



OSGiTM Alliance

RFC 219 LogService Update

Draft

40 Pages

Abstract

Logging is a crucial component to discover software bugs in a software system. The OSGi Log Service was the first compendium service and the Java eco-system gained over time many different log solutions: Log4j 2, Logback, Java Util Logging, etc. Since the OSGi Log Service was not further developed, the API does not take advantages of any of the new features in Java and looks very simplistic in comparison to mainstream Java. This document seeks to improve the Log Service API and add additional roles to upgrade it to Java 8.

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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.

0.6 Revision History

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

Revision	Date	Comments
Initial	2016-01-05	Initial draft. BJ Hargrave
<u>2nd draft</u>	<u>2016-01-14</u>	<u>Updates from CPEG meeting in Madrid.</u> <u>Add FormatterLogger, LogService extends LoggerFactory, DS support for Logger injection.</u> <u>BJ Hargrave</u>

1 Introduction

This RFC originates from a general desire in the OSGi community to upgrade the OSGi Log service and provide a more mainstream solution to make OSGi logging look more modern. The RFC is influenced by the OSGi enRoute project.

2 Application Domain

2.1 OSGi Log Service

The Log Service API has 4 methods. Each method takes a log level and a *message* string. In the OSGi Log Service this is an int. The ERROR level is 1, the TRACE level is 4, additional levels are accepted and stored. The 4 variations are used to pass a Service Reference and a Throwable.

Since the Log Service is aware of the bundle logging it can automatically provide this bundle in the entries. The OSGi Log Service is a dispatcher, it brokers between a *log client* and zero or more *log appenders*. The clients get the OSGi Log Service and the appenders get the OSGi Log Reader Service and register a listener with the Log Reader Service. The listener is then updated of any logging entries submitted by any client. The OSGi Log Reader has an optional history of recent events. The purpose of the history is to capture the log *entries* before the appender had been able to register itself.

A log entry consists of the bundle, a message, and an optional Service Reference and/or Throwable.

Since the OSGi Log Service uses services there can be multiple implementations and there is no guarantee that there is a log service is present. However, in general, there is only one Log Service and Log Reader service registered. In Declarative Services (DS) terms, the Log service should in general be a static dependency of a log client, which implies that the highest ranking log service is used. Though theoretically possible, few clients log to all registered service. Multiple Log Services is deemed an anomaly because it is a broker model and multiple brokers forfeit the purpose a bit.

Since the Log Service is a service it is possible that there is a need to log before the Log Service is available. Best practices in this case is to record the events until the Log Service becomes available, print to standard out, or ignore events. In Declarative Services, the bind methods that are called before the component is activated (and thus can be called before the Log Service is bound) can throw exceptions that are then logged by the Service Component Runtime.

2.2 Open Source

In the Open Source world a frenzy took place in developing log APIs. The current situation is quite complex because there are so many choices which created their own problems requiring facades that could log to many

different logging subsystems. About ten years ago Java introduced `java.util.logging` but received a lot of flack from the industry because they had not followed best practices. Logging seems to be a quite sensitive product in our industry.

Today it seems that the Simple Logging Facade for Java (SLF4J) is the most mainstream API for clients. The reason of its success is partly its design. It provides an API that is identical to some of the other APIs and it can easily forward the logged entries to other log subsystems. This makes SLF4J attractive from the point of view of the log client.

SLF4J has the concept of a named *logger*. A logger is generally created in a static variable and is obtained from the `LoggerFactory` class. The name is generally the class name (there is an overloaded method on the `LoggerFactory` to give a class object). When the first logger is created, the SLF4J code does some very heavy handed dynamic class loading magic to find a *provider*. The factory classes of the provider are generally implemented in a standard package in the SLF4J namespace. The provider then creates an implementation of the `Logger` class that is returned to the client. Since this is all static, it happens lazily on the first creation. However, it does require all classes to be visible from the API classes. In OSGi it is therefore necessary to provide the implementation in the same bundle as the API bundle, or use a fragment on the API bundle.

The name of the logger is then used to establish on what level should actually be logged. Since Java class names are hierarchical, wildcards can be used to set the levels for related loggers. In SLF4J, the configuration is set with a properties file/resource that is searched for on well known places. In OSGi, fragments on the API bundle are often used to provide these properties. If a different configuration is needed then the application must be restarted. A logger is set to be *active* for a given level when log messages are passed to the appender.

The SLF4J API is a hodgepodge of log methods that come from different other log APIs and improvements over time. In general, the level is encoded in the method name. i.e. there are error, warn, trace, debug and info.

An important aspect of logging is the performance. Enterprise code is heavily instrumented and logging can take a significant portion of the code and CPU time. It is crucial to minimize the overhead of logging. This is the reason why often the actual log method is not called when the level is not active:

```
if (logger.isDebugEnabled())
    logger.debug("Hello " + name );
```

The reason of this pattern that this way the concatenation of the strings only takes place when the level is active. With the advent of Java 5 we got varargs. Varargs made it easy to defer the cost of computations of the parameters to when it is actually necessary. This made printf like loggers popular:

```
logger.debug("Hello {}", name );
```

This reduced the clutter of log messages significantly. The SLF4J Logger provides printf like methods for all supported levels but does not use the familiar % syntax of the Java String Formatters. It uses the message based format with curly braces.

SLF4J also provides capture of the current threads and *markers*. Markers allow the introduction of variables in the log that can bind different parts in an execution.

