SomeKey {
```

```
String value();
```

```
}
```

```
@Inject @Service @SomeKey("somevalue")
```

```
MyService service;
```

The name of the qualifier is used as the name of the property, the value passed into the qualifier annotation the value. If the value is not a String (e.g. an enum value), the String representation of the value is used. If the qualifier has a default value, the annotation can be used without specifying a value. In the following example the used filter is "(somekey=somevalue)". This mechanism provides a slightly more type-safe approach to using service filters.

```
@Qualifier
```

```
@ServiceFilter
```

```
public @interface SomeKey {
```

```
String value() default "somevalue";
```

```
}
```

```
@Inject @Service @SomeKey
```

```
MyService service;
```

It is possible to combine multiple qualifiers to create AND filters. In the following example both annotations are qualifiers, and the resulting filter is "(&(somekey=somevalue)(someotherkey=someothervalue))".

```
@Inject @Service @SomeKey("somevalue") @SomeOtherKey("someothervalue")
```

```
MyService service;
```

More complex filters are not supported using qualifiers, the standard filter syntax should be used instead with the `@Service` annotation.

When using OSGi service filters it is common to use dots in property names, e.g. 'service.ranking'. It is not possible however to use dots in a Java Annotation type name. To work around this issue the Annotation type name is parsed and certain markers in the name are interpreted as dots. Because service properties are case insensitive, camel casing can be used as a marker.

For example the qualifier `@MyServiceProperty("example")` translates to "(my.service.property=example)". The first character is lowercased. Each following capital is translated to a dot.

### Requiring configuration

An `@Component` can require a Config Admin Configuration object with a specific PID. The component will only become available when a configuration object with the specified PID is found. This is useful when a component does not have usable default configuration values. If the configuration object is not available, the behaviour is the same as for a unavailable required service dependency.

A configuration dependency can be configured as follows:

```
@Component(requireConfiguration="PID.of.configuration")
```

---

## 5.7 BundleContext injection

It's possible to inject the BundleContext using CDI annotations.

```
@Inject BundleContext context;
```

This will always inject the BundleContext of the bundle that registered the component, even if the component's class was imported from another bundle. For example we could have the following scenario. Although the `@Inject BundleContext` annotation is declared in a class exported by Bundle A, Bundle B does the actual component registration. This means that the BundleContext of bundle B will be injected.

Bundle A

```
public abstract class MyBaseClass {  
  
    @Inject BundleContext bundleContext;  
  
