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Chapter 13. java.nio and Subpackages

This chapter documents the New I/O API defined by the `java.nio` package and its subpackages. It covers:

`java.nio`

Defines the `Buffer` class and type-specific subclasses, most notably the `ByteBuffer` class that is heavily used for I/O in the `java.nio.channels` class.

`java.nio.channels`

Defines the `Channel` abstraction for high-performance I/O, and implements channels for file and network I/O. Also allows nonblocking I/O with the `Selector` class.

`java.nio.channels.spi`

The service provider interface for channel and selector implementations.

`java.nio.charset`

Defines classes for encoding sequences of characters into bytes and decoding sequences of bytes into characters, according to the encoding rules of a named charset.

`java.nio.charset.spi`

The service provider interface for charset implementations.

Package java.nio

Java 1.4

This package defines buffer classes that are fundamental to the `java.nio` API. See `Buffer` for an overview of buffers, and see `ByteBuffer` (the most important of the buffer classes) for full documentation of byte buffers. The other type-specific buffer classes are

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close analogs to `ByteBuffer` and are documented in terms of that class. See the `java.nio.channels` package for classes that perform I/O operations on buffers.

Classes

```
public abstract class Buffer;
   public abstract class ByteBuffer extends Buffer
   implements Comparable<ByteBuffer>;
      public abstract class MappedByteBuffer extends ByteBuffer;
   public abstract class CharBuffer extends Buffer
      implements Comparable<CharBuffer>, Appendable, CharSequence,
      Readable;
   public abstract class DoubleBuffer extends Buffer
   implements Comparable<DoubleBuffer>;
   public abstract class FloatBuffer extends Buffer
   implements Comparable<FloatBuffer>;
   public abstract class IntBuffer extends Buffer
   implements Comparable<IntBuffer>;
   public abstract class LongBuffer extends Buffer
   implements Comparable<LongBuffer>;
   public abstract class ShortBuffer extends Buffer
   implements Comparable<ShortBuffer>;
public final class ByteOrder;
```

Exceptions

```
public class BufferOverflowException extends RuntimeException;
public class BufferUnderflowException extends RuntimeException;
public class InvalidMarkException extends IllegalStateException;
public class ReadOnlyBufferException extends UnsupportedOperationException;
```

Buffer java.nio

Java 1.4

This class is the abstract superclass of all buffer classes in the `java.nio` API. A *`buffer`* is a linear (finite) sequence of prmitive values. The `java.nio` package defines a `Buffer` subclass for each primitive type in Java except for `boolean`. `Buffer` itself defines the common, type-independent features of all buffers. `Buffer` and its subclasses are intended for use by a single thread at a time, and contain no synchronization code to make them thread-safe.

The purpose of a buffer is to store data, and buffer classes must define methods for reading data from a buffer and writing data into a buffer. Because each `Buffer` subclass stores data of a different primitive type, however, the `get( )` and `put( )` methods that read and write data must be defined by each of the individual subclasses. See `ByteBuffer` (the most important subclass) for documentation of these methods; all the other subclasses define similar methods which differ only in the datatype of the values being read or written.

Each buffer has four numbers associated with it:

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Buffer defines several methods that perform important operations on a buffer:

Buffer objects may be read-only, in which case any attempt to store data in the buffer results in a `ReadonlyBufferException`. The `isReadOnly( )` method returns `true` if a buffer is read-only.

```
public abstract class Buffer {
// No Constructor
// Public Instance Methods
     public final int capacity( );
     public final Buffer clear( );  omu
     public final Buffer flip( );
     public final boolean hasRemaining( );
     public abstract boolean isReadOnly( );
     public final int limit( );
     public final Buffer limit(int newLimit);
     public final Buffer mark( );
     public final int position( );
     public final Buffer position(int newPosition);
     public final int remaining( );
     public final Buffer reset( );
     public final Buffer rewind( );
}
```

Subclasses

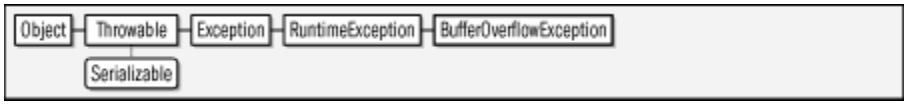
`ByteBuffer`, `CharBuffer`, `DoubleBuffer`, `FloatBuffer`, `IntBuffer`, `LongBuffer`, `ShortBuffer`

BufferOverflowException java.nio

Java 1.4 ***serializable unchecked***

Signals that a relative `put( )` operation on a buffer could not complete because the number of elements to write exceeds the number of remaining elements between the buffer's position and its limit.

Figure 13-1. java.nio.BufferOverflowException




```
public class BufferOverflowException extends RuntimeException {
// Public Constructors
     public BufferOverflowException( );
}
```

BufferUnderflowException java.nio

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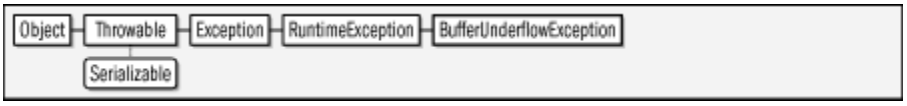
Java 1.4 ***serializable unchecked***

Signals that a relative `get( )` operation on a buffer could not complete because the number of elements to read exceeds the number of remaining elements between the buffer's position and its limit.