List of currently used logging frameworks:

- Log4j and the next version Log4j 2
- SLF4J and the update Logback
- Java 2 Logging API

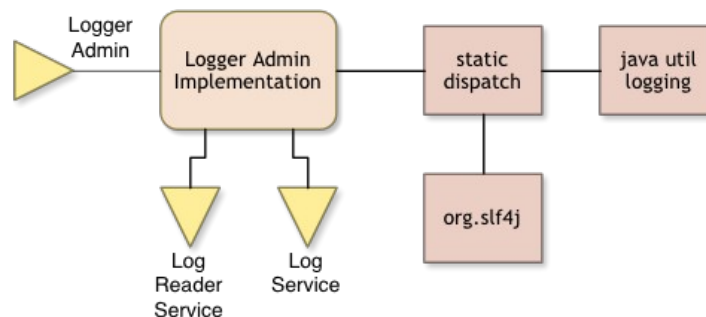
2.3 OSGi enRoute

In the OSGi enRoute [7]. project it was clear from the beginning that SLF4J was so popular in open source that it needed to be supported. However, though SLF4J and its appenders are delivered as bundles, it was not seen as a good idea to bypass the OSGi service model since the factory model is heavily based on dynamic class loading, causing all kinds of visibility problems. Therefore the approach was taken to provide a special enRoute appender that captured the log entries and forwarded them to the Log Service. Since this appender can be created before any OSGi framework is available it cannot rely on any of the OSGi mechanisms. It therefore buffers the log entry in memory as well as any loggers that access it.

Once the enRoute logger bundle becomes available it then accesses the static history and registers itself as the master. This logger bundle is configured with rules for the active levels for each logger. Based on these rules it forwards the entries to the OSGi Log Service. It is assumed to any appenders to other log systems would then use a Log Reader service. Mapping SLF4J entries to OSGi entries was a tad painful since the OSGi entries missed concepts like threads, sequence numbers, and markers.

Since dynamics are so important in OSGi, it also defined a Log Service Admin that could be used to manage the active levels of the loggers as well as provide the names of loggers that have logged. With this service (and corresponding Gogo commands) it is possible to dynamically change the active level of loggers.

The service diagram of the enRoute solution looked as depicted here:



OSGi enRoute registers an SLF4J Logger service and uses a Service Factory to capture the bundle. The name of this logger is then the symbolic name and version of the captured bundle. Though a logging service has the slight disadvantage that it is not available during initialization, it has the huge benefit of the service model. Since Declarative Services takes care of logging for errors in binding methods, the practical disadvantage is actually quite small.

Additionally, the OSGi enRoute also provided a utility to log based on a mechanism pioneered in bnd. The utility took an interface and a Logger and returned a proxy. Each method on the interface was a log message. The proxy handler would take the method name and turn it into a message, interleaving it with the arguments of the method. The level was defined by the return type.

Annotations were added to override the automatic message generation and to allow reorder and format arguments with the Java String Formatter API. By using Java types, the IDE helps finding log messages and refactoring log messages. The overhead is quite minimal since dynamic proxies have become quite fast today.

Last, and maybe least, OSGi enRoute added an additional level: AUDIT. This is a non-maskable level. Many financial institutions use log messages to audit, using a special level can provide more guarantees.

2.4 Apache Sling Log Service

The Apache Sling Log Service follows similar patterns but uses a slightly different route. In addition to consider SLF4J the most used log library, it also acknowledges that logback (<http://logback.qos.ch/>) is the most common backend for processing log entries.

Instead of funneling all log entries through the OSGi LogService, everything is passed on to SLF4J and from there to logback. Therefore the OSGi LogService logs to SLF4J and all the bridges are in place to pass log entries done through JUL or LOG4J to SLF4J.

Loggers and log levels can be configured through OSGi configurations. Config changes are of course processed dynamically and directly applied. On the other hand instead of using the OSGi LogService as an extension model, logback concepts are used through the whiteboard pattern. Logback TurboFilters, Filters, Appenders etc. can be registered dynamically as well as some other extensions.

This approach uses the most common parts today used for logging: SLF4J for clients and logback for processing.

[1] <http://sling.apache.org/documentation/development/logging.html>

2.5 Terminology + Abbreviations

- SLF4J - Simple Logging Facade for Java

3 Problem Description

The current OSGi Log Service suffers from the following problems:

- There is no way to set log levels so that not all messages are logged or a certain client.
- The OSGi Log Service API with its separate level is awkward to use in the code, the current practice is to use methods with the level name.
- The log client must construct the full message before the call is executed. This costs time and screen space.
- The current API does not capture threads, nor provides markers, or maintains sequence numbers
- The Log Service is not always available when a entry must be logged, especially during initialization. Then bundles need to buffer the log entries or print them on the console.
- The Log Service specification was developed before the whiteboard model was popular. This means that Log Listeners must first get the Log Reader Service and then register themselves. This is awkward, the whiteboard is much more convenient.

- Static loggers like SLF4J do not capture the bundle information
- Static loggers like SLF4J require class loading hacks to link them to an appender that are very non-OSGi like.

4 Requirements

4.1 SLF4J Loggers

- S0010 – It must be possible to use SLF4J API to log
- S0020 – It must be possible to create a static SLF4J logger (the normal way)
- S0030 – It must be possible to use a SFL4J Logger service that is automatically named according to the bundle's symbolic name and version.
- S0040 – Describe how static loggers are cleaned up when a bundle is uninstalled
- S0050 – Define how the the SLF4J go to the OSGi Log Service, taking into account that the bundle implementing the Log Service might be active when the SLF4J log entry is made and no entries may be lost.
- S0060 - Provide SLF4J support as an open source impl (via github for example) rather than bake SLF4J into a specification.

4.2 Log Service

- L0010 – The Log Service must provide a new level for AUDIT that cannot be ignored
- L0020 – The Log Service must provide a new level for TRACE to match SLF4J.
- L0030 – The Log Service API should be extended with the methods from the SLF4J Logger API. A varargs method should be added as will as the common 1, 2, ... n arg versions for performance (avoid compiler always creating array to hold varargs).
- L0050 – Generally ensure that all SLF4J concepts map to a Log Service concept.
- L0060 – Provide visibility to the current log level so it can be interrogated.

