# OSGi

## Dynamisches Komponenten Modell

https://docs.osgi.org/specification/osgi.core/7.0.0/

# OSGi Agenda

1. Einführung, Geschichte
2. Bundle
3. Bundle MANIFEST.MF (Bundle-Header)
4. Bundle Version
5. Bundle Class Loading (Demo + Übung)
6. Bundle State/Lifecycle (Demo + Übung)
7. Service (Demo + Übung)
8. ServiceTracker (Demo + Übung)
9. Declarative Service (Demo + Übung)
10. Configuration Admin (Demo + Übung)
11. Wie geht's weiter?

## Was nicht?

- Kein Eclipse RCP
- Kein Maven Tycho
- Kein Maven Bnd
- Kein Bnd deep dive

https://docs.osgi.org/specification/osgi.core/7.0.0/

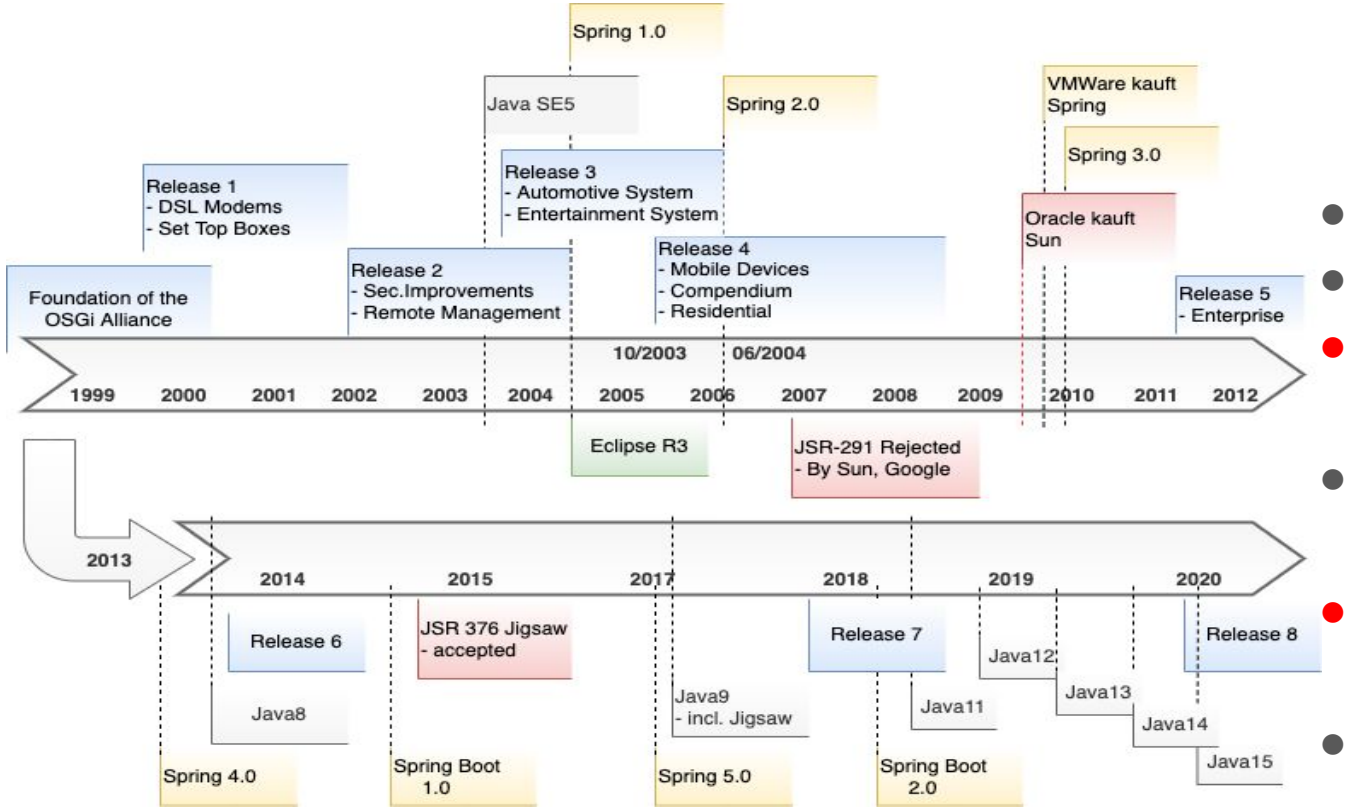
# Jan Winter

- 45 Jahre, wohnt in Leipzig
- Seit ca. 20 Jahren Software Entwickler
  - Freiberuflich während des Studiums
  - 5 Jahre in einem Startup
  - 7 Jahre als Berater bei Itemis AG (3 Jahre bei Qivicon ~ Eclipse-Smarthome/Openhub)
  - Seit 3 Jahren Freiberufler
- Seit ca. 15 Jahren OSGi Entwickler
- Seit ca. 10 Jahren Trainer (Nebentätigkeit)
  - Git, Gitlab CI, Bitbucket CI
  - Kubernetes/Docker, GitOps/FluxCD
  - OSGi

# OSGi vs. JEE vs Spring

| | OSGi | J2EE/JEE | Spring |
|---|---|---|---|
| **Spezifikation/ Framework** | Spezifikation | Spezifikation | Framework |
| **Classpath** | Hierarchisch, Dynamisch | Hierarchisch, Dynamisch | Klassisch, Statisch |
| **Services/CDI** | Dynamisch | Dynamisch | Statisch |
| **Einstiegshürde** | Hoch | Hoch | Niedrig |
| **Organisation** | Alliance/NGO | Sun/Oracle | VMWare |
| **Implementierungen** | Apache Felix/Equinox | Wildfly/Glassfish | Spring/-Boot |