Figure 13-2. java.nio.BufferUnderflowException




```
public class BufferUnderflowException extends RuntimeException {
// Public Constructors
     public BufferUnderflowException( );
}
```

ByteBuffer **java.nio**

Java 1.4 ***comparable***

`ByteBuffer` holds a sequence of bytes for use in an I/O operation. `ByteBuffer` is an abstract class, so you cannot instantiate one by calling a constructor. Instead, you must use `allocate( )` , `allocateDirect( )`, or `wrap( )`.

`allocate( )` returns a `ByteBuffer` with the specified capacity. The position of this new buffer is zero, and its limit is set to its capacity. `allocateDirect( )` is like `allocate( )` except that it attempts to allocate a buffer that the underlying operating system can use "directly." Such direct buffers" may be substantially more efficient for low-level I/O operations than normal buffers, but may also have significantly larger allocation costs.

If you have already allocated an array of bytes, you can use the `wrap( )` method to create a `ByteBuffer` that uses the byte array as its storage. In the one-argument version of `wrap( )` you specify only the array; the buffer capacity and limit are set to the array length, and the position is set to zero. In the other form of `wrap( )` you specify the array, as well as an offset and length that specify a portion of that array. The capacity of the resulting `ByteBuffer` is again set to the total array length, but its position is set to the specified offset, and its limit is set to the offset plus length.

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Once you have obtained a `ByteBuffer`, you can use the various `get( )` and `put( )` methods to read data from it or write data into it. Several versions of these methods exist to read and write single bytes or arrays of bytes. The single-byte methods come in two forms. Relative `get( )` and `put( )` methods query or set the byte at the current position and then increment the position. The absolute forms of the methods take an additional arguement that specifies the buffer element that is to be read or written and do not affect the buffer position. Two other relative forms of the `get( )` method exist to read as sequence of bytes (starting at and incrementing the buffer's position) into a specified byte array or a specified sub-array. These methods throw a `BufferUnderflowException` if there are not enough bytes left in the buffer. Two relative forms of the `put( )` method copy bytes from a specified array or sub-array into the buffer (starting at and incrementing the buffer's position). They throw a `BufferOverflowException` if there is not enough room left in the buffer to hold the bytes. One final form of the `put( )` method transfers all the remaining bytes from one `ByteBuffer` into this buffer, incrementing the positions of both buffers.

In addition to the `get( )` and `put( )` methods, `ByteBuffer` also defines another operation that affect the buffer's content. `compact( )` discards any bytes before the buffer position, and copies all bytes between the position and limit to the beginning of the buffer. The position is then set to the new limit, and the limit is set to the capacity. This method compacts a buffer by discarding elements that have already been read, and then prepares the buffer for appending new elements to those that remain.

All `Buffer` subclasses, such as `CharBuffer`, `IntBuffer` and `FloatBuffer` have analogous methods which are just like these `get( )` and `put( )` methods except that they operate on different data types. `ByteBuffer` is unique among `Buffer` subclasses in that it has additional methods for reading and writing values of other primitive types from and into the byte buffer. These methods have names like `getInt( )` and `putChar( )`, and there are methods for all primitive types except `byte` and `boolean`. Each method reads or writes a single primitive value. Like the `get( )` and `put( )` methods, they come in relative and absolute variations: the relative methods start with the byte at the buffer's position, and increment the position by the appropriate number of bytes (two bytes for a `char`, four bytes for an `int`, eight bytes for a `double`, etc.). The absolute methods take an buffer index (it is a byte index and is not multiplied by the size of the primitive value) as an argument and do not modify the buffer position. The encoding of multi-byte primitive values into a byte buffer can be done most-significant byte to least-significant byte ("big-endian byte order") or the reverse ("little-endian byte order"). The byte order used by these primitive-type get and put methods is specified by a `ByteOrder` object. The byte order for a `ByteBuffer` can be queried and set with the two forms of the `order( )` method. The default byte order for all newly-created `ByteBuffer` objects is `ByteOrder.BIG_ENDIAN`.

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Other methods that are unique to `ByteBuffer( )` are a set of methods that allow a buffer of bytes to be viewed as a buffer of other primitive types. `asCharBuffer( )`, `asIntBuffer( )` and related methods return "view buffers" that allow the bytes between the position and the limit of the underlying `ByteBuffer` to be viewed as a sequence of characters, integers, or other primitive values. The returned buffers have position, limit, and mark values that are independent of those of the underlying buffer. The initial position of the returned buffer is zero, and the limit and capacity are the number of bytes between the position and limit of the original buffer divided by the size in bytes of the relevant primitive type (two for `char` and `short`, four for `int` and `float`, and eight for `long` and `double`). Note that the returned view buffer is a view of the bytes between the position and limit of the byte buffer. Subsequent changes to the position and limit of the byte buffer do not change the size of the view buffer, but changes to the bytes themselves to change the values that are viewed through the view buffer. View buffers use the byte ordering that was current in the byte buffer when they were created; subsequent changes to the byte order of the byte buffer do not affect the view buffer. If the underlying byte buffer is direct, then the returned buffer is also direct; this is important because `ByteBuffer` is the only buffer class with an `allocateDirect( )` method.