4.3 Log Admin

- A0010 – The active levels of the loggers must be dynamically changeable

- A0020 – It must be possible to get a list of active loggers with their active level.
- A0030 – It must be possible to set the active level of a bundle for all logger from that bundle, assuming that static loggers come from the bundle they were loaded from.
- A0040 – It must be possible to get some Key Performance Indicators (KPIs) of the Logging subsystem like log entries per second, total entries, black listed readers, etc.
- A0050 – Provide a means to take action if a KPI reaches a threshold.

4.4 Log Reader

- R0010 – The Log Reader Listener must become whiteboard

4.5 Log Entry

- E0010 – It must be possible to capture thread information (thread id/thread name) in a Log Entry
- E0030 – The solution must provide the log entry with a sequence number.
- E0040 – The solution must provide the log entry with a logger name.
- E0050 – The solution should provide an option to include location info like the class and the method and line number if available.

5 Technical Solution

5.1 Logger

A new type is added to hold the various logging methods: `Logger`. The old log methods on `LogService` are now deprecated and [a super interface, `LoggerFactory`, is methods are added having methods](#) to obtain a named `Logger` object. In SLF4J parlance, the [ServiceLogLoggerFactory](#) serves the function of an `ILoggerFactory`.

Like SLF4J, logging method names are based upon the log levels and will only log if the level is in effect. Methods are present to test if a log level is in effect to enable work avoidance.

Like SLF4J, the [Logger](#) log methods support formatted messages with “{}” place holders to avoid object-to-string conversion and string concatenation if the log level is not in effect.

[As an option, the `LoggerFactory` also supports obtaining `FormatterLogger` objects which use printf-style formatting](#)

The implementation of the LogService specification must register the logging service under both the LogService name and the LoggerFactory name since they represent the same log and since LogService extends LoggerFactory.

5.1.1 DS Support for Logger

Since logging is both important and needed early in code execution, DS will add special support for injecting Logger and FormatterLogger objects even though they themselves are not services. When a component references the Logger or FormatterLogger types, SCR must first get the LoggerFactory service matching the reference and then call the `getLogger(String, Class)` method passing the component implementation class name as the first argument and the Logger type as the second argument. The returned Logger object is then injected for the reference, rather than the LoggerFactory service used to create the Logger.

A DS example using Logger:

```
@Component
public class MyComponent {
    @Reference
    private Logger logger;
    @Reference
    void setLogger(LogService logService) {
        logger = logService.getLogger(getClass());
    }
    @Activate
    void activate(ComponentContext context) {
        logger.trace("activating component id {}",
            context.getProperties().get("component.id"));
    }
}
```

5.2 LogListener as a service

The LogListener type can now be registered as a service. Adding it as a listener via LogReaderService is now deprecated.

5.3 Obtaining LogEntries

A new LogStream service is defined to replace the LogReaderService. The LogStream service is a prototype scope service which must be obtained as a prototype scope service using ServiceObjects or `@Reference(scope = ReferenceScope.PROTOTYPE_REQUIRED)` in a Declarative Service component.

Since the log is basically an ongoing stream of LogEntries having asynchronous arrival, a LogStream object is a `PushStream<LogEntry>` and can be used receive the LogEntries. The following code snippet show how one could get the log entries and print them.

```
@Reference(scope = ReferenceScope.PROTOTYPE_REQUIRED)
public void handleLog(LogStream logs) {
    logs.forEach(l -> System.out.println(l))
    .onResolve(() -> System.out.println("LogStream closed"));
}
```

An existing LogListener implementation can also be used with LogStream.

```
private LogListener ll;
@Reference(scope = ReferenceScope.PROTOTYPE_REQUIRED)
public void handleLog(LogStream logs) {
    logs.forEach(ll::logged)
}
```

```
.onResolve(() -> System.out.println("LogStream closed"));  
}
```

With the new LogStream service, LogListener and the LogReaderService methods to add and remove LogListeners are deprecated.

This change depends upon RFC 216 Push Streams.

5.4 LogEntry

LogEntry is extended to include:

- Thread information on the log entry creator.
- A sequence number which increases for each created log entry.
- The name of the Logger used to create the log entry.
- A StackTraceElement element of the caller that created the log entry.

5.5 Outstanding work

- The means to dynamically inspect and modify the state of Loggers.
- Static access to Loggers. This may be done outside of this specification as an open source project on the OSGi GitHub account.

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

1/14/16 9:45 AM

Package Summary		Page
org.osgi.service.log	Log Service Package Version 1.4.	15

Package org.osgi.service.log

@org.osgi.annotation.versioning.Version(value="1.4")

Log Service Package Version 1.4.

See:

[Description](#)

Interface Summary		Page
FormatterLogger	Provides methods for bundles to write messages to the log using printf-style format strings.	16
LogEntry	Provides methods to access the information contained in an individual Log Service log entry.	17
Logger	Provides methods for bundles to write messages to the log using SLF4J-style format strings.	21
LoggerFactory	Logger Factory service for logging information.	29
LogListener	Deprecated. <i>Since 1.4.</i>	33
LogReaderService	LogReaderService for obtaining logging information.	34
LogService	LogService for logging information.	36
LogStream	LogStream service for receiving log information.	39

Enum Summary		Page
LogLevel	Log Levels.	31

Package org.osgi.service.log Description

Log Service Package Version 1.4.

