Published on **ONJava.com** (http://www.onjava.com/)
http://www.onjava.com/pub/a/onjava/2002/06/19/log.html
See this if you're having trouble printing code examples

An Introduction to the Java Logging API

by Brian R. Gilstrap
06/19/2002

Unless you've been living under a rock, you already know that the official release of JDK 1.4 came out in the first quarter of this year, and included with it is a new logging API. This API was first described in JSR 47. Essentially the same description is also available in the documentation of logging for JDK 1.4 .

In addition to the implementation provided in JDK 1.4, there is an open source implementation of the API for JDKs 1.2 and 1.3 called Lumberjack, available on SourceForge. The library provides a way for people to begin using the API before they make the move to JDK 1.4. It also allows them to use the API in work they do which must be done in 1.2 or 1.3 for some reason.

What is the Logging API?

The logging API is part of J2SE as of JDK 1.4, and it ships with the JDK. It is designed to let a Java program, servlet, applet, EJB, etc. produce messages of interest to end users, system administrators, field engineers, and software developers. Especially in production situations, where things can't be run in a debugger, or if doing so masks the problem that is occurring (because it is timing related, for example), such logs are frequently the greatest (and sometimes the only) source of information about a running program.

To make sure that logging can be left in a production program, the API is designed to make logging as inexpensive as possible. To let code produce fine-grained logging when needed but not slow the application in normal production use, the API provides mechanisms to dynamically change what log messages are produced, so that the impact of the logging code is minimized during normal operation. It also provides a number of Java interfaces and superclasses that provide "hooks" for developers to extend the API.

The entire logging API is contained in the package `java.util.logging` and is made up of the following *interfaces* and classes:

- `ConsoleHandler`
- `FileHander`
- `Filter`
- `Formatter`
- `Handler`
- `Level`
- `Logger`
- `LoggingPermission`

- `LogManager`
- `LogRecord`
- `MemoryHandler`
- `SimpleFormatter`
- `SocketHandler`
- `StreamHandler`
- `XMLFormatter`

We'll examine many of these types in more detail below.

An Example

To help motivate the use of the logging API, we will use a simple program, based on the idea of a "Hello World" program.

```
package logging.example1;
/**
 * A simple Java Hello World program, in the tradition of
 * Kernighan and Ritchie.
 */
public class HelloWorld {
 public static void main(String[] args) {
     HelloWorld hello = new HelloWorld("Hello world!");
     hello.sayHello();
 }

 private String theMessage;

 public HelloWorld(String message) {
     theMessage = message;
 }

 public void sayHello() {
     System.err.println(theMessage);
 }
}
```

We will expand upon this simple program in order to demonstrate and motivate the logging API. The first thing we will do is actually generate a logging message. This is straightforward; we need to create a `Logger` object, which represents the `HelloWorld` class, like this:

```
package logging.example2;
import java.util.logging.Logger;
/**
* A simple Java Hello World program, in the tradition of
* Kernighan and Ritchie.
*/
public class HelloWorld {
 private static Logger theLogger =
         Logger.getLogger(HelloWorld.class.getName());

 public static void main(String[] args) {
     HelloWorld hello = new HelloWorld("Hello world!");
     hello.sayHello();
 }

 private String theMessage;
```

```
 public HelloWorld(String message) {
     theMessage = message;
 }

 public void sayHello() {
     System.err.println(theMessage);
 }
}
```

This generates a `Logger`, which we can use to generate logging messages. Since you typically use one logger per class, we can make it a static field of the `HelloWorld` class. We use the fully qualified name of the `HelloWorld` class as the name of the `Logger`. We'll look at the reasons for this in more detail later. Now, let's actually use the `Logger` to try to generate a logging message:

```
package logging.example3;
import java.util.logging.Logger;
/**
* A simple Java Hello World program, in the tradition of
* Kernighan and Ritchie.
*/
public class HelloWorld {
  private static Logger theLogger =
          Logger.getLogger(HelloWorld.class.getName());

  public static void main(String[] args) {
      HelloWorld hello = new HelloWorld("Hello world!");
      hello.sayHello();
  }

  private String theMessage;

  public HelloWorld(String message) {
      theMessage = message;
  }

  public void sayHello() {
      // use the 'least important' type of message, one at
      // the 'finest' level.
      theLogger.finest("Hello logging!");
      System.err.println(theMessage);
  }
}
```

The logging API has a configuration file and by default, it provides a handler that will send logging messages, in the form of a `LogRecord` to the console (`System.err`). So we would expect to see the string `"Hello logging!";` appear before our message of `"Hello world!"`. But if you run this program you only see `"Hello world!"`:

```
    % java logging.example3.HelloWorld    Hello world
```

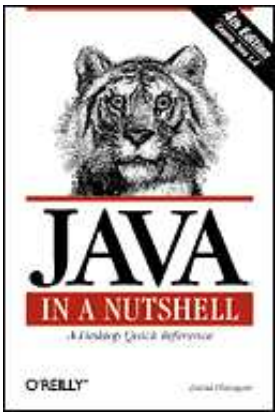
What's going on here? The answer lies in the notion of logging levels.