`ByteBuffer` defines some additional methods, which, like the `get( )` and `put( )` methods have analogs in all `Buffer` subclasses. `duplicate( )` returns a new buffer that shares the content with this one. The two buffers have independent position, limit, and mark values, although the duplicate buffer starts off with the same values as the original buffer. The duplicate buffer is direct if the original is direct and is read-only if the original is read-only. The buffers share content, and content changes made to either buffer are visible through the other. `asReadOnlyBuffer( )` is like `duplicate( )` except that the returned buffer is read-only, and all of its `put( )` and related methods throw a `ReadOnlyBufferException`. `slice( )` is also somewhat like `duplicate( )` except the returned buffer represents only the content between the current position and limit. The returned buffer has a position of zero, a limit and capacity equal to the number of remaining elements in this buffer, and an undefined mark. `isDirect( )` is a simple method that returns `true` if a buffer is a direct buffer and `false` otherwise. If this buffer has a backing array and is not a read-only buffer (e.g., if it was created with the `allocate( )` or `wrap( )` methods) then `hasArray( )` returns `true`, `array( )` returns the backing array, and `arrayOffset( )` returns the offset within that array of the first element of the buffer. If `hasArray( )` returns false, then `array( )` and `arrayOffset( )` may throw an `UnsupportedOperationException` or a `ReadOnlyBufferException`.

Finally, `ByteBuffer` and other `Buffer` subclasses override several standard object methods. The `equals( )` methods compares the elements between the position and limit of two buffers and returns `true` only if there are the same number and have the same

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value. Note that elements before the position of the buffer are not considered. The `hashCode( )` method is implemented to match the `equals( )` method: the hashcode is based only upon the elements between the position and limit of the buffer. This means that the hashcode changes if either the contents or position of the buffer changes. This means that instances of `ByteBuffer` and other `Buffer` subclasses are not usually useful as keys for hashtables or `java.util.Map` objects. `toString( )` returns a string summary of the buffer, but the precise contents of the string are unspecified. `ByteBuffer` and each of the other `Buffer` subclasses also implement the `Comparable` interface and define a `compareTo( )` method that performs an element-by-element comparison operation on the buffer elements between the position and the limit of the buffer.

Figure 13-3. java.nio.ByteBuffer


```
public abstract class ByteBuffer extends Buffer
implements Comparable<ByteBuffer> {
// No Constructor
// Public Class Methods
     public static ByteBuffer allocate(int capacity);
     public static ByteBuffer allocateDirect(int capacity);
     public static ByteBuffer wrap(byte[ ] array);
     public static ByteBuffer wrap(byte[ ] array, int offset, int length);
// Public Instance Methods
     public final byte[ ] array( );
     public final int arrayOffset( );
     public abstract CharBuffer asCharBuffer( );
     public abstract DoubleBuffer asDoubleBuffer( );
     public abstract FloatBuffer asFloatBuffer( );
     public abstract IntBuffer asIntBuffer( );
     public abstract LongBuffer asLongBuffer( );
     public abstract ByteBuffer asReadOnlyBuffer( );
     public abstract ShortBuffer asShortBuffer( );
     public abstract ByteBuffer compact( );
     public abstract ByteBuffer duplicate( );
     public abstract byte get( );
     public abstract byte get(int index);
     public ByteBuffer get(byte[ ] dst);
     public ByteBuffer get(byte[ ] dst, int offset, int length);
     public abstract char getChar( );
     public abstract char getChar(int index);
     public abstract double getDouble( );
     public abstract double getDouble(int index);
     public abstract float getFloat( );
     public abstract float getFloat(int index);
     public abstract int getInt( );
     public abstract int getInt(int index);
     public abstract long getLong( );
     public abstract long getLong(int index);
     public abstract short getShort( );
     public abstract short getShort(int index);
     public final boolean hasArray( );
     public abstract boolean isDirect( );
     public final ByteOrder order( );
     public final ByteBuffer order(ByteOrder bo);
     public ByteBuffer put(ByteBuffer src);
     public abstract ByteBuffer put(byte b);
     public final ByteBuffer put(byte[ ] src);
```


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```
        public abstract ByteBuffer put(int index, byte b);
        public ByteBuffer put(byte[ ] src, int offset, int length);
        public abstract ByteBuffer putChar(char value);
        public abstract ByteBuffer putChar(int index, char value);
        public abstract ByteBuffer putDouble(double value);
        public abstract ByteBuffer putDouble(int index, double value);
        public abstract ByteBuffer putFloat(float value);
        public abstract ByteBuffer putFloat(int index, float value);
        public abstract ByteBuffer putInt(int value);
        public abstract ByteBuffer putInt(int index, int value);
        public abstract ByteBuffer putLong(long value);
        public abstract ByteBuffer putLong(int index, long value);
        public abstract ByteBuffer putShort(short value);
        public abstract ByteBuffer putShort(int index, short value);
        public abstract ByteBuffer slice( );
    // Methods Implementing Comparable
    5.0  public int compareTo(ByteBuffer that);
    // Public Methods Overriding Object
        public boolean equals(Object ob);
        public int hashCode( );
        public String toString( );
    }
```

Subclasses

`MappedByteBuffer`

Passed To

Too many methods to list.

Returned By

`java.nio.charset.Charset.encode( )`, `java.nio.charset.CharsetEncoder.encode( )`

ByteOrder java.nio

Java 1.4

This class is a type-safe enumeration of byte orders, and is used by the `ByteBuffer` class. The two constant fields define the two legal byte order values: `BIG_ENDIAN` byte order means most-significant-byte first. `LITTLE_ENDIAN` means least-significant-byte first. The static `nativeOrder( )` method returns whichever of these two constants represents the native byte order of the underlying operating system and hardware. Finally, the `toString( )` method returns the string "BIG_ENDIAN" or "LITTLE_ENDIAN".