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.log; version="[1.4,2.0)"
```

Example import for providers implementing the API in this package:

```
Import-Package: org.osgi.service.log; version="[1.4,1.5)"
```

Interface FormatterLogger

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

All Superinterfaces:

[Logger](#)

```
@org.osgi.annotation.versioning.ProviderType
public interface FormatterLogger
extends Logger
```

Provides methods for bundles to write messages to the log using printf-style format strings.

Messages can be formatted by the Logger once the Logger determines the log level is enabled. Uses printf-style format strings as described in [Formatter](#).

You can also add a [Throwable](#) and/or [ServiceReference](#) to the generated [LogEntry](#) by passing them to the logging methods as additional arguments. If the last argument is a [Throwable](#) or [ServiceReference](#), it is added to the generated [LogEntry](#) and then if the next to last argument is a [ServiceReference](#) or [Throwable](#), it is added to the generated [LogEntry](#). For example:

```
logger.info("Found service %s.", serviceReference, serviceReference);
logger.warn("Something named %s happened.", name, serviceReference,
    throwable);
logger.error("Thing failed.", exception);
```

If an exception occurs formatting the message, the logged message will indicate the formatting failure including the format string and the arguments.

Since:

1.4

ThreadSafe

Methods inherited from interface [org.osgi.service.log.Logger](#)

[audit](#), [audit](#), [audit](#), [audit](#), [debug](#), [debug](#), [debug](#), [debug](#), [error](#), [error](#), [error](#), [error](#), [getName](#),
[info](#), [info](#), [info](#), [info](#), [isDebugEnabled](#), [isErrorEnabled](#), [isInfoEnabled](#), [isTraceEnabled](#),
[isWarnEnabled](#), [trace](#), [trace](#), [trace](#), [trace](#), [warn](#), [warn](#), [warn](#), [warn](#)

Interface LogEntry

org.osgi.service.log

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

Provides methods to access the information contained in an individual Log Service log entry.

A `LogEntry` object may be acquired from the `LogReaderService.getLog` method or by registering a `LogListener` object.

ThreadSafe

Method Summary		Page
<code>org.osgi.framework.Bundle</code>	getBundle() Returns the bundle that created this <code>LogEntry</code> object.	17
<code>Throwable</code>	getException() Returns the exception object associated with this <code>LogEntry</code> object.	18
<code>int</code>	getLevel() Deprecated. Since 1.4.	18
<code>StackTraceElement</code>	getLocation() Returns the location information of the creation of this <code>LogEntry</code> object.	20
<code>String</code>	getLoggerName() Returns the name of the Logger object used to create this <code>LogEntry</code> object.	19
LogLevel	getLogLevel() Returns the level of this <code>LogEntry</code> object.	19
<code>String</code>	getMessage() Returns the human readable message associated with this <code>LogEntry</code> object.	18
<code>long</code>	getSequence() Returns the sequence number for this <code>LogEntry</code> object.	19
<code>org.osgi.framework.ServiceReference<?></code>	getServiceReference() Returns the <code>ServiceReference</code> object for the service associated with this <code>LogEntry</code> object.	18
<code>String</code>	getThreadInfo() Returns a string representing the thread which created this <code>LogEntry</code> object.	19
<code>long</code>	getTime() Returns the value of <code>currentTimeMillis()</code> at the time this <code>LogEntry</code> object was created.	18

Method Detail

getBundle

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

Returns the bundle that created this `LogEntry` object.

Returns:

The bundle that created this `LogEntry` object; null if no bundle is associated with this `LogEntry` object.

getServiceReference

```
org.osgi.framework.ServiceReference<?> getServiceReference()
```

Returns the `ServiceReference` object for the service associated with this `LogEntry` object.

Returns:

`ServiceReference` object for the service associated with this `LogEntry` object; `null` if no `ServiceReference` object was provided.

getLevel

```
@Deprecated  
int getLevel()
```

Deprecated. Since 1.4. Replaced by [getLogLevel\(\)](#).

Returns the level of this `LogEntry` object.

This is one of the severity levels defined by the `LogService` interface.

Returns:

Level of this `LogEntry` object.

getMessage

```
String getMessage()
```

Returns the human readable message associated with this `LogEntry` object.

Returns:

`String` containing the message associated with this `LogEntry` object.

getException

```
Throwable getException()
```

Returns the exception object associated with this `LogEntry` object.

In some implementations, the returned exception may not be the original exception. To avoid references to a bundle defined exception class, thus preventing an uninstalled bundle from being garbage collected, the Log Service may return an exception object of an implementation defined `Throwable` subclass. The returned object will attempt to provide as much information as possible from the original exception object such as the message and stack trace.

Returns:

`Throwable` object of the exception associated with this `LogEntry`; `null` if no exception is associated with this `LogEntry` object.

getTime

```
long getTime()
```

Returns the value of `currentTimeMillis()` at the time this `LogEntry` object was created.

Returns:

The system time in milliseconds when this `LogEntry` object was created.

See Also:

"`System.currentTimeMillis()`"

getLogLevel

[LogLevel](#) `getLogLevel()`

Returns the level of this `LogEntry` object.

Returns:

The level of this `LogEntry` object.

Since:

1.4

getLoggerName

`String getLoggerName()`

Returns the name of the [Logger](#) object used to create this `LogEntry` object.

Returns:

The name of the [Logger](#) object used to create this `LogEntry` object or "" if this `LogEntry` object was created using one of the original `LogService` log methods.

Since:

1.4

getSequence

`long getSequence()`

Returns the sequence number for this `LogEntry` object.

The `LogService` assigns a unique, non-negative value that is larger than all previously assigned values since the `LogService` was started. These values are transient and are reused upon restart of the `LogService`.

Returns:

The sequence number for this `LogEntry` object.

Since:

1.4

getThreadInfo

`String getThreadInfo()`

Returns a string representing the thread which created this `LogEntry` object.

This string contains the name of the thread.

Returns:

A string representing the thread which created this `LogEntry` object.

Since:

1.4

getLocation

`StackTraceElement` **getLocation**()

Returns the location information of the creation of this `LogEntry` object.

Returns:

The location information of the creation of this `LogEntry` object.

Since:

1.4

Interface Logger

org.osgi.service.log

All Known Subinterfaces:

[FormatterLogger](#)

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

Provides methods for bundles to write messages to the log using SLF4J-style format strings.

Messages can be formatted by the Logger once the Logger determines the log level is enabled. Use "{}" as a place holder for an argument. If you need to use the literal "{}" in the formatted message, precede the place holder with a backslash: "\\{}". If you need to place a backslash before the place holder, precede the backslash with a backslash: "\\\\{}".

You can also add a `Throwable` and/or `ServiceReference` to the generated [LogEntry](#) by passing them to the logging methods as additional arguments which do not have a corresponding place holder. For example:

```
logger.info("Found service {}.", serviceReference, serviceReference);
logger.warn("Something named {} happened.", name, serviceReference,
    throwable);
logger.error("Thing failed.", exception);
```

Since:

1.4

ThreadSafe

Method Summary		Page
void	audit (String message) Log a message at the LogLevel.AUDIT level.	27
void	audit (String format, Object arg) Log a formatted message at the LogLevel.AUDIT level.	28
void	audit (String format, Object arg1, Object arg2) Log a formatted message at the LogLevel.AUDIT level.	28
void	audit (String format, Object... arguments) Log a formatted message at the LogLevel.AUDIT level.	28
void	debug (String message) Log a message at the LogLevel.DEBUG level.	24
void	debug (String format, Object arg) Log a formatted message at the LogLevel.DEBUG level.	24
void	debug (String format, Object arg1, Object arg2) Log a formatted message at the LogLevel.DEBUG level.	24
void	debug (String format, Object... arguments) Log a formatted message at the LogLevel.DEBUG level.	24
void	error (String message) Log a message at the LogLevel.ERROR level.	27
void	error (String format, Object arg) Log a formatted message at the LogLevel.ERROR level.	27
void	error (String format, Object arg1, Object arg2) Log a formatted message at the LogLevel.ERROR level.	27
void	error (String format, Object... arguments) Log a formatted message at the LogLevel.ERROR level.	27
String	getName () Return the name of this Logger.	22

void	info (String message) Log a message at the LogLevel.INFO level.	25
void	info (String format, Object arg) Log a formatted message at the LogLevel.INFO level.	25
void	info (String format, Object arg1, Object arg2) Log a formatted message at the LogLevel.INFO level.	25
void	info (String format, Object... arguments) Log a formatted message at the LogLevel.INFO level.	25
boolean	isDebugEnabled () Is logging enabled for the LogLevel.DEBUG level?	23
boolean	isErrorEnabled () Is logging enabled for the LogLevel.ERROR level?	26
boolean	isInfoEnabled () Is logging enabled for the LogLevel.INFO level?	24
boolean	isTraceEnabled () Is logging enabled for the LogLevel.TRACE level?	22
boolean	isWarnEnabled () Is logging enabled for the LogLevel.WARN level?	25
void	trace (String message) Log a message at the LogLevel.TRACE level.	23
void	trace (String format, Object arg) Log a formatted message at the LogLevel.TRACE level.	23
void	trace (String format, Object arg1, Object arg2) Log a formatted message at the LogLevel.TRACE level.	23
void	trace (String format, Object... arguments) Log a formatted message at the LogLevel.TRACE level.	23
void	warn (String message) Log a message at the LogLevel.WARN level.	26
void	warn (String format, Object arg) Log a formatted message at the LogLevel.WARN level.	26
void	warn (String format, Object arg1, Object arg2) Log a formatted message at the LogLevel.WARN level.	26
void	warn (String format, Object... arguments) Log a formatted message at the LogLevel.WARN level.	26

Method Detail

getName

String **getName**()

Return the name of this Logger.

Returns:
The name of this Logger.

isTraceEnabled

boolean **isTraceEnabled**()

Is logging enabled for the [LogLevel.TRACE](#) level?

Returns:

true if logging is enabled for the [LogLevel.TRACE](#) level.

trace

```
void trace(String message)
```

Log a message at the [LogLevel.TRACE](#) level.

Parameters:

message - The message to log.

trace

```
void trace(String format,  
           Object arg)
```

Log a formatted message at the [LogLevel.TRACE](#) level.

Parameters:

format - The format of the message to log.
arg - The argument to format into the message.

trace

```
void trace(String format,  
           Object arg1,  
           Object arg2)
```

Log a formatted message at the [LogLevel.TRACE](#) level.

Parameters:

format - The format of the message to log.
arg1 - The first argument to format into the message.
arg2 - The second argument to format into the message.

trace

```
void trace(String format,  
           Object... arguments)
```

Log a formatted message at the [LogLevel.TRACE](#) level.

Parameters:

format - The format of the message to log.
arguments - The arguments to format into the message.

isDebugEnabled

```
boolean isDebugEnabled()
```

Is logging enabled for the [LogLevel.DEBUG](#) level?

Returns:

true if logging is enabled for the [trace](#) level.

debug

```
void debug(String message)
```

Log a message at the [LogLevel.DEBUG](#) level.

Parameters:

message - The message to log.

debug

```
void debug(String format,  
           Object arg)
```

Log a formatted message at the [LogLevel.DEBUG](#) level.

Parameters:

format - The format of the message to log.
arg - The argument to format into the message.

debug

```
void debug(String format,  
           Object arg1,  
           Object arg2)
```

Log a formatted message at the [LogLevel.DEBUG](#) level.

Parameters:

format - The format of the message to log.
arg1 - The first argument to format into the message.
arg2 - The second argument to format into the message.

debug