Logging Levels

Because we want to leave logging code in an application that goes into production, we need logging to cost us very little at runtime when it is not being used. To help achieve this, the logging system defines a class called `Level` to specify the importance of a logging record. The logging library has a set of predefined logging levels:

SEVERE	*The highest value;* intended for extremely important messages (e.g. fatal program errors).
WARNING	Intended for warning messages.
INFO	Informational runtime messages.
CONFIG	Informational messages about configuration settings/setup.
FINE	Used for greater detail, when debugging/diagnosing problems.
FINER	Even greater detail.
FINEST	*The lowest value;* greatest detail.

In addition to these levels, there is a level `ALL`, which enables logging of all records, and one called `OFF` that can be used to turn off logging. It is also possible to define custom levels, but in this article we will stick with the predefined levels.



Related Reading

Java In a Nutshell
By David Flanagan

Table of Contents
Index
Sample Chapter
Read Online--Safari
Search this book on Safari:

Go

◇ Only This Book

◇ All of Safari

☐ Code Fragments only

So now we can explain why our logging record didn't appear. We used the `finest()` method of our logger, which generates a logging record at the `Level.FINEST` level. By default, only records at the `Level.INFO` level or higher will be logged to the console, so our record wasn't printed. We can cause our logging record to appear by increasing the logging level used in generating the record, like this:

```
package logging.example4;
import java.util.logging.Logger;
/**
 * A simple Java Hello World program, in the tradition of
 * Kernighan and Ritchie.
 */
public class HelloWorld {
  private static Logger theLogger =
      Logger.getLogger(HelloWorld.class.getName());

  public static void main(String[] args) {
      HelloWorld hello = new HelloWorld("Hello world!");
      hello.sayHello();
  }

  private String theMessage;

  public HelloWorld(String message) {
      theMessage = message;
  }

  public void sayHello() {
      theLogger.info("Hello logging!");
      System.err.println(theMessage);
  }
}
```

Now, when we run this program, we see output like this:

```
% java logging.example4.HelloWorld
INFO; 992149105222ms; 3207485;# 1; logging.example4.HelloWorld;
sayHello; Hello logging!
Hello world!
```

Of course, using a higher logging level for a logging record is not always what we want. Sometimes we have messages that are finer-grained than the `INFO` level, and we only want them printed when the information they contain is needed. To allow this, the logging library allows us to control the log level of our `Logger`s.

Logger Levels and Handlers

When we created our `Logger`, we specified the name of our class (`logging.example4.HelloWorld`) as the `Logger` name, but didn't specify anything else. Each `Logger` has its own `Level`, used to screen out any record which doesn't have a high enough level (this is part of what makes logging inexpensive at runtime when not turned up). By default, the threshold is set to `Level.INFO`. This means that records we log through our `Logger` will only get printed if they are at least has high as `Level.INFO`.

To get finer-grained records to be logged, we need to set the logging level for our class to something more verbose. But that isn't quite enough, because when a record is logged to a `Logger`, that `Logger` actually delegates the output of the record to a subclass of the `Handler` class, like this:

And each `Handler` has its own `Level`, in additon to the one for the `Logger`. So even if we turn up the log level of our `Logger`, when the logger hands the record to its handler(s), the handler(s) would ignore a `Level.FINE` record. To get the handler(s) to actually output the record, we need to turn up their level(s), like this:

```
package logging.example5;
import java.util.logging.Handler;
import java.util.logging.Level;
import java.util.logging.Logger;
import java.util.logging.LogManager;
/**
 * A simple Java Hello World program, in the tradition of
 * Kernighan and Ritchie.
 */
public class HelloWorld {
  private static Logger theLogger =
    Logger.getLogger(HelloWorld.class.getName());

  public static void main( String[] args ) {

    // The root logger's handlers default to INFO. We have to
    // crank them up. We could crank up only some of them
    // if we wanted, but we will turn them all up.
    Handler[] handlers =
      Logger.getLogger( "" ).getHandlers();
    for ( int index = 0; index < handlers.length; index++ ) {
      handlers[index].setLevel( Level.FINE );
    }

    // We also have to set our logger to log finer-grained
    // messages
    theLogger.setLevel(Level.FINE);
    HelloWorld hello =
      new HelloWorld("Hello world!");
      hello.sayHello();
    }

    private String theMessage;

    public HelloWorld(String message) {
      theMessage = message;
    }

    public void sayHello() {
      theLogger.fine("Hello logging!");
      System.err.println(theMessage);
    }
}
```