# OSGi Geschichte




- 1999 Founded
- 2004 Eclipse R3
- 2007 JSR-291 rejected
- 2009 Oracle kauft Sun
- 2014 JSR-376 Jigsaw accepted
- 2017 Java 9

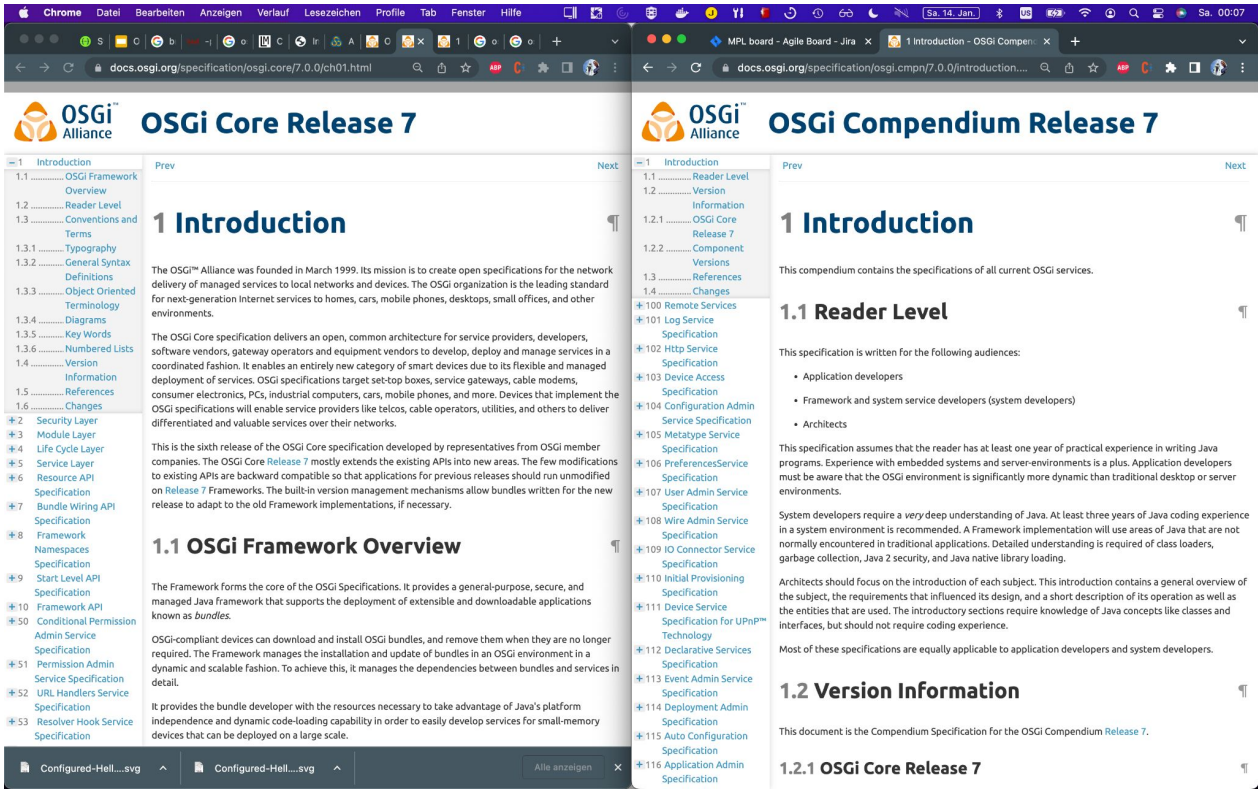
# OSGi - Spec

Core Spec - Basis

- Bundle
- Bundle Lifecycle
- Start level
- Service
- Security
- …

Compendium

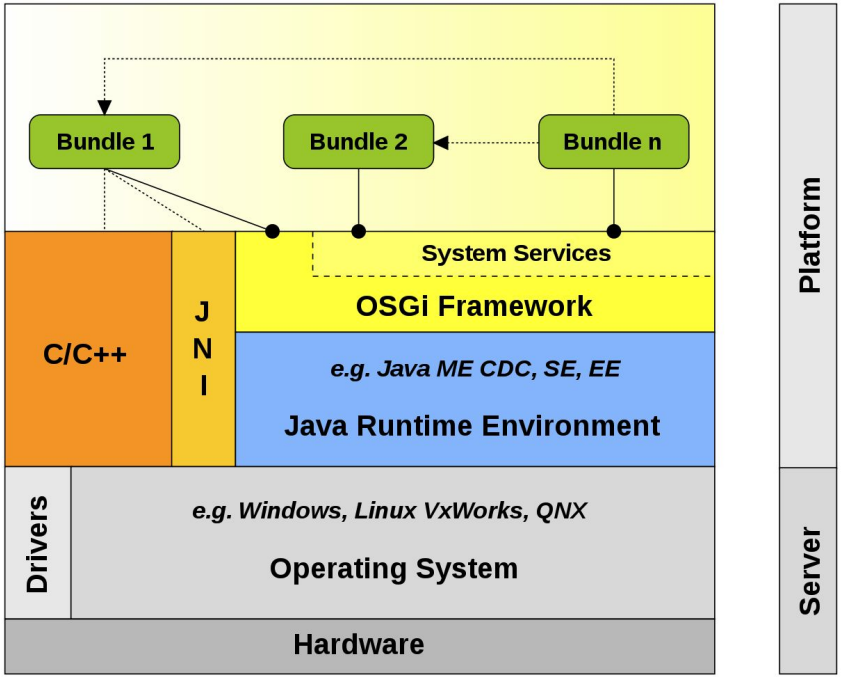
- Declarative Service
- Configuration Admin
- Http Service Spec
- Http Whiteboard
- …




https://docs.osgi.org/specification/#release-7

# OSGi Bundle

- **Bundle** ~ Module/JAR
- **Bundle** ~ Package Provider
- **Package** ~ API/Service/Component Provider
- **API** ~ Interface
- **Service** ~ API Instance
- **Component** ~ Class Instance
- **Version**ierbare Bundle, Package, API, Service