```
public final class ByteOrder {
// No Constructor
// Public Constants
    public static final ByteOrder BIG_ENDIAN;
    public static final ByteOrder LITTLE_ENDIAN;
// Public Class Methods
    public static ByteOrder nativeOrder( );
// Public Methods Overriding Object
    public String toString( );
}
```


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Passed To

`ByteBuffer.order( )`

Returned By

`ByteBuffer.order( ), CharBuffer.order( ), DoubleBuffer.order( ), FloatBuffer.order( ), IntBuffer.order( ), LongBuffer.order( ), ShortBuffer.order( )`

CharBuffer java.nio

Java 1.4 ***comparable appendable readable***

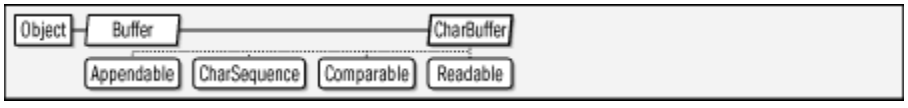
`CharBuffer` holds a sequence of Unicode character values for use in an I/O operation. Most of the methods of this class are directly analogous to methods defined by `ByteBuffer` except that they use `char` and `char[ ]` argument and return values instead of `byte` and `byte[ ]` values. See `ByteBuffer` for details.

In addition to the `ByteBuffer` analogs, this class also implements the `java.lang.CharSequence` interface so that it can be used with `java.util.regex` regular expression operations or anywhere else a `CharSequence` is expected. In Java 5.0, `CharBuffer` adds the `append( )` and `read( )` methods of the `java.lang.Appendable` and `java.lang.Readable` interfaces, making `CharBuffer` objects suitable for use with the `Formatter` and `Scanner` classes of `java.util`.

Note that `CharBuffer` is an abstract class and does not defined a constructor. There are three ways to obtain a `CharBuffer`:

Note that this class holds a sequence of 16-bit Unicode characters, and does not represent text in any other encoding. Classes in the `java.nio.charset` package can be used to encode a `CharBuffer` of Unicode characters into a `ByteBuffer`, or decode the bytes in a `ByteBuffer` into a `CharBuffer` of Unicode text. Java 5.0 supports Unicode supplementary characters that do not fit in 16 bits. See `java.lang.Character` for details. Note that `CharBuffer` does not include any utility methods for working with `int` codepoints or surrogate pairs.

Figure 13-4. java.nio.CharBuffer



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```
public abstract class CharBuffer extends Buffer
implements Comparable<CharBuffer>, Appendable, CharSequence, Readable {
// No Constructor
// Public Class Methods
     public static CharBuffer allocate(int capacity);
     public static CharBuffer wrap(char[ ] array);
     public static CharBuffer wrap(CharSequence csq);
     public static CharBuffer wrap(char[ ] array, int offset, int length);
     public static CharBuffer wrap(CharSequence csq, int start, int end);
// Public Instance Methods
5.0  public CharBuffer append(char c);
5.0  public CharBuffer append(CharSequence csq);
5.0  public CharBuffer append(CharSequence csq, int start, int end);
     public final char[ ] array( );
     public final int arrayOffset( );
     public abstract CharBuffer asReadOnlyBuffer( );
     public abstract CharBuffer compact( );
     public abstract CharBuffer duplicate( );
     public abstract char get( );
     public abstract char get(int index);
     public CharBuffer get(char[ ] dst);
     public CharBuffer get(char[ ] dst, int offset, int length);
     public final boolean hasArray( );
     public abstract boolean isDirect( );
     public abstract ByteOrder order( );
     public final CharBuffer put(char[ ] src);
     public CharBuffer put(CharBuffer src);
     public final CharBuffer put(String src);
     public abstract CharBuffer put(char c);
     public abstract CharBuffer put(int index, char c);
     public CharBuffer put(String src, int start, int end);
     public CharBuffer put(char[ ] src, int offset, int length);
     public abstract CharBuffer slice( );
// Methods Implementing CharSequence
     public final char charAt(int index);
     public final int length( );
     public abstract CharSequence subSequence(int start, int end);
     public String toString( );
// Methods Implementing Comparable
5.0  public int compareTo(CharBuffer that);
// Methods Implementing Readable
5.0  public int read(CharBuffer target) throws java.io.IOException;
// Public Methods Overriding Object
     public boolean equals(Object ob);
     public int hashCode( );
}
```

Passed To

java.io.Reader.read( ),Readable.read( ), java.nio.charset.Charset.encode( ), java.nio.charset.CharsetDecoder.{decode( ),decodeLoop( ),flush( ), implFlush( )},java.nio.charset.CharsetEncoder.{encode( ), encodeLoop( )}

Returned By

ByteBuffer.asCharBuffer( ),java.nio.charset.Charset.decode( ), java.nio.charset.CharsetDecoder.decode( )

DoubleBuffer java.nio

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Java 1.4 ***comparable***

`DoubleBuffer` holds a sequence of `double` values for use in an I/O operation. Most of the methods of this class are directly analogous to methods defined by `ByteBuffer` except that they use `double` and `double[ ]` argument and return values instead of `byte` and `byte[ ]` values. See `ByteBuffer` for details.

`DoubleBuffer` is abstract and has no constructor. Create one by calling the static `allocate( )` or `wrap( )` methods, which are also analogs of `ByteBuffer` methods. Or, create a "view" `DoubleBuffer` by calling the `asDoubleBuffer( )` method of an underlying `ByteBuffer`.