This will produce output on the console like this:

```
FINE; 992190676635ms; 5213611;# 1; logging.example5.HelloWorld;
sayHello; Hello logging!
Hello world!
```

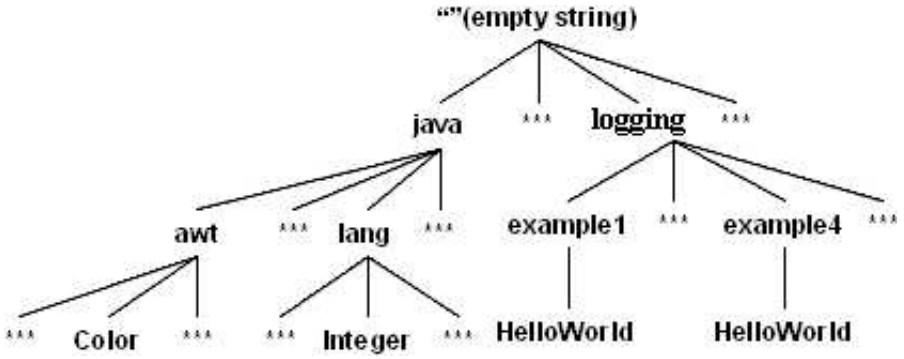
The Logging Hierarchy and Record Forwarding

This might lead you to wonder what handler is actually producing this output. After all, our test program didn't create any handler. The answer lies in the tree structure of loggers. Once a particular `Logger` decides to log a `LogRecord`, the `Logger` not only passes it to any `Handler(s)` attached to it, but it also forwards the record to its parent `Logger`. The parent `Logger` does not perform a level or `Filter` check, but instead forwards it to any attached `Handler(s)` and forwards it to its parent `Logger`. Eventually, the record reaches the root `Logger`. The root `Logger` has a `ConsoleHandler` that produces the output we see. Note that this forwarding behavior be controlled via the `setUseParentHandlers(boolean)` method in the `Logger` class.

There is much more that can be done with the provided handlers. It is also possible to create your own custom handlers. Space won't allow us to discuss them in more detail here; see the references below for places to learn more about handlers.

The `LogManager`

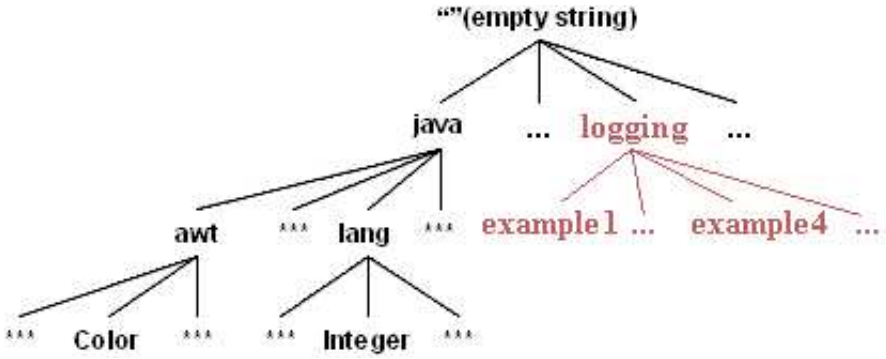
The `LogManager` is, in many ways, the central class of the logging library. It provides much of the control over what gets logged and where it gets logged, including control over initialization of logging. In terms of logging levels, it allows us to set different logging levels for different "areas" of the program. To understand this, we need to think of our program as being broken down into different areas based on the package prefix of the classes involved. So our program areas are organized in a tree structure, like this (only some of the tree is shown, to simplify the discussion):



But the `LogManager` will allow us to control things at more than just the class level. We could set the logging level for a package, or even a set of packages, by calling the `LogManager.setLevel(String name, Level level)` method. So, for example, we could set the logging level of all loggers for this article to `Level.FINE` by making this call:

```
LogManager.getLogManager().setLevel("logging", Level.FINE);
```

This would make every `Logger` with the package prefix of "`logging`" have a level of `Level.FINE`, unless that particular `Logger` already had a `Level` explicitly set:



We would still need to turn up the levels of the root handlers as before, but would not have to set the individual loggers one at a time.