}
```


Bundle B

```
@Component  
  
public class MySubClass extends MyBaseClass {  
  
}
```

---

## 5.8 CdiContainer service

The implementation will provide a `CdiContainer` service which provides access to a `javax.enterprise.inject.spi.BeanManager` implementation. The `BeanManager` provides a standard portable introspective interfaces into the CDI container.

The `BeanManager` service is registered under the Bundle Context of the associated CDI bundle.  each CDI bundle has its own container. As a result many `CdiContainer` services will be present in the system.

---

## 5.9 osgi.contract Capability

The OSGi Enterprise specification version 5 defines the `osgi.contract` capability namespace and RFC 180 defines mappings of JSR-defined technologies to these capabilities. Relevant technologies from RFC 180 to this specification are the `JavaCDI` and `JavaInject` API contracts.

An implementation of this specification is not required to export the associated `javax.**` packages, but if it does, it must also provide the `JavaCDI` and `JavaInject` capabilities in the `osgi.contract` namespace.

## 6 Data Transfer Objects

---

*RFC 185 defines Data Transfer Objects as a generic means for management solutions to interact with runtime entities in an OSGi Framework. DTOs provides a common, easily serializable representation of the technology.*

*For all new functionality added to the OSGi Framework the question should be asked: would this feature benefit from a DTO? The expectation is that in most cases it would.*

*The DTOs for the design in this RFC should be described here and if there are no DTOs being defined an explanation should be given explaining why this is not applicable in this case.*

*This section is optional and could also be provided in a separate RFC.*

---

## 7 Javadoc

---

## OSGi Javadoc

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Package Summary		Page
<a href="http://org.osgi.service.cdi">org.osgi.service.cdi</a>	CDI Integration Package Version 1.0.	23

## Package org.osgi.service.cdi

CDI Integration Package Version 1.0.

See:

[Description](#)

Interface Summary		Page
<a href="#">CdiContainer</a>	A CdiContainer object is registered by the the cdi extender in the OSGi registry for each managed CDI bundle.	25
<a href="#">CdiListener</a>	A CdiListener object can be registered in the OSGi registry.	29

Class Summary		Page
<a href="#">CdiEvent</a>	CdiEvent are sent by the cdi extender and received by registered CdiListener services.	26
<a href="#">ComponentEvent</a>	CDI Event sent by the CDI extender whenever a component has been registered or unregistered to/from the OSGi registry.	31
<a href="#">Constants</a>	Defines CDI constants	35
<a href="#">ServiceEvent</a>	The event sent by the CDI extender whenever a service that matches an injection point is registered or unregistered from the OSGi registry.	39

Enum Summary		Page
<a href="#">ServiceType</a>	Defines the type of service injected.	42

Exception Summary		Page
<a href="#">ServiceNotAvailableException</a>	Exception that can be thrown from the injected Service if a matching service is not available.	40

Annotation Types Summary		Page
<a href="#">Component</a>	The @Component annotation exposes a CDI bean in the OSGi registry.	30
<a href="#">ComponentProperty</a>	Annotation used to define a property that will be associated to Component registered in the OSGi registry.	32
<a href="#">ComponentRegistered</a>	The @ComponentRegistered can be used to observe ComponentEvent events whenever a component has been registered from the OSGi registry.	33
<a href="#">ComponentUnregistered</a>	The @ComponentUnregistered can be used to observe ComponentEvent events whenever a component has been unregistered from the OSGi registry.	34
<a href="#">Filter</a>	The @Filter annotation can be used to filter objects.	36
<a href="#">Service</a>	The @Service annotation can be used to annotate a CDI injection point and inform the CDI extender that the injection should be done by a service grabbed from the OSGi registry.	37
<a href="#">ServiceAdded</a>	The @ServiceAdded can be used to observe ServiceEvent events whenever a matching service injected via @Service is registered in the OSGi registry.	38
<a href="#">ServiceRemoved</a>	The @ServiceRemoved can be used to observe ServiceEvent events whenever a matching service injected via @Service is unregistered in the OSGi registry.	41

## Package org.osgi.service.cdi Description

CDI Integration Package Version 1.0.

Bundles wishing to use this package must list the package in the Import-Package header of the bundle's manifest. This package has two types of users: the consumers that use the API in this package and the providers that implement the API in this package.

Example import for consumers using the API in this package:

Import-Package: org.osgi.service.cdi; version="[1.0,2.0)"

Example import for providers implementing the API in this package:

Import-Package: org.osgi.service.cdi; version="[1.0,1.1)"



# Interface CdiContainer

[org.osgi.service.cdi](http://org.osgi.service.cdi)

```
public interface CdiContainer
```

A CdiContainer object is registered by the the cdi extender in the OSGi registry for each managed CDI bundle.

Method Summary		Page
BeanManager	<a href="#">getBeanManager</a> ()	25

## Method Detail

### getBeanManager

```
BeanManager getBeanManager ()
```

# Class CdiEvent

[org.osgi.service.cdi](#)

```
java.lang.Object
└─ org.osgi.service.cdi.CdiEvent
```

```
public class CdiEvent
extends Object
```

CdiEvent are sent by the cdi extender and received by registered CdiListener services.

See Also:  
[CdiListener](#)

Field Summary		Page
static int	<a href="#">CREATED</a>	26
static int	<a href="#">CREATING</a>	26
static int	<a href="#">DESTROYED</a>	27
static int	<a href="#">DESTROYING</a>	27
static int	<a href="#">FAILURE</a>	27

Constructor Summary		Page
<a href="#">CdiEvent</a> (int type, org.osgi.framework.Bundle bundle, org.osgi.framework.Bundle extenderBundle)		27
<a href="#">CdiEvent</a> (int type, org.osgi.framework.Bundle bundle, org.osgi.framework.Bundle extenderBundle, Throwable cause)		27
<a href="#">CdiEvent</a> ( <a href="#">CdiEvent</a> event, boolean replay)		27

Method Summary		Page
org.osgi.framework.Bundle	<a href="#">getBundle</a> ()	27
Throwable	<a href="#">getCause</a> ()	28
org.osgi.framework.Bundle	<a href="#">getExtenderBundle</a> ()	28
long	<a href="#">getTimestamp</a> ()	27
int	<a href="#">getType</a> ()	27
boolean	<a href="#">isReplay</a> ()	28

## Field Detail

### CREATING