Figure 13-5. java.nio.DoubleBuffer


```
public abstract class DoubleBuffer extends Buffer
implements Comparable<DoubleBuffer> {
// No Constructor
// Public Class Methods
     public static DoubleBuffer allocate(int capacity);
     public static DoubleBuffer wrap(double[ ] array);
     public static DoubleBuffer wrap(double[ ] array, int offset, int length);
// Public Instance Methods
     public final double[ ] array( );
     public final int arrayOffset( );
     public abstract DoubleBuffer asReadOnlyBuffer( );
     public abstract DoubleBuffer compact( );
     public abstract DoubleBuffer duplicate( );
     public abstract double get( );
     public abstract double get(int index);
     public DoubleBuffer get(double[ ] dst);
     public DoubleBuffer get(double[ ] dst, int offset, int length);
     public final boolean hasArray( );
     public abstract boolean isDirect( );
     public abstract ByteOrder order( );
     public DoubleBuffer put(DoubleBuffer src);
     public abstract DoubleBuffer put(double d);
     public final DoubleBuffer put(double[ ] src);
     public abstract DoubleBuffer put(int index, double d);
     public DoubleBuffer put(double[ ] src, int offset, int length);
     public abstract DoubleBuffer slice( );
// Methods Implementing Comparable
5.0  public int compareTo(DoubleBuffer that);
// Public Methods Overriding Object
     public boolean equals(Object ob);
     public int hashCode( );
     public String toString( );
}
```

Returned By

`ByteBuffer.asDoubleBuffer( )`

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FloatBuffer **java.nio**

Java 1.4 ***comparable***

`FloatBuffer` holds a sequence of `float` values for use in an I/O operation. Most of the methods of this class are directly analogous to methods defined by `ByteBuffer` except that they use `float` and `float[ ]` argument and return values instead of `byte` and `byte[ ]` values. See `ByteBuffer` for details.

`FloatBuffer` is abstract and has no constructor. Create one by calling the static `allocate( )` or `wrap( )` methods, which are also analogs of `ByteBuffer` methods. Or, create a "view" `FloatBuffer` by calling the `asFloatBuffer( )` method of an underlying `ByteBuffer`.

Figure 13-6. java.nio.FloatBuffer


```
public abstract class FloatBuffer extends Buffer
implements Comparable<FloatBuffer> {
// No Constructor
// Public Class Methods
     public static FloatBuffer allocate(int capacity);
     public static FloatBuffer wrap(float[ ] array);
     public static FloatBuffer wrap(float[ ] array, int offset, int length);
// Public Instance Methods
     public final float[ ] array( );
     public final int arrayOffset( );
     public abstract FloatBuffer asReadOnlyBuffer( );
     public abstract FloatBuffer compact( );
     public abstract FloatBuffer duplicate( );
     public abstract float get( );
     public abstract float get(int index);
     public FloatBuffer get(float[ ] dst);
     public FloatBuffer get(float[ ] dst, int offset, int length);
     public final boolean hasArray( );
     public abstract boolean isDirect( );
     public abstract ByteOrder order( );
     public FloatBuffer put(FloatBuffer src);
     public abstract FloatBuffer put(float f);
     public final FloatBuffer put(float[ ] src);
     public abstract FloatBuffer put(int index, float f);
     public FloatBuffer put(float[ ] src, int offset, int length);
     public abstract FloatBuffer slice( );
// Methods Implementing Comparable
5.0  public int compareTo(FloatBuffer that);
// Public Methods Overriding Object
     public boolean equals(Object ob);
     public int hashCode( );
     public String toString( );
}
```


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Returned By

`ByteBuffer.asFloatBuffer( )`

IntBuffer java.nio

Java 1.4 ***comparable***

`IntBuffer` holds a sequence of `int` values for use in an I/O operation. Most of the methods of this class are directly analogous to methods defined by `ByteBuffer` except that they use `int` and `int[ ]` argument and return values instead of `byte` and `byte[ ]` values. See `ByteBuffer` for details.

`IntBuffer` is abstract and has no constructor. Create one by calling the static `allocate( )` or `wrap( )` methods, which are also analogs of `ByteBuffer` methods. Or, create a "view" `IntBuffer` by calling the `asIntBuffer( )` method of an underlying `ByteBuffer`.

Figure 13-7. java.nio.IntBuffer


```
public abstract class IntBuffer extends Buffer implements Comparable<IntBuffer> {
// No Constructor
// Public Class Methods
     public static IntBuffer allocate(int capacity);
     public static IntBuffer wrap(int[ ] array);
     public static IntBuffer wrap(int[ ] array, int offset, int length);
// Public Instance Methods
     public final int[ ] array( );
     public final int arrayOffset( );
     public abstract IntBuffer asReadOnlyBuffer( );
     public abstract IntBuffer compact( );
     public abstract IntBuffer duplicate( );
     public abstract int get( );
     public abstract int get(int index);
     public IntBuffer get(int[ ] dst);
     public IntBuffer get(int[ ] dst, int offset, int length);
     public final boolean hasArray( );
     public abstract boolean isDirect( );
     public abstract ByteOrder order( );
     public IntBuffer put(IntBuffer src);
     public abstract IntBuffer put(int i);
     public final IntBuffer put(int[ ] src);
     public abstract IntBuffer put(int index, int i);
     public IntBuffer put(int[ ] src, int offset, int length);
     public abstract IntBuffer slice( );
// Methods Implementing Comparable
5.0  public int compareTo(IntBuffer that);
// Public Methods Overriding Object
     public boolean equals(Object ob);
     public int hashCode( );
     public String toString( );
}
```


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Returned By

`ByteBuffer.asIntBuffer( )`

InvalidMarkException java.nio

Java 1.4 ***serializable unchecked***

Signals that a buffer's position cannot be `reset( )` because there is no mark defined.