# Bundle - META-INF/MANIFEST.MF

**Bundle-SymbolicName: com.acme.daffy**

**Bundle-Version: 1.1**

**Export-Package: com.acme.daffy.tracker**

**Import-Package: org.osgi.util.tracker;version=1.4**

**DynamicImport-Package: com.acme.plugin.***

**Require-Bundle: com.acme.chess,com.acme.chess.2**

**Bundle-ClassPath: /provided-lib.jar,.**

**Fragment-Host: org.eclipse.swt**

**Bundle-Activator: com.acme.fw.Activator**

**Bundle-RequiredExecutionEnvironment: CDC-1.0/Foundation-1.0**

**Bundle-ContactAddress: Leipzig**

**Bundle-Copyright: OSGi (c) 2022**

**Bundle-Description: Network Firewall**

**Bundle-Developers: Jan Winter**

**Bundle-Icon: /icons/acme-logo.png;size=64**

**Bundle-DocURL: http://www.example.com/doc**

**Bundle-License: Apache-2.0**

**Bundle-ManifestVersion: 2**

**Bundle-Name: Firewall**

**Bundle-Vendor: OSGi Alliance**

https://docs.osgi.org/specification/osgi.core/7.0.0/framework.module.html#i2654895

# Bundle - META-INF/MANIFEST.MF (Sample)

**Manifest-Version:** 1.0

**Bundle-ManifestVersion:** 2

**Bundle-Name:** de.jwausle.osgi.api.consumer.v1

**Bundle-SymbolicName:** de.jwausle.osgi.api.consumer.v1

**Bundle-Version:** 1.0.0.202204241327

**Import-Package:** de.jwausle.osgi.api.provider;version="[1.0,2)"

**Export-Package:** de.jwausle.osgi.api.consumer.v1;version="1.0.0"

**Private-Package:** de.jwausle.osgi.api.consumer.v1.internal

**Require-Capability:** osgi.ee;filter:="(&(osgi.ee=JavaSE)(version=12))"

# Bundle - Version

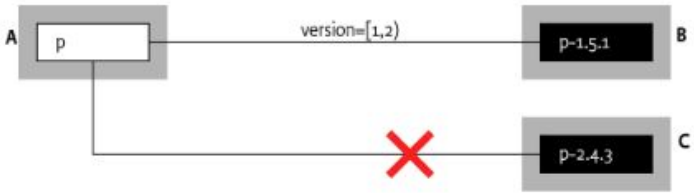
**1.5.1 ~ {major}.{minor}.{micro}.rest**

- **major** - Changes for an incompatible update for both a consumer and a provider of an API
- **minor** - Changes for a backward compatible update for a consumer but not for a provider.
- **micro** - A change that does not affect the API, for example, a typo in a comment or a bug fix in an implementation.

```
A: Import-Package: p; version="[1,2)"
B: Export-Package: p; version=1.5.1
```

Figure 3.9 graphically shows how a constraint can exclude an exporter.

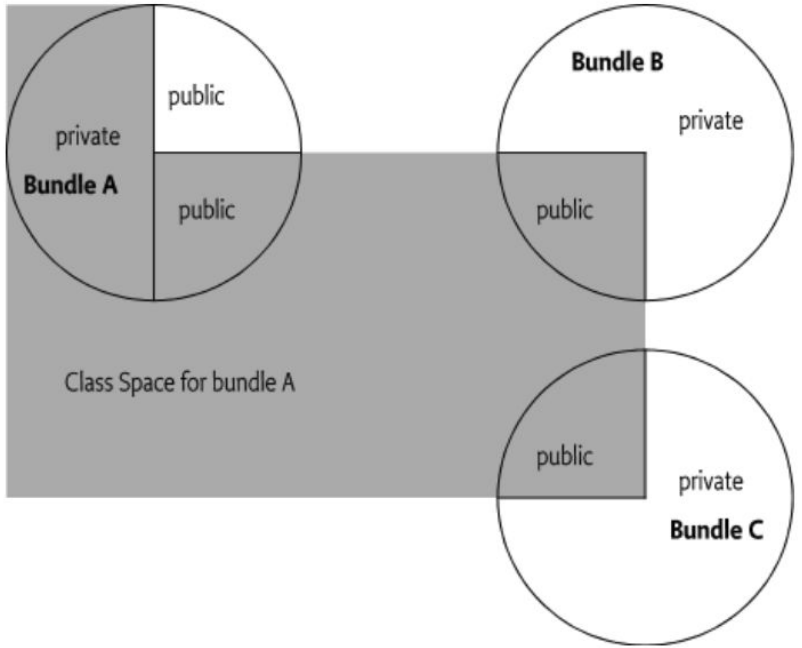
***Figure 3.9 Version Constrained***




https://docs.osgi.org/specification/osgi.core/7.0.0/framework.module.html#d0e3894

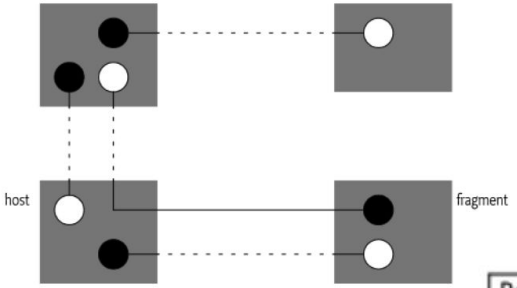
# Bundles - Class Loading Architecture

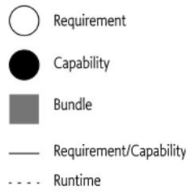
- *Boot class path* - The boot class path contains the java.* packages and its implementation packages.
- *Framework class path* - The Framework usually has a separate class loader for the Framework implementation classes as well as key service interface classes.
- *Bundle Space* - The bundle space consists of the JAR file that is associated with the bundle, plus any additional JAR that are closely tied to the bundle, like *fragments*