```
public static final int CREATING = 1
```

### CREATED

```
public static final int CREATED = 2
```

## DESTROYING

```
public static final int DESTROYING = 3
```

---

## DESTROYED

```
public static final int DESTROYED = 4
```

---

## FAILURE

```
public static final int FAILURE = 5
```

## Constructor Detail

### CdiEvent

```
public CdiEvent(int type,  
                org.osgi.framework.Bundle bundle,  
                org.osgi.framework.Bundle extenderBundle)
```

---

### CdiEvent

```
public CdiEvent(int type,  
                org.osgi.framework.Bundle bundle,  
                org.osgi.framework.Bundle extenderBundle,  
                Throwable cause)
```

---

### CdiEvent

```
public CdiEvent(CdiEvent event,  
                boolean replay)
```

## Method Detail

### getType

```
public int getType()
```

---

### getTimestamp

```
public long getTimestamp()
```

---

### getBundle

```
public org.osgi.framework.Bundle getBundle()
```

---

## **getExtenderBundle**

```
public org.osgi.framework.Bundle getExtenderBundle()
```

---

## **getCause**

```
public Throwable getCause()
```

---

## **isReplay**

```
public boolean isReplay()
```

## Interface **CdiListener**

[org.osgi.service.cdi](http://org.osgi.service.cdi)

---

```
public interface CdiListener
```

A CdiListener object can be registered in the OSGi registry. The cdi extender will call each listener whenever an event happens.

### See Also:

[CdiEvent](#)

---

### Method Summary

		<i>Page</i>
void	<a href="#">cdiEvent</a> ( <a href="#">CdiEvent</a> event)	29

### Method Detail

#### **cdiEvent**

```
void cdiEvent(CdiEvent event)
```

# Annotation Type Component

[org.osgi.service.cdi](http://org.osgi.service.cdi)

```
@Qualifier
@Target (value={
    ElementType.FIELD,
    ElementType.TYPE,
    ElementType.PARAMETER,
    ElementType.CONSTRUCTOR
})
@Retention (value=RetentionPolicy.RUNTIME)
@Documented
public @interface Component
```

The @Component annotation exposes a CDI bean in the OSGi registry.

Required Element Summary		Page
Class<?>[]	<a href="#">interfaces</a>	30
<a href="#">ComponentProperty</a> []	<a href="#">properties</a>	30
String	<a href="#">requireConfiguration</a>	30

## Element Detail

### interfaces

```
public abstract Class<?>[] interfaces
```

```
Default:
    {}
```

### properties

```
public abstract ComponentProperty[] properties
```

```
Default:
    {}
```

### requireConfiguration

```
public abstract String requireConfiguration
```

```
Default:
    ""
```

# Class ComponentEvent

[org.osgi.service.cdi](#)

```
java.lang.Object
└─ org.osgi.service.cdi.ComponentEvent
```

```
public class ComponentEvent
extends Object
```

CDI Event sent by the CDI extender whenever a component has been registered or unregistered to/from the OSGi registry.

**See Also:**  
[ComponentRegistered](#), [ComponentUnregistered](#), [javax.enterprise.event.Observes](#)

Constructor Summary	Page
<a href="#">ComponentEvent</a> (org.osgi.framework.ServiceRegistration< <a href="#">T</a> > registration, <a href="#">T</a> service)	31

Method Summary	Page
org.osgi.framework.ServiceRegistration< <a href="#">T</a> > <a href="#">getRegistration</a> ()	31
<a href="#">T</a> <a href="#">getService</a> ()	31

## Constructor Detail

### ComponentEvent

```
public ComponentEvent (org.osgi.framework.ServiceRegistration<T> registration,  
                       T service)
```

## Method Detail

### getRegistration

```
public org.osgi.framework.ServiceRegistration<T> getRegistration ()
```

### getService

```
public T getService ()
```

# Annotation Type ComponentProperty

[org.osgi.service.cdi](http://org.osgi.service.cdi)

```
@Retention(value=RetentionPolicy.RUNTIME)
public @interface ComponentProperty
```

Annotation used to define a property that will be associated to Component registered in the OSGi registry.

Required Element Summary		Page
String	<a href="#">key</a>	32
String	<a href="#">value</a>	32

## Element Detail

### key