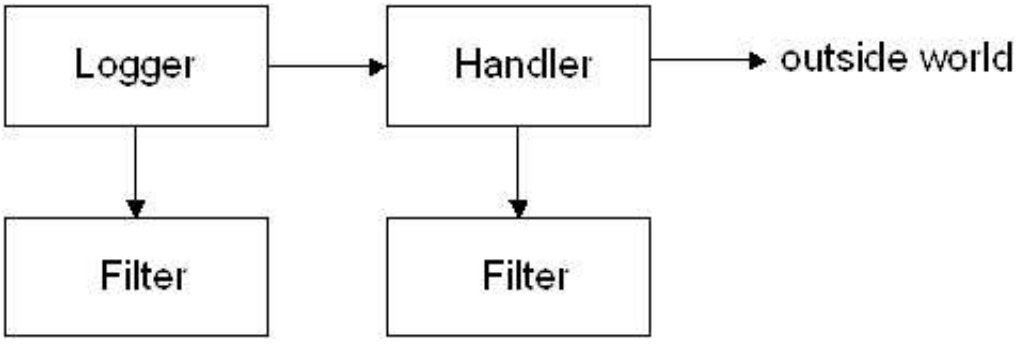
In addition to providing this ability to control log levels *en masse*, the `LogManager` provides:

- The means to manage and alter a set of global handlers (as described above).
- The ability to create new named `Logger`s (seen above).
- The ability to create anonymous `Logger`s (useful to applets running in a more constrained security environment).
- Get/Set the log `Level` of a given package prefix or class.

There is one thing to keep in mind when setting the level for a package and everything below it: any `Logger` for a class or package below the one being set that has had its `Level` explicitly set will keep that `Level`, as will any `Logger` whose `Level` is set subsequent to setting the package's `Level`. To get a `Logger` to pick up the setting for the package, you can set its `Level` to `null`.

About Filters

While space won't permit us to go into a description of `Filter`s, the logging API provides them as a means to further control what records get logged. So, if you are using logging and find that you want use more than the log `Level` of the record when deciding whether to log it, `Filter`s are there. They can be attached to both `Logger`s and `Handler`s, and can be thought of like this:



In this situation, the record must pass the `Logger`'s level check, the `Logger`'s `Filter`, the `Handler`'s level check, and the `Handler`'s `Filter` before it would actually be sent to the outside world. This allows things to start out simple (with no filters) and become more sophisticated as needed. In situations where you're trying to get at just the right information without altering the behavior of the program too much (and without overwhelming someone reading the output), the ability to create more sophisticated filters can be key to learning what needs to be known.

About Logger Names

This article demonstrates using the fully qualified class name of your class as the name of your `Logger`. This is the approach recommended by the Logging API documentation. However, the `LogManager` and `Loggers` really only care that the names used are made up of strings separated by period characters. So if you need to organize the logging of your software in some other manner, you can -- as long as your scheme fits into a tree hierarchy.

In addition, it is possible to use anonymous loggers, which don't have a name or affect any other loggers. These are good for applets running in a browser, as well as other high-security situations. They can also be used to keep classes relatively self-contained. However, when using anonymous loggers, you don't get many of the benefits of a named logger (the ability to have records forwarded to the global handlers, the ability to alter logging levels of groups of loggers by their common prefix, etc.).

Summary

The Logging API seems to strike a good balance between simplicity and power. As the examples above show, it is possible to get started with the Logging API very quickly, yet it is designed to be extensible so that it can be tailored to your needs. This article has really just scratched the surface of what can be done with logging. In particular, topics that we didn't discuss, which the API allows for, include:

- Use of `Filter`s.
- Custom `Filter`s.
- The `SocketHandler`.
- Writing your own `Handler`s.
- Altering the configuration of logging via custom config files.
- Internationalization.
- J2EE integration.

For more information about logging, the best sources of information are the JDK 1.4 documentation on logging and JSR 47. There is also Javadoc for the `java.util.logging` package, which provides details about the classes.

References

- The JDK 1.4 documentation on Logging
- The 1.4 Javadoc for Logging
- JSR 47
- The Lumberjack project (the Logging API for JDKs 1.2 & 1.3; open source)

Brian R. Gilstrap is an experienced Java developer, Mac user, Tai Chi practitioner and more.

Return to ONJava.com.

Copyright © 2005 O'Reilly Media, Inc.