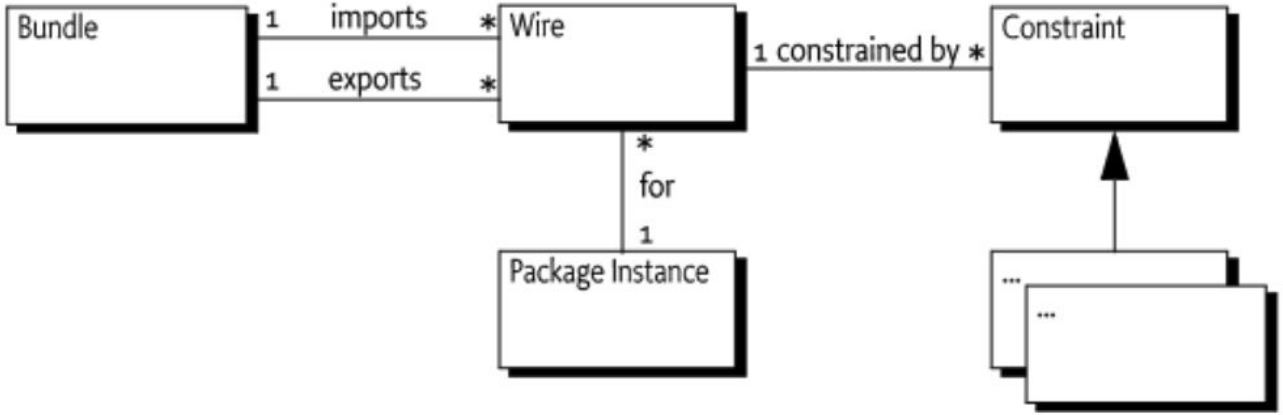

https://docs.osgi.org/specification/osgi.core/7.0.0/framework.module.html#i3174728

# Bundle - Resolving




osgi.wiring.package

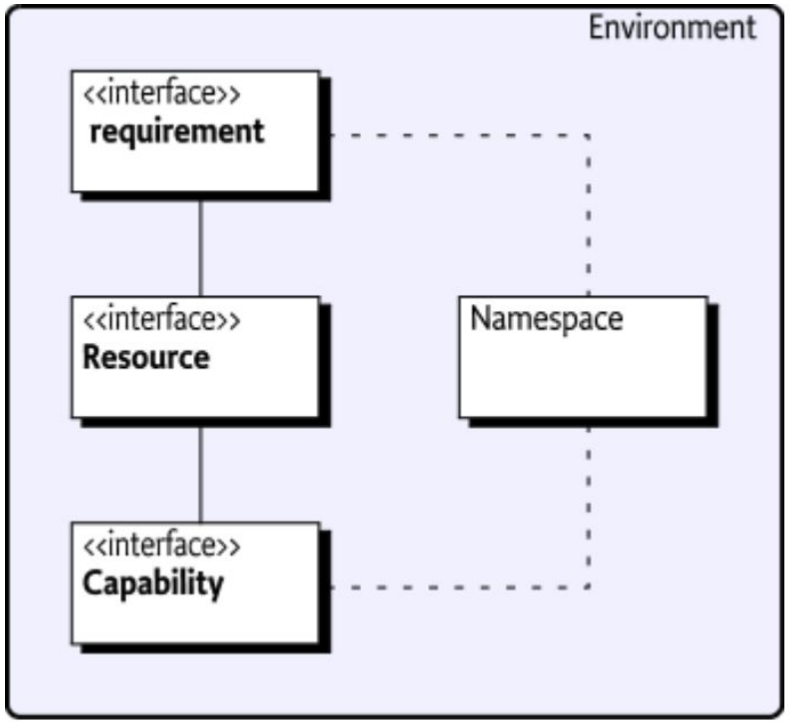


# Example - Classpath

de.jwausle.osgi.classpath

# Dependencies - Requirement/Capability model

- *Resource* - An abstraction for an artifact that needs to become installed in some way to provide its intended function. A Bundle is modeled by a Resource but for example a display or secure USB key store can also be Resources.
- *Namespace* - Defines what it means for the Environment when a requirement and capability match in a given Namespace.
- *Capability* - Describing a feature or function of the Resource when installed in the Environment. A capability has attributes and directives.
- *Requirement* - An assertion on the availability of a capability in the Environment. A requirement has attributes and directives. The filter directive contains the filter to assert the attributes of the capability in the same Namespace.




https://docs.osgi.org/specification/osgi.core/7.0.0/framework.module.html#framework.module.dependencies

# Framework - Requirement/Capability

- **osgi.ee** Namespace (Bundle-RequiredExecutionEnvironment)
- **osgi.wiring.package** Namespace (Import-Package, Export-Package)
- **osgi.wiring.bundle** Namespace (Required-Bundle)
- **osgi.wiring.host** Namespace (Fragment-Host)
- **osgi.identity** Namespace (Bundle-SymbolicName, Bundle-Version)
- **osgi.native** Namespace