```
void debug(String format,  
           Object... arguments)
```

Log a formatted message at the [LogLevel.DEBUG](#) level.

Parameters:

format - The format of the message to log.
arguments - The arguments to format into the message.

isInfoEnabled

```
boolean isInfoEnabled()
```

Is logging enabled for the [LogLevel.INFO](#) level?

Returns:

true if logging is enabled for the [trace](#) level.

info

```
void info(String message)
```

Log a message at the [LogLevel.INFO](#) level.

Parameters:

message - The message to log.

info

```
void info(String format,  
          Object arg)
```

Log a formatted message at the [LogLevel.INFO](#) level.

Parameters:

format - The format of the message to log.

arg - The argument to format into the message.

info

```
void info(String format,  
          Object arg1,  
          Object arg2)
```

Log a formatted message at the [LogLevel.INFO](#) level.

Parameters:

format - The format of the message to log.

arg1 - The first argument to format into the message.

arg2 - The second argument to format into the message.

info

```
void info(String format,  
          Object... arguments)
```

Log a formatted message at the [LogLevel.INFO](#) level.

Parameters:

format - The format of the message to log.

arguments - The arguments to format into the message.

isWarnEnabled

```
boolean isWarnEnabled()
```

Is logging enabled for the [LogLevel.WARN](#) level?

Returns:

true if logging is enabled for the [trace](#) level.

warn

```
void warn(String message)
```

Log a message at the [LogLevel.WARN](#) level.

Parameters:

message - The message to log.

warn

```
void warn(String format,  
          Object arg)
```

Log a formatted message at the [LogLevel.WARN](#) level.

Parameters:

format - The format of the message to log.
arg - The argument to format into the message.

warn

```
void warn(String format,  
          Object arg1,  
          Object arg2)
```

Log a formatted message at the [LogLevel.WARN](#) level.

Parameters:

format - The format of the message to log.
arg1 - The first argument to format into the message.
arg2 - The second argument to format into the message.

warn

```
void warn(String format,  
          Object... arguments)
```

Log a formatted message at the [LogLevel.WARN](#) level.

Parameters:

format - The format of the message to log.
arguments - The arguments to format into the message.

isErrorEnabled

```
boolean isErrorEnabled()
```

Is logging enabled for the [LogLevel.ERROR](#) level?

Returns:

true if logging is enabled for the [trace](#) level.

error

```
void error(String message)
```

Log a message at the [LogLevel.ERROR](#) level.

Parameters:

message - The message to log.

error

```
void error(String format,  
           Object arg)
```

Log a formatted message at the [LogLevel.ERROR](#) level.

Parameters:

format - The format of the message to log.

arg - The argument to format into the message.

error

```
void error(String format,  
           Object arg1,  
           Object arg2)
```

Log a formatted message at the [LogLevel.ERROR](#) level.

Parameters:

format - The format of the message to log.

arg1 - The first argument to format into the message.

arg2 - The second argument to format into the message.

error

```
void error(String format,  
           Object... arguments)
```

Log a formatted message at the [LogLevel.ERROR](#) level.

Parameters:

format - The format of the message to log.

arguments - The arguments to format into the message.

audit

```
void audit(String message)
```

Log a message at the [LogLevel.AUDIT](#) level.

Parameters:

message - The message to log.

audit

```
void audit(String format,  
           Object arg)
```

Log a formatted message at the [LogLevel.AUDIT](#) level.

Parameters:

format - The format of the message to log.
arg - The argument to format into the message.

audit

```
void audit(String format,  
           Object arg1,  
           Object arg2)
```

Log a formatted message at the [LogLevel.AUDIT](#) level.

Parameters:

format - The format of the message to log.
arg1 - The first argument to format into the message.
arg2 - The second argument to format into the message.

audit

```
void audit(String format,  
           Object... arguments)
```

Log a formatted message at the [LogLevel.AUDIT](#) level.

Parameters:

format - The format of the message to log.
arguments - The arguments to format into the message.

Interface LoggerFactory

org.osgi.service.log

All Known Subinterfaces:

[LogService](#)

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

Logger Factory service for logging information.

Provides methods for bundles to obtain named [Logger](#)s that can be used to write messages to the log.

Since:

1.4

ThreadSafe

Method Summary		Page
Logger	getLogger (Class<?> clazz) Return a Logger named with the specified class.	29
L	getLogger (Class<?> clazz, Class<L> loggerType) Return a Logger of the specified type named with the specified class.	30
Logger	getLogger (String name) Return a Logger named with the specified name.	29
L	getLogger (String name, Class<L> loggerType) Return a Logger of the specified type named with the specified name.	30

Method Detail

getLogger

[Logger](#) **getLogger**(String name)

Return a [Logger](#) named with the specified name.

Parameters:

name - The name to use for the logger name.

Returns:

A [Logger](#) named with the specified name.

getLogger

[Logger](#) **getLogger**(Class<?> clazz)

Return a [Logger](#) named with the specified class.

Parameters:

clazz - The class to use for the logger name.

Returns:

A [Logger](#) named with the specified class.

getLogger

```
L getLogger(String name,  
            Class<L> loggerType)
```

Return a [Logger](#) of the specified type named with the specified name.

Type Parameters:

L - A Logger type.

Parameters:

name - The name to use for the logger name.

loggerType - The type of Logger. Can be [Logger](#) or [FormatterLogger](#).

Returns:

A [Logger](#) named with the specified name.

Throws:

[IllegalArgumentException](#) - If the specified type is not a supported Logger type.

getLogger