Figure 13-8. java.nio.InvalidMarkException


```
public class InvalidMarkException extends IllegalStateException {
// Public Constructors
     public InvalidMarkException( );
}
```

LongBuffer java.nio

Java 1.4 ***comparable***

`LongBuffer` holds a sequence of `long` values for use in an I/O operation. Most of the methods of this class are directly analogous to methods defined by `ByteBuffer` except that they use `long` and `long[ ]` argument and return values instead of `byte` and `byte[ ]` values. See `ByteBuffer` for details.

`LongBuffer` is abstract and has no constructor. Create one by calling the static `allocate( )` or `wrap( )` methods, which are also analogs of `ByteBuffer` methods. Or, create a "view" `LongBuffer` by calling the `asLongBuffer( )` method of an underlying `ByteBuffer`.

Figure 13-9. java.nio.LongBuffer

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```
public abstract class LongBuffer extends Buffer
implements Comparable<LongBuffer> {
// No Constructor
// Public Class Methods
     public static LongBuffer allocate(int capacity);
     public static LongBuffer wrap(long[ ] array);
     public static LongBuffer wrap(long[ ] array, int offset, int length);
// Public Instance Methods
     public final long[ ] array( );
     public final int arrayOffset( );
     public abstract LongBuffer asReadOnlyBuffer( );
     public abstract LongBuffer compact( );
     public abstract LongBuffer duplicate( );
     public abstract long get( );
     public abstract long get(int index);
     public LongBuffer get(long[ ] dst);
     public LongBuffer get(long[ ] dst, int offset, int length);
     public final boolean hasArray( );
     public abstract boolean isDirect( );
     public abstract ByteOrder order( );
     public LongBuffer put(LongBuffer src);
     public abstract LongBuffer put(long l);
     public final LongBuffer put(long[ ] src);
     public abstract LongBuffer put(int index, long l);
     public LongBuffer put(long[ ] src, int offset, int length);
     public abstract LongBuffer slice( );
// Methods Implementing Comparable
5.0  public int compareTo(LongBuffer that);
// Public Methods Overriding Object
     public boolean equals(Object ob);
     public int hashCode( );
     public String toString( );
}
```

Returned By

`ByteBuffer.asLongBuffer( )`

MappedByteBuffer java.nio

Java 1.4 ***comparable***

This class is a `ByteBuffer` that represents a memory-mapped portion of a file. Create a `MappedByteBuffer` by calling the `map( )` method of a `java.nio.channels.FileChannel`. All `MappedByteBuffer` buffers are direct buffers.

`isLoaded( )` returns a hint as to whether the contents of the buffer are currently in primary memory (as opposed to resident on disk). If it returns `true`, then operations on the buffer will probably execute very quickly. The `load( )` method requests (but does not require) that the operating system load the buffer contents into primary memory. It is not guaranteed to succeed. For buffers that are mapped in read/write mode, the `force( )` method outputs any changes that have been made to the buffer contents to the underlying

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file. If the file is on a local device, then it is guaranteed to be updated before `force( )` returns. No such guarantees can be made for mapped network files.

Note that the underlying file of a `MappedByteBuffer` may be shared, which means that the contents of such a buffer can change asynchronously if the contents of the file are modified by another thread or another process (such asynchronous changes to the underlying file may or may not be visible through the buffer; this is a platform-dependent, and should not be relied on). Furthermore, if another thread or process truncates the file, some or all of the elements of the buffer may no longer map to any content of the file. An attempt to read or write such an inaccesible element of the buffer will cause an implementation-defined exception, either immediately or at some later time.

Figure 13-10. java.nio.MappedByteBuffer


```
public abstract class MappedByteBuffer extends ByteBuffer {
// No Constructor
// Public Instance Methods
     public final MappedByteBuffer force( );
     public final boolean isLoaded( );
     public final MappedByteBuffer load( );
}
```

Returned By

`java.nio.channels.FileChannel.map( )`

ReadOnlyBufferException java.nio

Java 1.4 ***serializable unchecked***

Signals that a buffer is read-only and that its `put( )` or `compact( )` methods are not allowed to modify the buffer contents.

Figure 13-11. java.nio.ReadOnlyBufferException


```
public class ReadOnlyBufferException extends UnsupportedOperationException {
// Public Constructors
     public ReadOnlyBufferException( );
}
```


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ShortBuffer **java.nio**

Java 1.4 ***comparable***

`ShortBuffer` holds a sequence of `short` values for use in an I/O operation. Most of the methods of this class are directly analogous to methods defined by `ByteBuffer` except that they use `short` and `short[ ]` argument and return values instead of `byte` and `byte[ ]` values. See `ByteBuffer` for details.

`ShortBuffer` is abstract and has no constructor. Create one by calling the static `allocate( )` or `wrap( )` methods, which are also analogs of `ByteBuffer` methods. Or, create a "view" `ShortBuffer` by calling the `asShortBuffer( )` method of an underlying `ByteBuffer`.

Figure 13-12. java.nio.ShortBuffer