https://docs.osgi.org/specification/osgi.core/7.0.0/framework.namespaces.html

# Example - Optional/Dynamic

de.jwausle.osgi.example01,
de.jwausle.osgi.optional,
de.jwausle.osgi.dynamic

# Example - FragmentHost

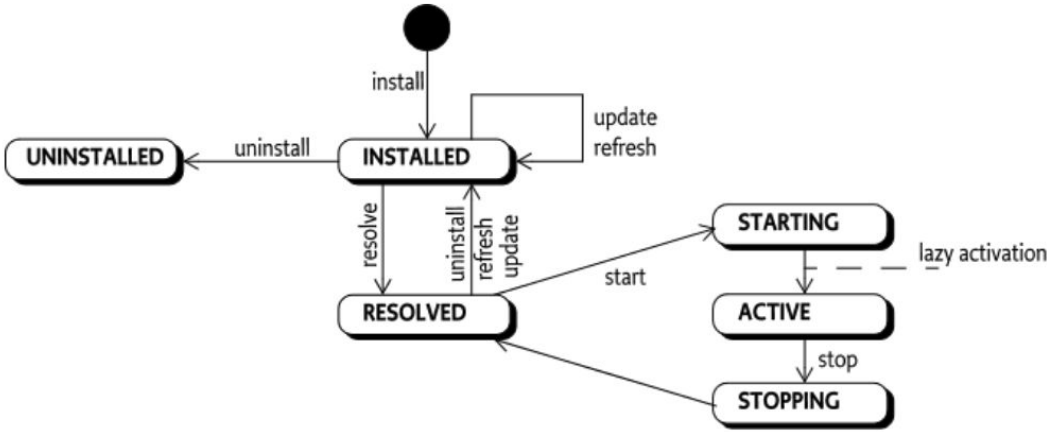
de.jwausle.osgi.fragmentHost,
de.jwausle.osgi.fragmentBundle

# Example - Packages

consumer.v2
consumer.v2 with provider.v2
fragmentHost

# Bundle - State

- INSTALLED - The bundle has been successfully installed.
- RESOLVED - All Java classes that the bundle needs are available. This state indicates that the bundle is either ready to be started or has stopped.
- STARTING - The bundle is being started, the BundleActivator.start method will be called
- ACTIVE - The bundle has been successfully activated and is running
- STOPPING - The bundle is being stopped
- UNINSTALLED - The bundle has been uninstalled. It cannot move into another state.

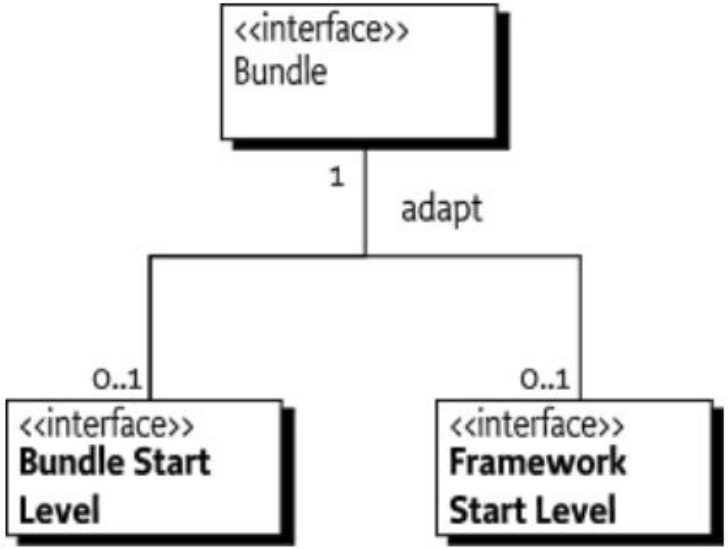



https://docs.osgi.org/specification/osgi.core/7.0.0/framework.lifecycle.html#d0e9143

# Bundle - StartLevel

- *BundleStartLevel* - Used to get and set the start level on a specific bundle
- *FrameworkStartLevel* - Used to get and control the framework start level.

- The Framework has an active start level that is used to decide which bundles can be started
- All bundles must be assigned a bundle start level
- When a bundle is installed, it is initially assigned the bundle start level



# Example - StartLevel

consumer.v1

https://bnd.bndtools.org/chapters/300-launching.html

# Bundle - API

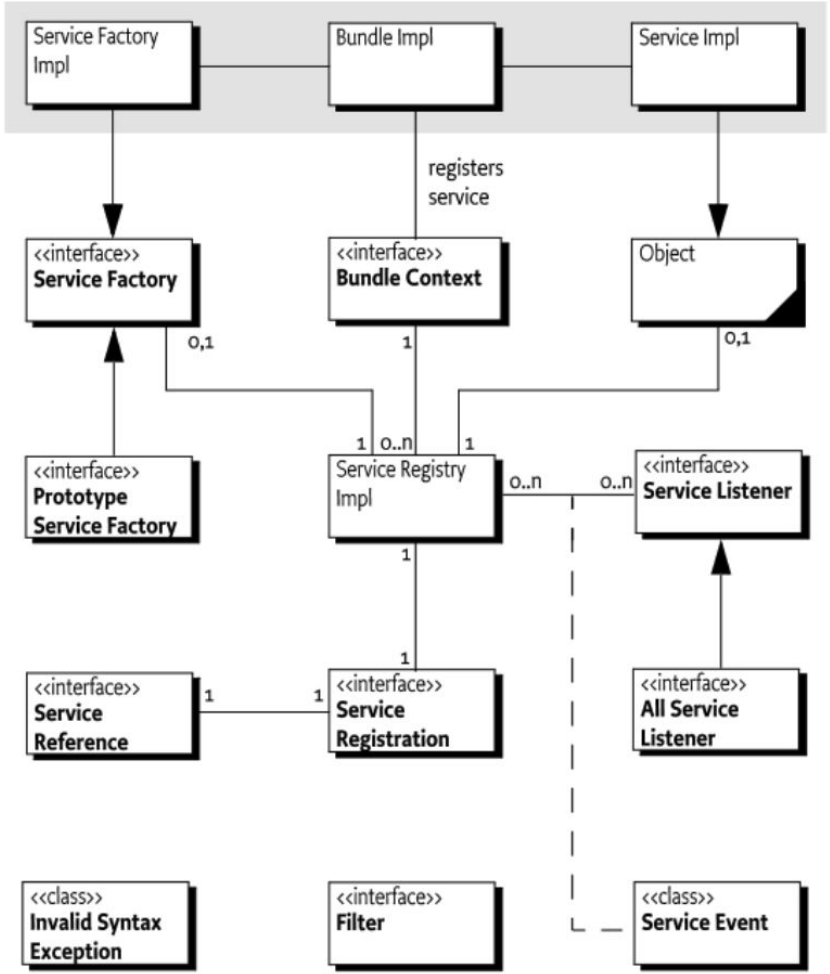
| | |
|---|---|
| METADATA | Bundle.getHeaders<br>Bundle.getLocation |
| RESOURCE | Bundle.getResource<br>Bundle.getResources<br>Bundle.getEntry<br>Bundle.getEntryPaths<br>Bundle.findEntries<br>Bundle resource/entry URL creation |
| CLASS | Bundle.loadClass |
| LIFECYCLE | BundleContext.installBundle<br>Bundle.update<br>Bundle.uninstall |
| EXECUTE | Bundle.start<br>Bundle.stop<br>BundleStartLevel.setBundleStartLevel |
| LISTENER | BundleContext.addBundleListener for SynchronousBundleListener<br>BundleContext.removeBundleListener for SynchronousBundleListener |
| EXTENSIONLIFECYLE | BundleContext.installBundle for extension bundles<br>Bundle.update for extension bundles<br>Bundle.uninstall for extension bundles |
| RESOLVE | FrameworkWiring.refreshBundles<br>FrameworkWiring.resolveBundles |
| STARTLEVEL | FrameworkStartLevel.setStartLevel<br>FrameworkStartLevel.setInitialBundleStartLevel |
| CONTEXT | Bundle.getBundleContext |
| WEAVE | WovenClass.setBytes<br>WovenClass.getDynamicImports |

