RFC 224: Resolver Service Updates

Draft

25 Pages

Abstract

Updates to the Resolver Service for Release 7.

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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/.

0.4 Table of Contents

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.
```

0.6 Revision History

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

Revision	Date	Comments
Initial	04/29/16	Initial Draft Thomas Watson, IBM
2nd draft	05/10/16	Updates from CPEG call • Improve words for requirements • Update description of findRelatedResources to include callbacks for the related resources • Change the name of the dynamic resolution method to resolveDynamic • Clarify that the resolver implementation is not required to validate the candidates, the dynamic requirement or the host wiring. Bad input will result in unspecified behavior. • Replaced isCancelled method with an onCancel method to allow a callback to be registered

Revision	Date	Comments
3rd draft	05/24/16	Updates from CPEG call • Specify that onCancel is called before any other method on ResolveContext for a resolve operation. • Specify the cause of the ResolutionException to be java.util.concurrent.CancellationException when the resolve operation has been canceled. • Removed requirements that the resolver validate matching candidates

1 Introduction

This RFC collects a numbers of requested enhancements to the Resolver Service that were suggested after Release 6 design work was completed.

2 Application Domain

The Resolver Service was first released as part of Release 5. From the Version 1.0 spec:

> Resolving transitive dependencies is a non-trivial process that requires careful design to achieve the required performance since the underlying problem is NP-complete. OSGi frameworks have always included such resolvers but these were built into the frameworks. They were not usable outside the framework for tooling, for example automatically finding the dependencies of a bundle that needs to be installed.

The Resolver Service provides the base for provisioning, build and diagnostic toolings. The Resolver service could also be used by a Framework implementation for resolving bundles at runtime, but the 1.0 version of the Resolver service did not focus on this use case. As a result the specification is lacking some basic runtime functionality needed in order to implement the Core Framework specification.

The Equinox and Felix Core Framework implementations both provide the Resolver Service implementation and use the Resolver implementation internally to resolve bundles at runtime. In both cases some additional implementation specific functionality was added to allow the resolver to be used for runtime bundle resolution.

3 Problem Description

3.1 Resolve Related Resources

When resolving bundles at runtime Framework implementations have several different approaches they can take to resolving the set of installed bundles. Below are the approaches taken by the Equinox and Felix Framework implementations

3.1.1 Resolve All Bundles At Once

With this approach the framework implementation of the ResolveContext `getOptionalResources()` places every existing bundle in the INSTALLED state as part of the collection of optional resources. This is guaranteed to pull in every bundle into the resolve operation and resolve as many as possible in one go.

The advantages of this approach is that it gives the resolver algorithm the greatest flexibility to pick a capability provider that will result in a consistent class space. The other advantage is that it will allow the greatest number of fragments to attach to their hosts that are being resolved at the same time.

The disadvantage of this approach is that can present more choices to the resolver which makes it more likely that the resolution algorithm is going to explode trying to find a valid solution. This may result in situations where a resolution operation appears to endlessly loop, crash with an out of memory exception, or stack overflow exception.

3.1.2 Resolve One Root Bundle At a Time

With this approach the framework implementation of the ResolveContext `getOptionalResources()` or `getMandatoryResources()` places a single bundle which is in the INSTALLED state as part of the collection of resources to resolve. The idea is for the resolve operation to start with a single root resource to resolve. The resolver then looks at the root resource's requirements and calls the ResolveContext to find providers which may pull in additional resources to resolve.

The advantage of this approach is that it limits the resolver's choice of possible providers to the tree required to resolve the single root resource. This may help reduce the possible explosion of the resolver algorithm when finding a valid solution for a consistent class space.

The disadvantage of this approach is that limiting the choices of the resolver by locking in provider selections of earlier root resources may make it impossible to resolve other bundles later. Another disadvantage is that fragment resources will only get pulled into the resolution if they have capabilities that are directly depended on by other bundles being resolved at the same time. This may leave a fragment unattached while its host bundle becomes resolved. Later the fragment bundle will not be allowed to resolve because its host is already resolved.

3.1.2.1 Pull in Related Resources

In order to allow a framework implementation to resolve bundles using the single root bundle approach the resolver needs the ability to pull in related resources when resolving a resource. For example, when resolving a host bundle at runtime it is mostly likely desired to pull in as many applicable fragments as possible to the resolve operation. The Felix Resolver implementation extended the ResolveContext with a implementation specific type which added a new method