```
L getLogger(Class<?> clazz,  
            Class<L> loggerType)
```

Return a [Logger](#) of the specified type named with the specified class.

Type Parameters:

L - A Logger type.

Parameters:

clazz - The class to use for the logger name.

loggerType - The type of Logger. Can be [Logger](#) or [FormatterLogger](#).

Returns:

A [Logger](#) named with the specified class.

Throws:

[IllegalArgumentException](#) - If the specified type is not a supported Logger type.

Enum LogLevel

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

```
java.lang.Object
├─ java.lang.Enum<LogLevel>
│   └─ org.osgi.service.log.LogLevel
```

All Implemented Interfaces:

Comparable<[LogLevel](#)>, Serializable

```
public enum LogLevel
extends Enum<LogLevel>
```

Log Levels.

Since:

1.4

Enum Constant Summary		Page
AUDIT	Audit – Information that must always be logged.	31
DEBUG	Debug – Detailed output for debugging operations.	32
ERROR	Error – Information about an error situation.	31
INFO	Info – Information about normal operation.	32
TRACE	Trace level – Large volume of output for tracing operations.	32
WARN	Warning – Information about a failure or unwanted situation that is not blocking.	32

Method Summary		Page
boolean	implies (LogLevel other) Returns whether this log level implies the specified log level.	32
static LogLevel	valueOf (String name)	32
static LogLevel []	values ()	32

Enum Constant Detail

AUDIT

```
public static final LogLevel AUDIT
```

Audit – Information that must always be logged.

ERROR

```
public static final LogLevel ERROR
```

Error – Information about an error situation.

WARN

```
public static final LogLevel WARN
```

Warning – Information about a failure or unwanted situation that is not blocking.

INFO

```
public static final LogLevel INFO
```

Info – Information about normal operation.

DEBUG

```
public static final LogLevel DEBUG
```

Debug – Detailed output for debugging operations.

TRACE

```
public static final LogLevel TRACE
```

Trace level – Large volume of output for tracing operations.

Method Detail

values

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

valueOf

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

implies

```
public boolean implies(LogLevel other)
```

Returns whether this log level implies the specified log level.

Parameters:

`other` - The other log level.

Returns:

`true` If this log level implies the specified log level; `false` otherwise.

Interface LogListener

org.osgi.service.log

All Superinterfaces:
EventListener

```
@org.osgi.annotation.versioning.ConsumerType
@Deprecated
public interface LogListener
extends EventListener
```

Deprecated.

Subscribes to LogEntry objects from the LogReaderService.

A LogListener object may be registered with the Log Reader Service using the LogReaderService.addLogListener method. After the listener is registered, the logged method will be called for each LogEntry object created. The LogListener object may be unregistered by calling the LogReaderService.removeLogListener method.

ThreadSafe

Method Summary		Page
void	logged (LogEntry entry) Deprecated. Since 1.4.	33

Method Detail

logged

```
@Deprecated
void logged(LogEntry entry)
```

Deprecated. Since 1.4. Replaced by [LogStream](#).

Listener method called for each LogEntry object created.

Parameters:
entry - A [LogEntry](#) object containing log information.

Interface LogReaderService

org.osgi.service.log

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

LogReaderService for obtaining logging information.

There are two ways to obtain [LogEntry](#) objects:

- ! The primary way to obtain [LogEntry](#) objects is to get a [LogStream](#) object from the service registry.
- ! To obtain past [LogEntry](#) objects, the [getLog\(\)](#) method can be called which will return an `Enumeration` of the [LogEntry](#) objects in the log.

ThreadSafe

Method Summary		Page
void	addLogListener (LogListener listener) Deprecated. Since 1.4.	34
<code>Enumeration<LogEntry></code>	getLog () Returns an <code>Enumeration</code> of the LogEntry objects in the log.	35
void	removeLogListener (LogListener listener) Deprecated. Since 1.4.	34

Method Detail

addLogListener

```
@Deprecated
void addLogListener(LogListener listener)
```

Deprecated. Since 1.4. Replaced by [LogStream](#).

Subscribes to [LogEntry](#) objects.

This method registers a [LogListener](#) object with the Log Reader Service. The [LogListener.logged\(LogEntry\)](#) method will be called for each [LogEntry](#) object placed into the log.

When a bundle which registers a [LogListener](#) object is stopped or otherwise releases the Log Reader Service, the Log Reader Service must remove all of the bundle's listeners.

If this Log Reader Service's list of listeners already contains a listener `l` such that `(l==listener)`, this method does nothing.

Parameters:

`listener` - A [LogListener](#) object to register; the [LogListener](#) object is used to receive [LogEntry](#) objects.

removeLogListener

```
@Deprecated
void removeLogListener(LogListener listener)
```

Deprecated. Since 1.4. Replaced by [LogStream](#).

Unsubscribes to [LogEntry](#) objects.

This method unregisters a [LogListener](#) object from the Log Reader Service.

If `listener` is not contained in this Log Reader Service's list of listeners, this method does nothing.

Parameters:

`listener` - A [LogListener](#) object to unregister.

getLog

`Enumeration<LogEntry> getLog()`

Returns an `Enumeration` of the [LogEntry](#) objects in the log.

Each element of the enumeration is a [LogEntry](#) object, ordered with the most recent entry first. Whether the enumeration is of all [LogEntry](#) objects since the Log Service was started or some recent past is implementation-specific. Also implementation-specific is which level [LogEntry](#) objects are included in the enumeration.

Returns:

An `Enumeration` of the [LogEntry](#) objects in the log.

Interface LogService

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

All Superinterfaces:

[LoggerFactory](#)