https://docs.osgi.org/specification/osgi.core/7.0.0/framework.lifecycle.html#framework.lifecycle.adminpermission

# OSGi Services

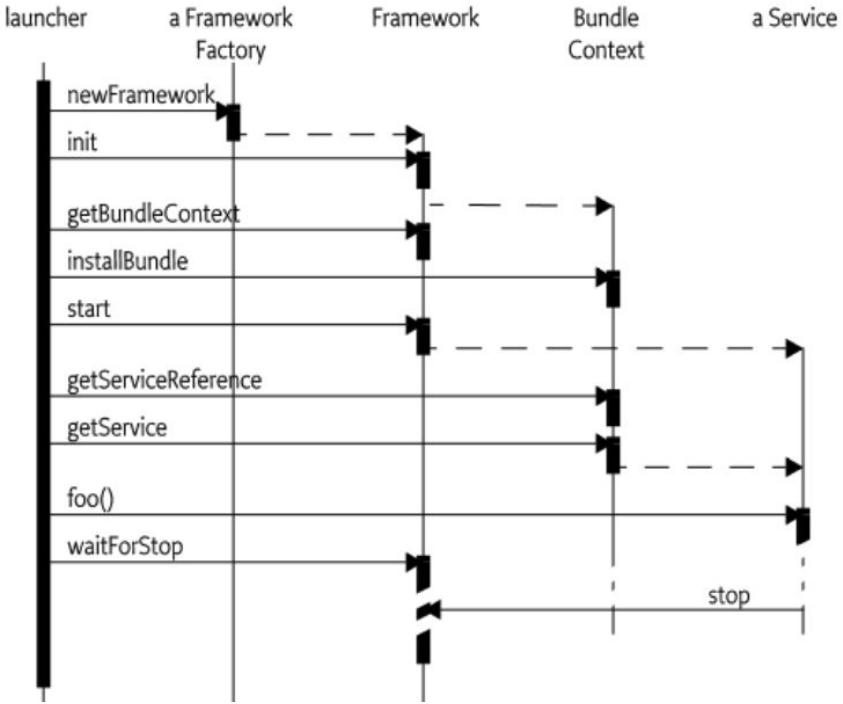
# Services

- *Service* - An object registered with the service registry under one or more interfaces together with properties. The service can be discovered and used by bundles.
- *Service Registry* - Holds the service registrations.
- *Service Reference* - A reference to a service. Provides access to the service's properties but not the actual service object. The service object must be acquired through a bundle's Bundle Context.
- *Service Registration* - The receipt provided when a service is registered. The service registration allows the update of the service properties and the unregistration of the service.




https://docs.osgi.org/specification/osgi.core/7.0.0/framework.service.html#d0e11540

# Service Registration




1. Bundle register Service
2. Bundle register Service over the bundleContext
3. Service reference is the key for Service instance
4. BundleContext get Service instance by Service reference
5. When Service instance exist

# Service Properties

| Property Key | Type | Constants | Property Description |
|---|---|---|---|
| `objectClass`† | `String[]` | OBJECTCLASS | The `objectClass` property contains the set of interface names under which a service object is registered with the Framework. The Framework must set this property automatically. The Framework must guarantee that when a service object is retrieved with getService(ServiceReference), it can be cast to any of the interface names. |
| `service.bundleid`† | `Long` | SERVICE_BUNDLEID | The `service.bundleid` property identifies the bundle registering the service. The Framework must set this property automatically with the value of the bundle id of the registering bundle. |
| `service.description` | `String` | SERVICE_DESCRIPTION | The `service.description` property is intended to be used as documentation and is optional. Frameworks and bundles can use this property to provide a short description of a registered service object. The purpose is mainly for debugging because there is no support for localization. |
| `service.id`† | `Long` | SERVICE_ID | Every registered service object is assigned a unique, non-negative `service.id` by the Framework. This number is added to the service's properties. The Framework assigns a unique, non-negative value to every registered service object that is larger than values provided to all previously registered service objects. |
| `service.pid` | `String+` | SERVICE_PID | The `service.pid` property optionally identifies a persistent, unique identifier for the service object. See Persistent Identifier (PID). |
| `service.scope`† | `String` | SERVICE_SCOPE | The `service.scope` property identifies the service's scope. The Framework must set this property automatically. If the registered service object implements PrototypeServiceFactory, then the value will be prototype. Otherwise, if the registered service object implements ServiceFactory, then the value will be bundle. Otherwise, the value will be singleton. See Service Scope. |
| `service.ranking` | `Integer` | SERVICE_RANKING | See Service Ranking Order. |
| `service.vendor` | `String` | SERVICE_VENDOR | This optional property can be used by the bundle registering the service object to indicate the vendor. |