```
public Collection<Resource> getOndemandResources(Resource host);
```

Each time the resolver attempts to resolve a resource it asks the ResolveContext for additional “on demand” resources which are to be added to the current resolve operation as if they were part of the original optional resources for the resolve operation.

3.2 Resolve Dynamic Package Imports

At runtime the framework must support dynamic package resolution. With the current Resolver API this is possible, but very cumbersome. It would involve treating the resolved bundle with the dynamic import as if it was unresolved and attempting to resolve it again. The resolve context would then have to ensure all non-dynamic requirements got re-wired to the same capabilities they already are wired to and then have an extra requirement that is used to represent the current package being requested for dynamic resolution.

This approach requires a lot of extra work during runtime class loading. The Felix resolver implementation adds a new implementation specific method that allows dynamic resolution of a requirement for an already resolved resource. The following method is available:

```
public Map<Resource, List<Wire>> resolve(
  ResolveContext rc, Resource host, Requirement dynamicReq,
  List<Capability> matches)
```

This method allows the resolution of the dynamicReq that is associated with a host resource to establish new wires from the host resource. This method also allows additional resources to get pulled into the resolve operation in order to resolve the dynamicReq.

3.3 Allow the ResolveContext to Cancel a Resolve Operation

The resolution problem is an np-complete problem. Depending on the resolver algorithm it is possible to introduce problem sets that will result in an apparent endless-loop, out of memory, or stack overflow. It would be useful if the ResolveContext could provide some heuristics to force the resolver to cancel the existing resolution operation that is “taking forever” or “too much memory” etc.

For example, a framework implementation may decide to first try to resolve a large set of bundles all at once because that gives the resolver the greatest level of flexibility to find a consist class space. But after a certain amount of time or memory usage the framework may want to force the resolution operation to quit. At that point the framework may decide to take a more manageable approach by resolving only a single root bundle at a time.

3.4 Move the Resolver Service to Core

The requirements of this design are generally applicable for use cases that involve a Core Framework implementation using the Resolver service implementation to resolve bundles at runtime. If the Resolver specification is being updated to address this use case then considerations should be made to move the Resolver service into the Core Framework specification.

The Core Framework specification is usually released before the other OSGi specifications (compendium, enterprise etc.). In order to ensure the resolver specification is up to date with the needs of the latest released Core Framework specification it may be necessary to move it to the Core Framework specification. That being said, it should remain reasonable and compliant with the specification for a framework implementation to provide the resolver service specification as a separate bundle. This will likely be desired if the Framework implementation does not use the resolver service implementation internally to resolve bundles at runtime.

4 Requirements

4.1 ResolveContext

- RC0010 – A ResolveContext must be able to add related resources to a resolve operation in response to a specific resource being pulled into a resolve operation.
- RC0020 – A ResolveContext must be able to add any type of related resource to the resolve operation. For example, related resources are not restricted to the osgi.fragment type.
- RC0030 – When related resources are added to a resolve operation, the resolve operation must treat the related resource as optional unless the related resource is already considered mandatory.
- RC0040 – A ResolveContext must be able to add related resources that already have existing wirings. For example, to attach a resolved fragment to another host resource.
- RC0070 – A ResolveContext must be able to cancel an ongoing resolve operation.

4.2 Resolver

- R0100 – A Resolver must be able to dynamically resolve osgi.wiring.package requirements for an existing wiring of a host resource.
- ~~R0120 – A Resolver must not dynamically resolve to an osgi.wiring.package capability when the host wiring is already wired to an osgi.wiring.package capability with the same package name.~~
- ~~R0130 – A Resolver must not dynamically resolve to an osgi.wiring.package capability when the host wiring is already providing an osgi.wiring.package capability with the same package name.~~
- R0140 – A Resolver must be able to resolve additional resources in order to resolve a dynamic requirement.
- R0150 – The Resolver Service specification must move into the Core Framework specification.

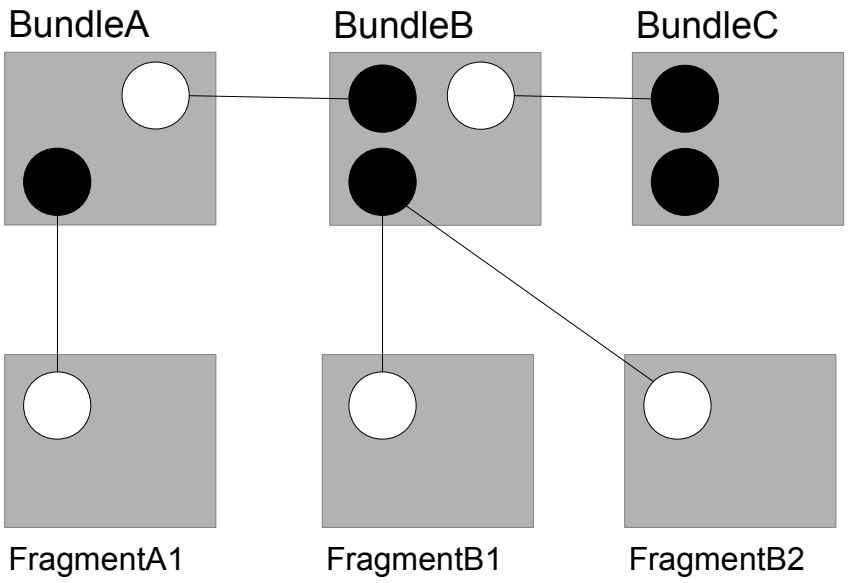
5 Technical Solution

5.1 Resolve Related Resources

In order to resolve related resources the ResolveContext is extended to include the following method:

```
public Collection<Resource> findRelatedResources(Resource resource) {
            return Collections.emptyList();
}
```

This method is used by the resolver to find resources that are related to the given resource. The Resolver implementation will call this method for each resource that is pulled into a resolve operation. Use the following set of bundles as an example:



A resolve operation starts with a collection of mandatory and optional resources to resolve according to the ResolveContext These are considered the root resources of the resolve operation. In the diagram above a resolve operation is started with a single root resource BundleA. BundleA has a single requirement the pulls in resource BundleB as providing a matching capability. BundleB has a single requirement that pulls in resource BundleC as a providing matching capability. Using the 1.0 version of the Resolver Service implementation will result in a wiring map being returned with only the resources BundleA, BundleB, and BundleC as resolved with a new set of wires. All fragment resources FragmentA1, FragmentB1 and FragmentB2 would be left out of the resolution results.

With the new `findRelatedResources(Resource resource)` method the resolver will call the ResolveContext for each resource that is pulled into the resolve operation. This includes the mandatory and optional root resources as well as the related resources returned by `findRelatedResources(Resource resource)`. In the example above the ResolveContext has the option to return FragmentA1 as a related resource for for BundleA and FragmentB1 and FragmentB2 as related resources for BunldeB. This results in all three fragments being included in the resolve operation.

Related resources that are already considered mandatory or optional resources have no effect on the final resolution result. Related resources that are not already considered mandatory or optional resources are added to the resolve operation as if they are optional resources. Failing to resolve the optional related resources does not result in a ResolutionException

Related resources may already have existing wirings. If the resource with an existing wiring does not have the osgi.fragment type then the additional resource has no effect on the final resolution result. If the resource with an existing wiring has the osgi.fragment type then the fragment resource is allowed to attach to new host osgi.bundle type resources if they provide a matching osgi.wiring.host capability for the fragment.

A ResolveContext is free to return any type of resource as a related resource, the types are not restricted to the osgi.fragment type.

5.2 Resolving Dynamic Package Imports

In order to resolve osgi.wiring.package requirements with the resolution directive of “dynamic” the Resolver interface is extended with the following method:

```
public Map<Resource,List<Wire>> resolveDynamic(
  ResolveContext context,
  Wiring hostWiring,
  Requirement dynamicRequirement)
    throws ResolutionException;
```

The resolveDynamic method must return a delta wiring on the existing state or throw a ResolutionException if the dynamic requirement cannot be resolved. The delta wiring map must contain the host resource of the provided host wiring as a key. The list of wires for the host resource entry will only contain a single wire which resolves the provided dynamic requirement to a valid capability. The delta wiring may also contain additional resources that are necessary to resolve in order to resolve the dynamic requirement.

The resolver implementation assumes the following about the host wiring and dynamic requirement:

1. The requirement uses the osgi.wiring.package namespace.
2. The requirement has a resolution directive of “dynamic”
3. The requirement is hosted by the provided host wiring.
4. A requirement that has a cardinality directive of “single” is not used by an existing required wire of the host wiring.

The resolver implementation is not required to validate these assumptions. If these assumptions are not true then the result of the resolveDynamic method is not specified.

The resolver uses the requirement to call findProviders on the resolve context in order to find valid matching capabilities. In order for a matching capability to be considered as valid for a dynamic wire it must satisfy the following rules:

1. The capability must use the osgi.wiring.package namespace

2. The wiring must not provide an osgi.wiring.package capability that has the same package name as the matching capability. In other words, the wiring must not already export the package.

3. The wiring must not have a required wire that wires to an osgi.wiring.package capability that has the same package name as the matching capability. In other words, the wiring must not already import the package.

The resolver implementation assumes the matching capabilities returned by findProviders are valid. If findProviders return invalid capabilities then the result of the resolveDynamic method is not specified.

At this point in the dynamic resolution process the resolution operation continues on as a normal resolution process. The only difference is that the root resource is the already resolved resource with the wiring that is hosting the dynamic package import requirement. The resources providing the matching capabilities are resolved as in a normal resolution operation.

5.3 Canceling a Resolution Process

The resolution problem is considered an np-complete problem. Depending on the resolution problem set (the set resources being resolved) and the resolution algorithm the resolve operation may cause the algorithm to take up large amounts of resources and/or appear to never complete. Given enough time and resources the resolve operation may be able to complete but this may be unacceptable to the resolve context. The resolve context may want to put a limit on the amount of time or resources used during a resolution operation. In order to allow a resolve context to cancel a current resolve process the following method is added to ResolveContext:

```
public void onCancel(Runnable callback) {
            // do nothing by default
}
```

When a resolve operation begins, ~~T~~the resolver must call th~~is~~ onCancel method once and only once the duration of the resolve operation and that call must happen before calling any other method on the resolve context ~~at the beginning of a resolve operation in order~~. ~~to~~ The onCancel method registers a callback with the resolve context. If the onCancel method is called more than once for a resolve operation then a runtime exception may be thrown. If the callback is executed then the resolver must cancel the current resolve operation and throw a resolution exception from the resolve method. The resolution exception that is thrown in response to a cancellation must have the cause set to a java.util.concurrent.CancellationException. This callback can be called at any time, by any thread, in order to cancel the resolve operation. This requires the callback to be thread safe. If the callback is executed after the resolve operation has completed then the callback is a no-op and must not result in an exception.

~~**TODO 1: I specified it as a must for the resolver to call onCancel to register a callback. I think if we spec this then it is a must.**~~

~~**TODO 2: would we rather have an IllegalStateException thrown if the resolve operation has completed before it could be cancelled?**~~

~~**TODO 3: I specified that onCancel is only to be called once and only once for each resolve process. I think this simplifies the burden for resolve context implementations**~~

5.4 Move the Resolver Service to the Core Specification

To ensure that the Resolver Service specification is able to resolve bundles using the latest Core Specification the Resolver Service specification chapter should be moved to the Core Specification.

6 Data Transfer Objects

No new DTOs required for this RFC

7 Javadoc

OSGi Javadoc

5/24/16 3:03 PM

Package Summary		Page
org.osgi.service.resolver	Resolver Service Package Version 1.1.	14

Package org.osgi.service.resolver