```
public abstract String key
```

### value

```
public abstract String value
```



## Annotation Type **ComponentRegistered**

[org.osgi.service.cdi](http://org.osgi.service.cdi)

---

```
@Target(value=ElementType.PARAMETER)
@Retention(value=RetentionPolicy.RUNTIME)
@Documented
public @interface ComponentRegistered
```

The `@ComponentRegistered` can be used to observe `ComponentEvent` events whenever a component has been registered from the OSGi registry.

**See Also:**

[ComponentEvent](#), `javax.enterprise.event.Observes`

## Annotation Type **ComponentUnregistered**

[org.osgi.service.cdi](http://org.osgi.service.cdi)

---

```
@Target(value=ElementType.PARAMETER)
@Retention(value=RetentionPolicy.RUNTIME)
@Documented
public @interface ComponentUnregistered
```

The `@ComponentUnregistered` can be used to observe `ComponentEvent` events whenever a component has been unregistered from the OSGi registry.

**See Also:**

[ComponentEvent](#), `javax.enterprise.event.Observes`

# Class Constants

[org.osgi.service.cdi](#)

```
java.lang.Object
└─ org.osgi.service.cdi.Constants
```

```
final public class Constants
extends Object
```

Defines CDI constants

Field Summary		Page
static String	<a href="#">CDI_EXTENDER</a> Opt-in manifest header, starting a CDI container	35
static String	<a href="#">CDI_EXTENSION_CAPABILITY</a>	35
static String	<a href="#">EXTENDER_CAPABILITY</a>	35

## Field Detail

### CDI\_EXTENDER

```
public static final String CDI_EXTENDER = "osgi.cdi"

    Opt-in manifest header, starting a CDI container
```

### EXTENDER\_CAPABILITY

```
public static final String EXTENDER_CAPABILITY = "osgi.extender"
```

### CDI\_EXTENSION\_CAPABILITY

```
public static final String CDI_EXTENSION_CAPABILITY = "osgi.cdi.extension"
```

# Annotation Type Filter

[org.osgi.service.cdi](http://org.osgi.service.cdi)

```
@Target (value={
    ElementType.FIELD,
    ElementType.TYPE,
    ElementType.PARAMETER,
    ElementType.CONSTRUCTOR
})
@Retention (value=RetentionPolicy.RUNTIME)
@Documented
public @interface Filter
```

The @Filter annotation can be used to filter objects. It can be applied to @Service or @EventAdmin injection points.

**See Also:**  
[Service](#), EventAdmin

Required Element Summary		Page
String	<a href="#">value</a>	36

## Element Detail

### value

```
public abstract String value
```

**Default:**  
""

# Annotation Type Service

[org.osgi.service.cdi](http://org.osgi.service.cdi)

```
@Qualifier
@Target (value={
    ElementType.FIELD,
    ElementType.PARAMETER,
    ElementType.CONSTRUCTOR
})
@Retention (value=RetentionPolicy.RUNTIME)
@Documented
public @interface Service
```

The @Service annotation can be used to annotate a CDI injection point and inform the CDI extender that the injection should be done by a service grabbed from the OSGi registry.

See Also:

[Filter](#)

Required Element Summary		Page
boolean	<a href="#">required</a>	37
<a href="#">ServiceType</a>	<a href="#">type</a>	37

## Element Detail

### required

```
public abstract boolean required
```

Default:  
false

### type

```
public abstract ServiceType type
```

Default:  
[ServiceType.NullObject](#)

## Annotation Type ServiceAdded

[org.osgi.service.cdi](http://org.osgi.service.cdi)

---

```
@Target(value=ElementType.PARAMETER)
@Retention(value=RetentionPolicy.RUNTIME)
@Documented
public @interface ServiceAdded
```

The `@ServiceAdded` can be used to observe `ServiceEvent` events whenever a matching service injected via `@Service` is registered in the OSGi registry.

**See Also:**

[ServiceEvent](#), `javax.enterprise.event.Observes`

# Class ServiceEvent

[org.osgi.service.cdi](#)