https://docs.osgi.org/specification/osgi.core/7.0.0/framework.service.html#framework.service.serviceproperties

# Example - ServiceReference

SimpleBundle-logging

# Service - Tracker

```
public class HelloWorldActivator implements BundleActivator {
   private ServiceTracker<LogService, LogService> logServiceTracker;
   private HelloWorld helloWorld;
   @Override
   public void start(BundleContext context) throws Exception {
      if (logServiceTracker == null) {
         logServiceTracker = new ServiceTracker<LogService, LogService>(context, LogService.class, null) {
            @Override
            public LogService addingService(ServiceReference<LogService> reference) {
               LogService result = context.getService(reference); // super.addingService(reference)
               helloWorld = new HelloWorld(result);
               System.out.println("Hello World started.");
               return result;
            }
            @Override
            public void removedService(ServiceReference<LogService> reference, LogService service) {
               super.removedService(reference, service);
               helloWorld = null;
               System.out.println("Hello World stopped.");
            }
         };
      }
      logServiceTracker.open();
   }
```

1. ServiceTracker init
2. ServiceTracker open
3. ServiceTracker get informed when Service instance created
4. ServiceTracker get informed when Service instance destroyed

https://docs.osgi.org/specification/osgi.core/7.0.0/util.tracker.html

# Example - Service Tracker

SimpleBundle-logging2

# Apache Felix Dependency Manager

- Library to simplify to service declaration and registration
- Alternative to Declarative Service (DS)
- Plus Declarative Service Builder

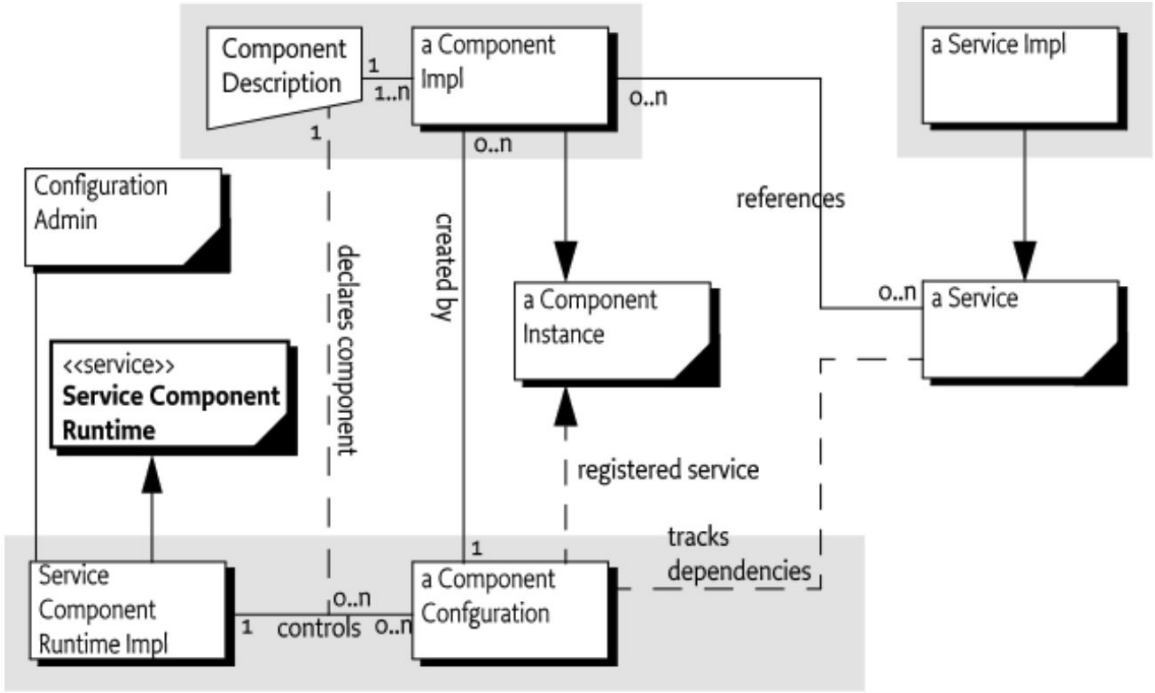
https://felix.apache.org/documentation/subprojects/apache-felix-dependency-manager.html

# Example - DM

SimpleBundle-DM,
SimpleBundle-DM2

# Declarative Services

- Declarative Service Registration Config
- To publishing, finding and binding OSGi Service
- Init and process all ServiceTracker
- Reflect Service instance when all depend Service References fulfilled