```
@org.osgi.annotation.versioning.Version(value="1.1")
```

Resolver Service Package Version 1.1.

See:

Description

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HostedCapability	A capability hosted by a resource.	15
Resolver	A resolver service resolves the specified resources in the context supplied by the caller.	23

Class Summary		Page
ResolveContext	A resolve context provides resources, options and constraints to the potential solution of a `resolve` operation.	18

Exception Summary		Page
ResolutionException	Indicates failure to resolve a set of requirements.	16

Package org.osgi.service.resolver Description

Resolver Service Package Version 1.1.

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.resolver; version="[1.1,2.0)"
```

Example import for providers implementing the API in this package:

```
Import-Package: org.osgi.service.resolver; version="[1.1,1.2)"
```

Interface HostedCapability

org.osgi.service.resolver

All Superinterfaces:

org.osgi.resource.Capability

```
@org.osgi.annotation.versioning.ProviderType
public interface HostedCapability
extends org.osgi.resource.Capability
```

A capability hosted by a resource.

A HostedCapability is a Capability where the `getResource()` method returns a Resource that hosts this Capability instead of declaring it. This is necessary for cases where the declaring Resource of a Capability does not match the runtime state. For example, this is the case for fragments attached to a host. Most fragment declared capabilities and requirements become hosted by the host resource. Since a fragment can attach to multiple hosts, a single capability can actually be hosted multiple times.

ThreadSafe

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org.osgi.resource.Capability	**getDeclaredCapability**() Return the Capability hosted by the Resource.	15
org.osgi.resource.Resource	**getResource**() Return the Resource that hosts this Capability.	15

Methods inherited from interface org.osgi.resource.Capability
equals, getAttributes, getDirectives, getNamespace, hashCode

Method Detail

getResource

```
org.osgi.resource.Resource getResource()
```

Return the Resource that hosts this Capability.

Specified by:

getResource in interface org.osgi.resource.Capability

Returns:

The Resource that hosts this Capability.

---

getDeclaredCapability

```
org.osgi.resource.Capability getDeclaredCapability()
```

Return the Capability hosted by the Resource.

Returns:

The Capability hosted by the Resource.

Class ResolutionException

org.osgi.service.resolver

```
java.lang.Object
  └java.lang.Throwable
      └java.lang.Exception
          └org.osgi.service.resolver.ResolutionException
```

All Implemented Interfaces:

Serializable

```
public class ResolutionException
extends Exception
```

Indicates failure to resolve a set of requirements.

If a resolution failure is caused by a missing mandatory dependency a resolver may include any requirements it has considered in the resolution exception. Clients may access this set of dependencies via the `getUnresolvedRequirements()` method.

Resolver implementations may extend this class to provide extra state information about the reason for the resolution failure.

Constructor Summary	Page
ResolutionException(String message) Create a ResolutionException with the specified message.	17
ResolutionException(String message, Throwable cause, Collection<org.osgi.resource.Requirement> unresolvedRequirements) Create a ResolutionException with the specified message, cause and unresolved requirements.	16
ResolutionException(Throwable cause) Create a ResolutionException with the specified cause.	17

Method Summary		Page
Collection<org.osgi.resource.Requirement>	**getUnresolvedRequirements**() Return the unresolved requirements, if any, for this exception.	17

Constructor Detail

ResolutionException

```
public ResolutionException(String message,
                           Throwable cause,
                           Collection<org.osgi.resource.Requirement> unresolvedRequirements)
```

Create a ResolutionException with the specified message, cause and unresolved requirements.

Parameters:

message - The message.
cause - The cause of this exception.

`unresolvedRequirements` - The unresolved mandatory requirements from mandatory resources or `null` if no unresolved requirements information is provided.

ResolutionException

```
public ResolutionException(String message)
```

Create a `ResolutionException` with the specified message.

Parameters:

`message` - The message.

ResolutionException

```
public ResolutionException(Throwable cause)
```

Create a `ResolutionException` with the specified cause.

Parameters:

`cause` - The cause of this exception.

Method Detail

getUnresolvedRequirements

```
public Collection<org.osgi.resource.Requirement> getUnresolvedRequirements()
```

Return the unresolved requirements, if any, for this exception.