```
public abstract class ShortBuffer extends Buffer
implements Comparable<ShortBuffer> {
// No Constructor
// Public Class Methods
     public static ShortBuffer allocate(int capacity);
     public static ShortBuffer wrap(short[ ] array);
     public static ShortBuffer wrap(short[ ] array, int offset, int length);
// Public Instance Methods
     public final short[ ] array( );
     public final int arrayOffset( );
     public abstract ShortBuffer asReadOnlyBuffer( );
     public abstract ShortBuffer compact( );
     public abstract ShortBuffer duplicate( );
     public abstract short get( );
     public abstract short get(int index);
     public ShortBuffer get(short[ ] dst);
     public ShortBuffer get(short[ ] dst, int offset, int length);
     public final boolean hasArray( );
     public abstract boolean isDirect( );
     public abstract ByteOrder order( );
     public ShortBuffer put(ShortBuffer src);
     public abstract ShortBuffer put(short s);
     public final ShortBuffer put(short[ ] src);
     public abstract ShortBuffer put(int index, short s);
     public ShortBuffer put(short[ ] src, int offset, int length);
     public abstract ShortBuffer slice( );
// Methods Implementing Comparable
5.0  public int compareTo(ShortBuffer that);
// Public Methods Overriding Object
     public boolean equals(Object ob);
     public int hashCode( );
     public String toString( );
}
```


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Returned By

`ByteBuffer.asShortBuffer( )`

Package java.nio.channels

Java 1.4

This package is at the heart of the NIO API. A *channel* is a communication channel for transferring bytes from or to a `java.nio.ByteBuffer`. Channels serve a similar purpose to the `InputStream` and `OutputStream` classes of the `java.io` package, but are completely unrelated to those classes, and provide important features not available with the `java.io` API. The `Channels` class defines methods that bridge the `java.io` and `java.nio.channels` APIs, by returning channels based on streams and streams based on channels.

The `Channel` interface simply defines methods for testing whether a channel is open and for closing a channel. The other interfaces in the package extend `Channel` and define `read( )` and `write( )` methods for reading bytes from the channel into one or more byte buffers and for writing bytes from one or more byte buffers to the channel.

The `FileChannel` class defines an channel-based API for reading and writing from files (and also provides other important file functionality such as file locking and memory mapping that is not available through the `java.io` package). `SocketChannel`, `ServerSocketChannel`, and `DatagramChannel` are channels for communication over a network, and `Pipe` defines two inner classes that use the channel abstraction for communication between threads.

The network and pipe channels are all subclasses of the `SelectableChannel` class, and may be put into nonblocking mode, in which calls to `read( )` and `write( )` return immediately, even if the channel is not ready for reading or writing. nonblocking IO and networking is not possible using the stream abstraction of the `java.io` and `java.net` packages, and is perhaps the most important new feature of the `java.nio` API. The `Selector` class is crucial to the efficient use of nonblocking channels: it allows a program to register interested in I/O operations on several different channels at once. A call to the `select( )` method of a `Selector` will block until one of those channels becomes ready for I/O, and will then wake up. This technique is important for writing scalable high-performance network servers. See `Selector` and `SelectionKey` for details.

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Finally, this package allows for very fine-grained error handling by defining a large number of exception classes, several of which may be thrown by only a single method within the `java.nio` API.

Interfaces

```
public interface ByteChannel extends ReadableByteChannel, WritableByteChannel;
public interface Channel extends java.io.Closeable;
public interface GatheringByteChannel extends WritableByteChannel;
public interface InterruptibleChannel extends Channel;
public interface ReadableByteChannel extends Channel;
public interface ScatteringByteChannel extends ReadableByteChannel;
public interface WritableByteChannel extends Channel;
```

Classes

```
public final class Channels;
public abstract class DatagramChannel extends java.nio.channels.spi.
AbstractSelectableChannel
      implements ByteChannel, GatheringByteChannel, ScatteringByteChannel;
public abstract class FileChannel extends java.nio.channels.spi.
AbstractInterruptibleChannel
      implements ByteChannel, GatheringByteChannel, ScatteringByteChannel;
public static class FileChannel.MapMode;
public abstract class FileLock;
public abstract class Pipe;
public abstract static class Pipe.SinkChannel extends java.nio.channels.spi.
AbstractSelectableChannel
      implements GatheringByteChannel, WritableByteChannel;
public abstract static class Pipe.SourceChannel extends java.nio.channels.spi.
AbstractSelectableChannel
      implements ReadableByteChannel, ScatteringByteChannel;
public abstract class SelectableChannel extends java.nio.channels.spi.
AbstractInterruptibleChannel
      implements Channel;
public abstract class SelectionKey;
public abstract class Selector;
public abstract class ServerSocketChannel extends java.nio.channels.spi.
AbstractSelectableChannel;
public abstract class SocketChannel extends java.nio.channels.spi.
AbstractSelectableChannel
      implements ByteChannel, GatheringByteChannel, ScatteringByteChannel;
```

Exceptions