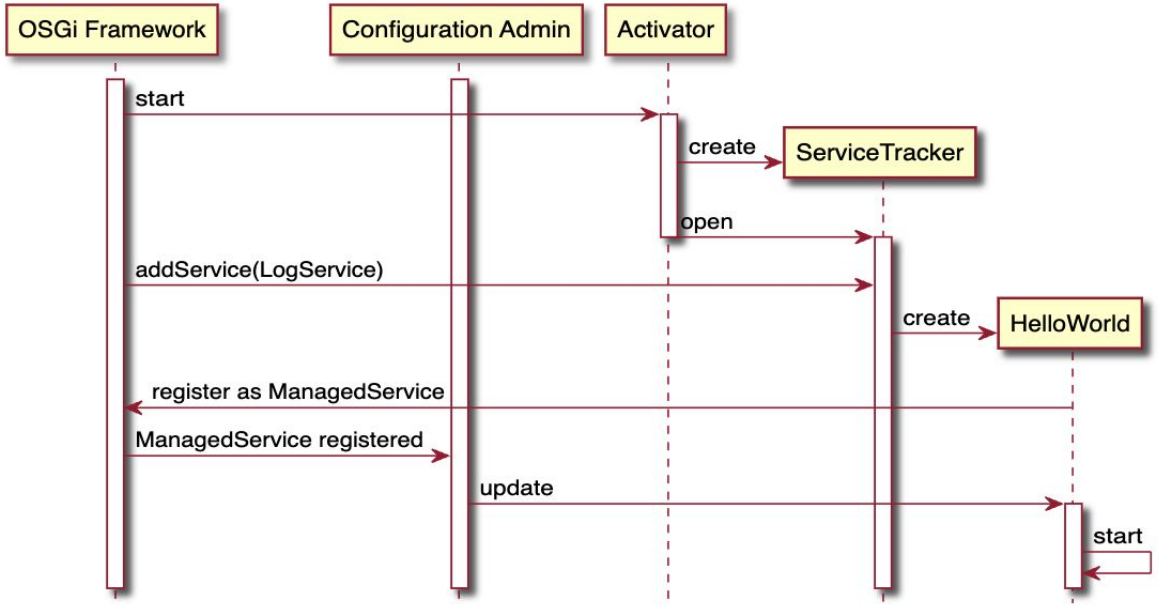



https://docs.osgi.org/specification/osgi.cmpn/7.0.0/service.component.html

# Example - DS

SimpleBundle-DS0 (XML)
SimpleBundle-DS (@)

# Configuration Admin

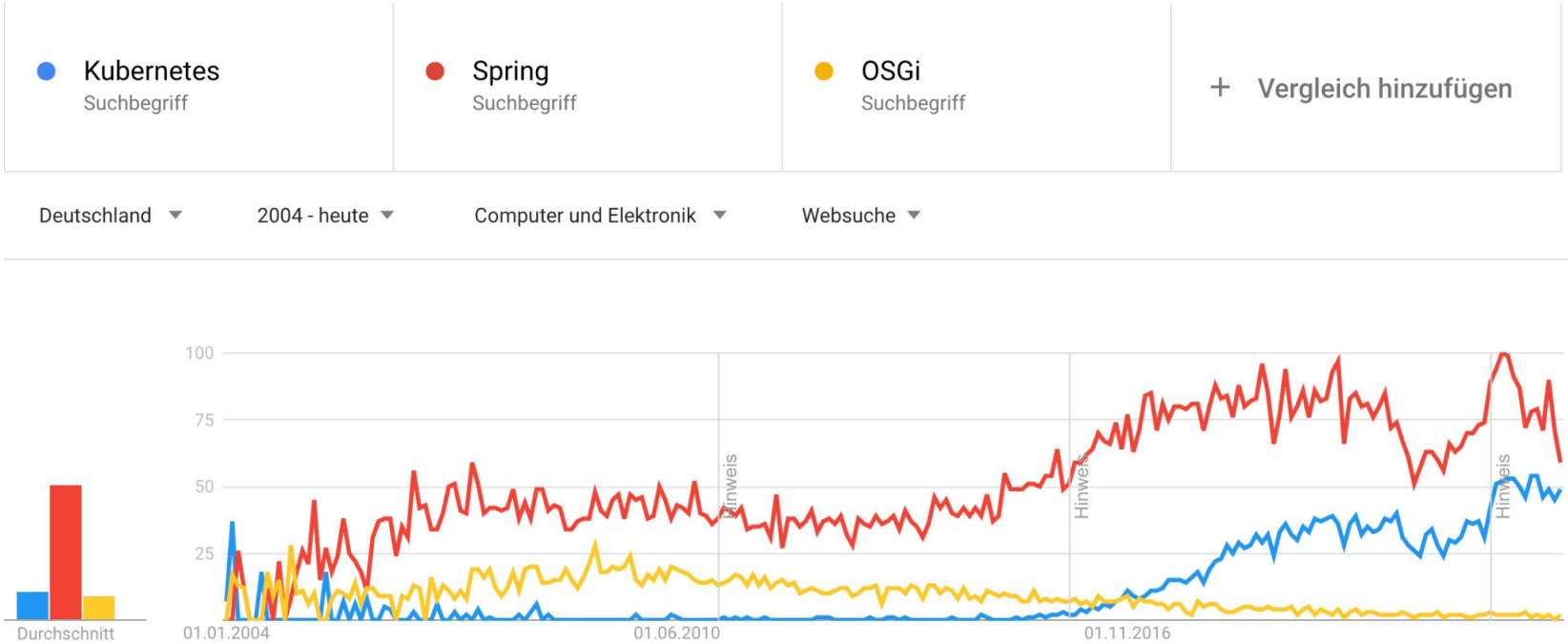



https://docs.osgi.org/specification/osgi.cmpn/7.0.0/service.cm.html#service.cm

# Example ConfigAdmin

logging-admin (LogLevel)
logging-admin2 (HelloWorld)

# OSGi vs Spring vs Kubernetes




https://trends.google.de/trends/explore?cat=5&date=all&geo=DE&q=OSGi,Kubernetes,Spring

# OSGi Links

https://docs.osgi.org/specification/

https://bnd.bndtools.org/

https://bndtools.org/

winter@jwausle.de