The unresolved requirements are provided for informational purposes and the specific set of unresolved requirements that are provided after a resolve failure is not defined.

Returns:

A collection of the unresolved requirements for this exception. The returned collection may be empty if no unresolved requirements information is available.

Class ResolveContext

org.osgi.service.resolver

```
java.lang.Object
  └ org.osgi.service.resolver.ResolveContext
```

```
@org.osgi.annotation.versioning.ConsumerType
abstract public class ResolveContext
extends Object
```

A resolve context provides resources, options and constraints to the potential solution of a `resolve` operation.

Resolve Contexts:

- Specify the mandatory and optional resources to resolve. The mandatory and optional resources must be consistent and correct. For example, they must not violate the singleton policy of the implementer.
- Provide `capabilities` that the Resolver can use to satisfy `requirements` via the `findProviders(Requirement)` method
- Constrain solutions via the `getWirings()` method. A wiring consists of a map of existing `resources` to `wiring`.
- Filter requirements that are part of a resolve operation via the `isEffective(Requirement)`.

A resolver may call the methods on the resolve context any number of times during a resolve operation using any thread. Implementors should ensure that this class is properly thread safe.

Except for `insertHostedCapability(List, HostedCapability)` and `onCancel(Runnable)`, the resolve context methods must be *idempotent*. This means that resources must have constant capabilities and requirements and the resolve context must return a consistent set of capabilities, wires and effective requirements.

ThreadSafe

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abstract List<org.osgi.resource.Capability>	**findProviders**(org.osgi.resource.Requirement requirement) Find Capabilities that match the given Requirement.	19
Collection<org.osgi.resource.Resource>	**findRelatedResources**(org.osgi.resource.Resource resource) Find resources that are related to the given resource.	21
Collection<org.osgi.resource.Resource>	**getMandatoryResources**() Return the resources that must be resolved for this resolve context.	19
Collection<org.osgi.resource.Resource>	**getOptionalResources**() Return the resources that the resolver should attempt to resolve for this resolve context.	19
abstract Map<org.osgi.resource.Resource,org.osgi.resource.Wiring>	**getWirings**() Returns the wirings for existing resolved resources.	20

abstract int	**insertHostedCapability**(List<org.osgi.resource.Capability> capabilities, HostedCapability hostedCapability) Add a HostedCapability to the list of capabilities returned from findProviders(Requirement).	20
abstract boolean	**isEffective**(org.osgi.resource.Requirement requirement) Test if a given requirement should be wired in the resolve operation.	20
void	**onCancel**(Runnable callback) Registers a callback with the resolve context that is associated with the currently running resolve operation.	21

Constructor Detail

ResolveContext

```
public ResolveContext()
```

Method Detail

getMandatoryResources

```
public Collection<org.osgi.resource.Resource> getMandatoryResources()
```

Return the resources that must be resolved for this resolve context.

The default implementation returns an empty collection.

Returns:

A collection of the resources that must be resolved for this resolve context. May be empty if there are no mandatory resources. The returned collection may be unmodifiable.

---

getOptionalResources

```
public Collection<org.osgi.resource.Resource> getOptionalResources()
```

Return the resources that the resolver should attempt to resolve for this resolve context. Inability to resolve one of the specified resources will not result in a resolution exception.

The default implementation returns an empty collection.

Returns:

A collection of the resources that the resolver should attempt to resolve for this resolve context. May be empty if there are no optional resources. The returned collection may be unmodifiable.

---

findProviders

```
public abstract List<org.osgi.resource.Capability> findProviders(org.osgi.resource.Requirement requirement)
```

Find Capabilities that match the given Requirement.

The returned list contains org.osgi.resource.Capability objects where the Resource must be the declared Resource of the Capability. The Resolver can then add additional HostedCapability objects with the insertHostedCapability(List, HostedCapability) method when it, for example, attaches

fragments. Those HostedCapability objects will then use the host's Resource which likely differs from the declared Resource of the corresponding Capability.

The returned list is in priority order such that the Capabilities with a lower index have a preference over those with a higher index. The resolver must use the insertHostedCapability(List, HostedCapability) method to add additional Capabilities to maintain priority order. In general, this is necessary when the Resolver uses Capabilities declared in a Resource but that must originate from an attached host.