```
@org.osgi.annotation.versioning.ProviderType
public interface LogService
extends LoggerFactory
```

LogService for logging information.

Replaced by [LoggerFactory](#).

ThreadSafe

Field Summary		Page
int	LOG_DEBUG Deprecated. Since 1.4.	37
int	LOG_ERROR Deprecated. Since 1.4.	36
int	LOG_INFO Deprecated. Since 1.4.	37
int	LOG_WARNING Deprecated. Since 1.4.	37

Method Summary		Page
void	log (int level, String message) Deprecated. Since 1.4.	37
void	log (int level, String message, Throwable exception) Deprecated. Since 1.4.	38
void	log (org.osgi.framework.ServiceReference<?> sr, int level, String message) Deprecated. Since 1.4.	38
void	log (org.osgi.framework.ServiceReference<?> sr, int level, String message, Throwable exception) Deprecated. Since 1.4.	38

Methods inherited from interface org.osgi.service.log.[LoggerFactory](#)

[getLogger](#), [getLogger](#), [getLogger](#), [getLogger](#)

Field Detail

LOG_ERROR

```
@Deprecated
public static final int LOG_ERROR = 1
```

Deprecated.

An error message (Value 1).

This log entry indicates the bundle or service may not be functional.

LOG_WARNING

```
@Deprecated
public static final int LOG_WARNING = 2
```

Deprecated.

A warning message (Value 2).

This log entry indicates a bundle or service is still functioning but may experience problems in the future because of the warning condition.

LOG_INFO

```
@Deprecated
public static final int LOG_INFO = 3
```

Deprecated.

An informational message (Value 3).

This log entry may be the result of any change in the bundle or service and does not indicate a problem.

LOG_DEBUG

```
@Deprecated
public static final int LOG_DEBUG = 4
```

Deprecated.

A debugging message (Value 4).

This log entry is used for problem determination and may be irrelevant to anyone but the bundle developer.

Method Detail

log

```
@Deprecated
void log(int level,
        String message)
```

Deprecated. Since 1.4. Replaced by [Logger](#). See [LoggerFactory](#).

Logs a message.

The `ServiceReference` field and the `Throwable` field of the `LogEntry` object will be set to `null`.

Parameters:

- `level` - The severity of the message. This should be one of the defined log levels but may be any integer that is interpreted in a user defined way.
 - `message` - Human readable string describing the condition or `null`.
-

log

```
@Deprecated
void log(int level,
        String message,
        Throwable exception)
```

Deprecated. Since 1.4. Replaced by [Logger](#). See [LoggerFactory](#).

Logs a message with an exception.

The `ServiceReference` field of the `LogEntry` object will be set to `null`.

Parameters:

`level` - The severity of the message. This should be one of the defined log levels but may be any integer that is interpreted in a user defined way.
`message` - The human readable string describing the condition or `null`.
`exception` - The exception that reflects the condition or `null`.

log

```
@Deprecated
void log(org.osgi.framework.ServiceReference<?> sr,
        int level,
        String message)
```

Deprecated. Since 1.4. Replaced by [Logger](#). See [LoggerFactory](#).

Logs a message associated with a specific `ServiceReference` object.

The `Throwable` field of the `LogEntry` will be set to `null`.

Parameters:

`sr` - The `ServiceReference` object of the service that this message is associated with or `null`.
`level` - The severity of the message. This should be one of the defined log levels but may be any integer that is interpreted in a user defined way.
`message` - Human readable string describing the condition or `null`.

log

```
@Deprecated
void log(org.osgi.framework.ServiceReference<?> sr,
        int level,
        String message,
        Throwable exception)
```

Deprecated. Since 1.4. Replaced by [Logger](#). See [LoggerFactory](#).

Logs a message with an exception associated and a `ServiceReference` object.

Parameters:

`sr` - The `ServiceReference` object of the service that this message is associated with.
`level` - The severity of the message. This should be one of the defined log levels but may be any integer that is interpreted in a user defined way.
`message` - Human readable string describing the condition or `null`.
`exception` - The exception that reflects the condition or `null`.

Interface LogStream

org.osgi.service.log

All Superinterfaces:

AutoCloseable, Closeable, org.osgi.util.pushstream.PushStream<[LogEntry](#)>

```
@org.osgi.annotation.versioning.ProviderType
public interface LogStream
extends org.osgi.util.pushstream.PushStream<LogEntry>
```

LogStream service for receiving log information.

This service must be registered as a prototype service so that each user can receive a new, distinct org.osgi.util.pushstream.PushStream of [LogEntry](#) objects. Users of this service must obtain this service using org.osgi.framework.ServiceObjects to get a new, distinct org.osgi.util.pushstream.PushStream. For example, to inject a LogStream service into a Declarative Services component:

```
@Reference(scope = ReferenceScope.PROTOTYPE_REQUIRED)
private LogStream logs;
```

When a LogStream service object is released and org.osgi.framework.PrototypeServiceFactory.ungetService(org.osgi.framework.Bundle, org.osgi.framework.ServiceRegistration, Object) is called, Closeable.close() must be called on the LogStream to ensure the stream is closed.

Since:

1.4

ThreadSafe

Methods inherited from interface org.osgi.util.pushstream.PushStream

allMatch, anyMatch, buffer, buffer, coalesce, coalesce, coalesce, collect, count, distinct, filter, findAny, findFirst, flatMap, forEach, forEachEvent, fork, limit, map, max, merge, min, noneMatch, onClose, onError, reduce, reduce, reduce, sequential, skip, sorted, sorted, split, toArray, toArray, window, window, window, window

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8 Considered Alternatives

None at this time.

9 Security Considerations

Bundles using the LogListener as a service will now need ServicePermission to register it as a service. The implementation will need ServicePermission to get it as a service.

10 Document Support

10.1 References

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10.2 Author's Address

Name	BJ Hargrave
Company	IBM

10.3 Acronyms and Abbreviations

10.4 End of Document