```
java.lang.Object
└─ org.osgi.service.cdi.ServiceEvent
```

```
public class ServiceEvent
extends Object
```

The event sent by the CDI extender whenever a service that matches an injection point is registered or unregistered from the OSGi registry.

**See Also:**  
[ServiceAdded](#), [ServiceRemoved](#), [javax.enterprise.event.Observes](#)

Constructor Summary	Page
<a href="#">ServiceEvent</a> (org.osgi.framework.ServiceReference< <a href="#">T</a> > reference, <a href="#">T</a> service)	39

Method Summary	Page
org.osgi.framework.ServiceReference< <a href="#">T</a> > <a href="#">getReference</a> ()	39
<a href="#">T</a> <a href="#">getService</a> ()	39

## Constructor Detail

### ServiceEvent

```
public ServiceEvent(org.osgi.framework.ServiceReference<T> reference,
                    T service)
```

## Method Detail

### getReference

```
public org.osgi.framework.ServiceReference<T> getReference()
```

### getService

```
public T getService()
```

Class **ServiceNotAvailableException**

[org.osgi.service.cdi](#)

```
java.lang.Object
└─ java.lang.Throwable
    └─ java.lang.Exception
        └─ java.lang.RuntimeException
            └─ org.osgi.service.cdi.ServiceNotAvailableException
```

**All Implemented Interfaces:**  
Serializable

---

```
public class ServiceNotAvailableException
extends RuntimeException
```

Exception that can be thrown from the injected Service if a matching service is not available.

---

Constructor Summary	Page
<a href="#">ServiceNotAvailableException</a> (String message)	40

Constructor Detail

**ServiceNotAvailableException**

```
public ServiceNotAvailableException(String message)
```



## Annotation Type **ServiceRemoved**

[org.osgi.service.cdi](http://org.osgi.service.cdi)

---

```
@Target(value=ElementType.PARAMETER)
@Retention(value=RetentionPolicy.RUNTIME)
@Documented
public @interface ServiceRemoved
```

The `@ServiceRemoved` can be used to observe `ServiceEvent` events whenever a matching service injected via `@Service` is unregistered in the OSGi registry.

**See Also:**

[ServiceEvent](#), `javax.enterprise.event.Observes`

# Enum **ServiceType**

[org.osgi.service.cdi](#)

```
java.lang.Object
└─ java.lang.Enum<ServiceType>
    └─ org.osgi.service.cdi.ServiceType
```

**All Implemented Interfaces:**  
Comparable<[ServiceType](#)>, Serializable

```
public enum ServiceType
extends Enum<ServiceType>
```

Defines the type of service injected.

Enum Constant Summary	Pag e
<a href="#">NullObject</a> A dummy proxy that simply returns <code>null</code> when a matching OSGi service is not available.	42

Method Summary	Pag e
static <a href="#">ServiceType</a> <a href="#">valueOf</a> (String name)	42
static <a href="#">ServiceType</a> <a href="#">values</a> ()	42

## Enum Constant Detail

### NullObject

```
public static final ServiceType NullObject
```

A dummy proxy that simply returns `null` when a matching OSGi service is not available.

## Method Detail

### values

```
public static ServiceType[] values()
```

### valueOf

```
public static ServiceType valueOf(String name)
```

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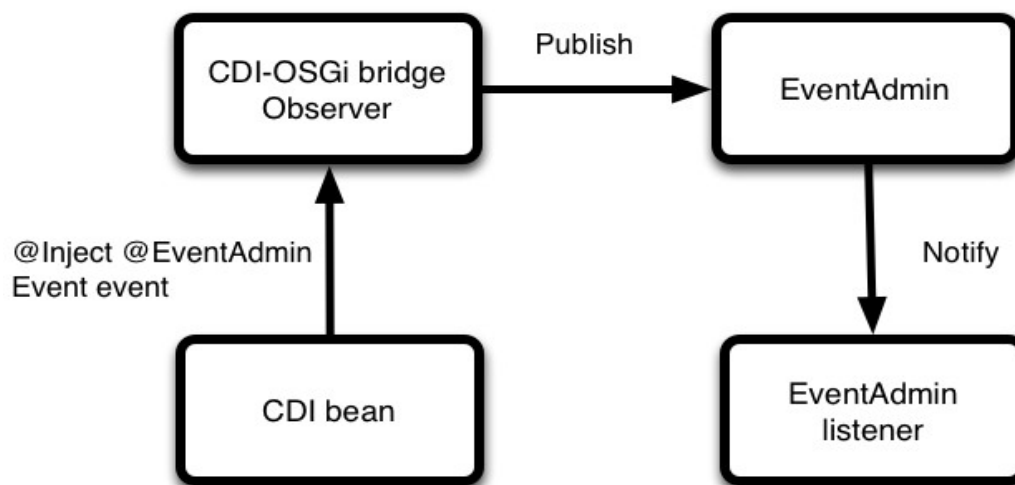
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## 8 Considered Alternatives

### 8.1 EventAdmin integration

This section has moved into the Considered Alternatives chapter as it's postponed to a later release.

#### Send EventAdmin event using CDI events



EventAdmin and CDI events are conceptually similar. The CDI programming model is much more user-friendly however. EventAdmin events can both be produced and observed using CDI annotations. Because not every event should be published to EventAdmin the developer has to use the `@EventAdmin` annotation. The value of this annotation should also contain the name of the *Topic*, or alternatively you can define your own qualifier that extends `@EventAdmin` to define the Topic.

The following is an example of using the `@EventAdmin` qualifier.