Each returned Capability must match the given Requirement. This means that the filter in the Requirement must match as well as any namespace specific directives. For example, the mandatory attributes for the osgi.wiring.package namespace.

Parameters:

requirement - The requirement that a resolver is attempting to satisfy. Must not be null.

Returns:

A list of org.osgi.resource.Capability objects that match the specified requirement.

---

insertHostedCapability

```
public abstract int insertHostedCapability(List<org.osgi.resource.Capability> capabilities,
                                           HostedCapability hostedCapability)
```

Add a HostedCapability to the list of capabilities returned from findProviders(Requirement).

This method is used by the Resolver to add Capabilities that are hosted by another Resource to the list of Capabilities returned from findProviders(Requirement). This function is necessary to allow fragments to attach to hosts, thereby changing the origin of a Capability. This method must insert the specified HostedCapability in a place that makes the list maintain the preference order. It must return the index in the list of the inserted HostedCapability.

Parameters:

capabilities - The list returned from findProviders(Requirement). Must not be null.

hostedCapability - The HostedCapability to insert in the specified list. Must not be null.

Returns:

The index in the list of the inserted HostedCapability.

---

isEffective

```
public abstract boolean isEffective(org.osgi.resource.Requirement requirement)
```

Test if a given requirement should be wired in the resolve operation. If this method returns false, then the resolver should ignore this requirement during the resolve operation.

The primary use case for this is to test the effective directive on the requirement, though implementations are free to use any effective test.

Parameters:

requirement - The Requirement to test. Must not be null.

Returns:

true if the requirement should be considered as part of the resolve operation.

---

getWirings

```
public abstract Map<org.osgi.resource.Resource,org.osgi.resource.Wiring> getWirings()
```

Returns the wirings for existing resolved resources.

For example, if this resolve context is for an OSGi framework, then the result would contain all the currently resolved bundles with each bundle's current wiring.

Multiple calls to this method for this resolve context must return the same result.

Returns:
The wirings for existing resolved resources. The returned map is unmodifiable.

---

findRelatedResources

```
public Collection<org.osgi.resource.Resource> findRelatedResources(org.osgi.resource.Resource resource)
```

Find resources that are related to the given resource.

The resolver attempts to resolve related resources during the current resolve operation. Failing to resolve one of the related resources will not result in a resolution exception unless the related resource is also a `mandatory` resource.

The resolve context is asked to return related resources for each resource that is pulled into a resolve operation. This includes the `mandatory` and `optional` resources and each related resource returned by this method.

For example, a fragment can be considered a related resource for a host bundle. When a host is being resolved the resolve context will be asked if any related resources should be added to the resolve operation. The resolve context may decide that the potential fragments of the host should be resolved along with the host.

Parameters:
`resource` - The Resource that a resolver is attempting to find related resources for. Must not be `null`.
Returns:
A collection of the resources that the resolver should attempt to resolve for this resolve context. May be empty if there are no related resources. The returned collection may be unmodifiable.
Since:
1.1

---

onCancel

```
public void onCancel(Runnable callback)
```

Registers a callback with the resolve context that is associated with the currently running resolve operation. The callback can be executed in order to cancel the currently running resolve operation.

When a resolve operation begins, the resolver must call this method once and only once for the duration of the resolve operation and that call must happen before calling any other method on this resolve context. If the specified callback is executed then the resolver must cancel the currently running resolve operation and throw a `ResolutionException` with a cause of type `CancellationException`.

The callback allows a resolve context to cancel a long running resolve operation that appears to be running endlessly or at risk of running out of resources. The resolve context may then decide to give up on resolve operation or attempt to try another resolve operation with a smaller set of resources which may allow the resolve operation to complete normally.

Parameters:

`callback` - the callback to execute in order to cancel the resolve operation

Throws:

`IllegalStateException` - if the resolver attempts to register more than one callback for a resolve operation

Interface Resolver

org.osgi.service.resolver

```
@org.osgi.annotation.versioning.ProviderType
public interface Resolver
```

A resolver service resolves the specified resources in the context supplied by the caller.

ThreadSafe

Method Summary		Page
Map<org.osgi.resource.Resource,List<org.osgi.resource.Wire>>	**resolve**(ResolveContext context) Resolve the specified resolve context and return any new resources and wires to the caller.	23
Map<org.osgi.resource.Resource,List<org.osgi.resource.Wire>>	**resolveDynamic**(ResolveContext context, org.osgi.resource.Wiring hostWiring, org.osgi.resource.Requirement dynamicRequirement) Resolves a given dynamic requirement dynamically for the given host wiring using the given resolve context and return any new resources and wires to the caller.	24

Method Detail

resolve

```
Map<org.osgi.resource.Resource,List<org.osgi.resource.Wire>> resolve(ResolveContext context)
                                                              throws ResolutionException
```

Resolve the specified resolve context and return any new resources and wires to the caller.

The resolver considers two groups of resources:

- Mandatory - any resource in the mandatory group must be resolved. A failure to satisfy any mandatory requirement for these resources will result in throwing a ResolutionException
- Optional - any resource in the optional group may be resolved. A failure to satisfy a mandatory requirement for a resource in this group will not fail the overall resolution but no resources or wires will be returned for that resource.

The resolve method returns the delta between the start state defined by ResolveContext.getWirings() and the end resolved state. That is, only new resources and wires are included.

The behavior of the resolver is not defined if the specified resolve context supplies inconsistent information.

Parameters:

`context` - The resolve context for the resolve operation. Must not be `null`.

Returns:

The new resources and wires required to satisfy the specified resolve context. The returned map is the property of the caller and can be modified by the caller.

Throws:

ResolutionException - If the resolution cannot be satisfied.

---

resolveDynamic

```
Map<org.osgi.resource.Resource,List<org.osgi.resource.Wire>> resolveDynamic(ResolveContext con
text,
                                                                            org.osgi.resource.
Wiring hostWiring,
                                                                            org.osgi.resource.
Requirement dynamicRequirement)
                                                                  throws ResolutionExceptio
n
```

Resolves a given dynamic requirement dynamically for the given host wiring using the given resolve context and return any new resources and wires to the caller.

The requirement must be a `requirement` of the wiring and must use the `package` namespace.

The resolve context is not asked for `mandatory` resources or for `optional` resources. The resolve context is asked to `find providers` for the given requirement. The matching `package` capabilities returned by the resolve context must not have a `osgi.wiring.package` attribute equal to a `package` capability already `wired to` by the wiring or equal a `package` capability `provided` by the wiring. The resolve context may be requested to `find providers` for other requirements in order to resolve the resources that provide the matching capabilities to the given requirement.

If the requirement `cardinality` is not `multiple` then no new wire must be created if the `wires` of the wiring already contain a wire that uses the `requirement`

This operation may resolve additional resources in order to resolve the dynamic requirement. The returned map will contain entries for each resource that got resolved in addition to the specified wiring `resource`. The wire list for the wiring resource will only contain one wire which is for the dynamic requirement.

Parameters:

`context` - The resolve context for the resolve operation. Must not be `null`.
`hostWiring` - The wiring with the dynamic `requirement`. Must not be `null`.
`dynamicRequirement` - The dynamic requirement. Must not be `null`.

Returns:

The new resources and wires required to satisfy the specified dynamic requirement. The returned map is the property of the caller and can be modified by the caller. If no new wires were created then a ResolutionException is thrown.

Throws:

`ResolutionException` - if the dynamic requirement cannot be resolved

8 Considered Alternatives

9 Security Considerations

No security concerns for this RFC

10 Document Support

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

Add references simply by adding new items. You can then cross-refer to them by chosing <Insert><Cross Reference><Numbered Item> and then selecting the paragraph. ***STATIC REFERENCES (I.E. BODGED) ARE NOT ACCEPTABLE, SOMEONE WILL HAVE TO UPDATE THEM LATER, SO DO IT PROPERLY NOW.***

10.2 Author's Address

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10.3 Acronyms and Abbreviations

10.4 End of Document