```

@Inject @EventAdmin("MyTopic") Event<MyEvent> event;

public void send() {
    event.fire(new MyEvent("example"));
}
  
```

The following is an example of extending the EventAdmin qualifier.

```

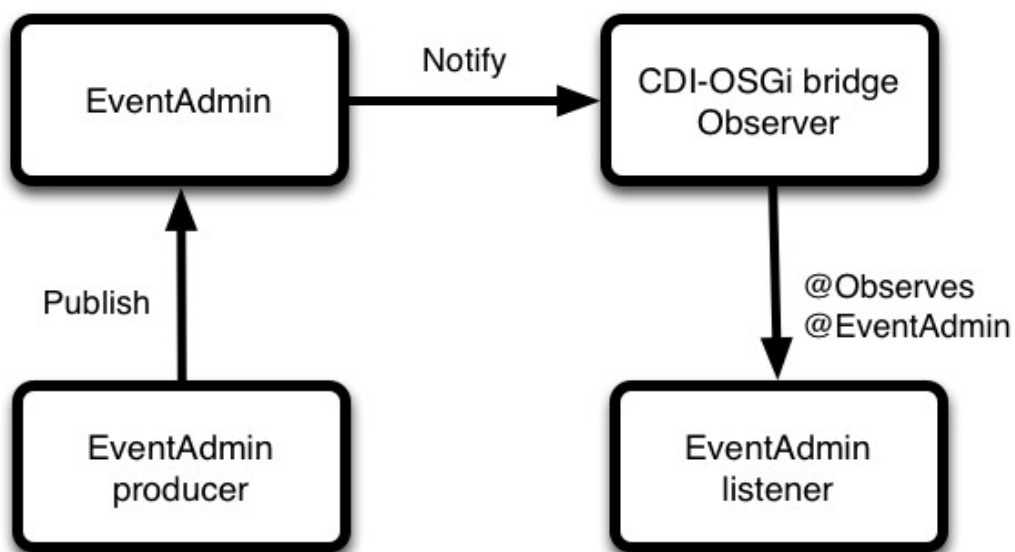
@EventAdmin
public @interface Demo {
    String value();
}

@Inject @Demo Event<MyEvent> event;
  
```

```
public void send() {  
    event.fire(new MyEvent("example"));  
}
```

The CDI-OSGi bridge observes `@EventAdmin` events and republish them as EventAdmin events.

### Listener to EventAdmin events using CDI observers



EventAdmin events can be observed using the CDI `@Observes` annotation. Similar to publishing EventAdmin events we need the `@EventAdmin` qualifier to specify the Topic name.

```
public class EventExample {  
  
    public void process(@Observes @EventAdmin("MyTopic") MyEvent event) {}  
  
}
```

Alternatively, similar with publishing events, a qualifier can be used to define the topic name.

`@EventAdmin`

```
public @interface Demo {  
  
    String value();  
  
}
```

```
public class EventExample {
```

```
public void process(@Observes @Demo MyEvent event) {}  
}
```

---

## 9 Security Considerations

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*Description of all known vulnerabilities this may either introduce or address as well as scenarios of how the weaknesses could be circumvented.*

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## 10 Document Support

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### 10.1 References

- [1]. Bradner, S., Key words for use in RFCs to Indicate Requirement Levels, RFC2119, March 1997.
- [2]. Software Requirements & Specifications. Michael Jackson. ISBN 0-201-87712-0

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### 10.2 Author's Address

Name	
Company	
Address	
Voice	
e-mail	

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### 10.3 Acronyms and Abbreviations

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### 10.4 End of Document