```
public class AlreadyConnectedException extends IllegalStateException;
public class CancelledKeyException extends IllegalStateException;
public class ClosedChannelException extends java.io.IOException;
   public class AsynchronousCloseException extends ClosedChannelException;
      public class ClosedByInterruptException extends AsynchronousCloseException;
public class ClosedSelectorException extends IllegalStateException;
public class ConnectionPendingException extends IllegalStateException;
public class FileLockInterruptionException extends java.io.IOException;
public class IllegalBlockingModeException extends IllegalStateException;
public class IllegalSelectorException extends IllegalArgumentException;
public class NoConnectionPendingException extends IllegalStateException;
public class NonReadableChannelException extends IllegalStateException;
public class NonWritableChannelException extends IllegalStateException;
public class NotYetBoundException extends IllegalStateException;
public class NotYetConnectedException extends IllegalStateException;
public class OverlappingFileLockException extends IllegalStateException;
public class UnresolvedAddressException extends IllegalArgumentException;
public class UnsupportedAddressTypeException extends IllegalArgumentException;
```

AlreadyConnectedException java.nio.channels

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Java 1.4 ***serializable unchecked***

Thrown by a call to `connect( )` on a `SocketChannel` that is already connected.

Figure 13-13. java.nio.channels.AlreadyConnectedException


```
public class AlreadyConnectedException extends IllegalStateException {
// Public Constructors
     public AlreadyConnectedException( );
}
```

AsynchronousCloseException **java.nio.channels**

Java 1.4 ***serializable checked***

Signals the termination of a blocked I/O operation because another thread closed the channel asynchronously. See also `ClosedByInterruptException`.

Figure 13-14. java.nio.channels.AsynchronousCloseException


```
public class AsynchronousCloseException extends ClosedChannelException {
// Public Constructors
     public AsynchronousCloseException( );
}
```

Subclasses

`ClosedByInterruptException`

Thrown By

`java.nio.channels.spi.AbstractInterruptibleChannel.end( )`

ByteChannel **java.nio.channels**

Java 1.4 ***closeable***

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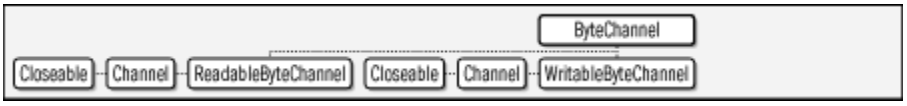
This interface extends `ReadableByteChannel` and `WritableByteChannel` but adds no methods or constants of its own. It exists simply as a convience that to unify the two interfaces.

Figure 13-15. java.nio.channels.ByteChannel




```
public interface ByteChannel extends ReadableByteChannelWritableByteChannel {
}
```

Implementations

`DatagramChannel`, `FileChannel`, `SocketChannel`

CancelledKeyException java.nio.channels

Java 1.4 ***serializable unchecked***

Signals an attempt to use a `SelectionKey` whose `cancel( )` method has previously been called.

Figure 13-16. java.nio.channels.CancelledKeyException


```
public class CancelledKeyException extends IllegalStateException {
// Public Constructors
     public CancelledKeyException( );
}
```

Channel java.nio.channels

Java 1.4 ***closeable***

This interface defines a communication channel for input and output. The `Channel` interface is a high-level generic interface which is extended by more specific interfaces, such as `ReadableByteChannel` and `WritableByteChannel`. `Channel` defines only two methods: `isOpen( )` determines whether a channel is open, and `close( )` closes

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a channel. Channels are open when they are first created. Once closed, a channel remains closed forever, and no further I/O operations may take place through it.

Many channel implementations are interruptible and asynchonously closeable, and implement the `InterruptibleChannel` interface to advertise this fact. See `InterruptibleChannel` for details.

Figure 13-17. java.nio.channels.Channel


```
public interface Channel extends java.io.Closeable {
// Public Instance Methods
     void close( ) throws java.io.IOException;
     boolean isOpen( );
}
```

Implementations

`InterruptibleChannel`, `ReadableByteChannel`, `SelectableChannel`, `WritableByteChannel`, `java.nio.channels.spi.AbstractInterruptibleChannel`

Returned By

`System.inheritedChannel( )`, `java.nio.channels.spi.SelectorProvider.inheritedChannel( )`

Channels java.nio.channels

Java 1.4

This class defines static methods that provide a bridge between the byte stream and character stream classes of the `java.io` package and the channel classes of `java.nio.channels`. `Channels` is never intended to be instantiated: it serves solely as a placeholder for static methods. These methods create byte channels based on `java.io` byte streams, and create `java.io` byte streams based on byte channels. Note that the channel objects returned by the `newChannel( )` methods may not implement `InterruptibleChannel`, and so may not be asynchonously closeable and interruptible like other channel classes in this package. `Channels` also defines methods to create character streams (`java.io.Reader` and `java.io.Writer`) based on the combination of a byte channel and a character encoding. The encoding may be specified by charset name, or with a `CharsetDecoder` or `CharsetEncoder` (see `java.nio.charset`).

```
public final class Channels {
// No Constructor
// Public Class Methods
```


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```
     public static ReadableByteChannel newChannel(java.io.InputStream in);
     public static WritableByteChannel newChannel(java.io.OutputStream out);
     public static java.io.InputStream newInputStream(ReadableByteChannel ch);
     public static java.io.OutputStream newOutputStream(WritableByteChannel ch);
     public static java.io.Reader newReader(ReadableByteChannel ch,
String csName);
     public static java.io.Reader newReader(ReadableByteChannel ch,
java.nio.charset.CharsetDecoder dec, int minBufferCap);
     public static java.io.Writer newWriter(WritableByteChannel ch,
String csName);
     public static java.io.Writer newWriter(WritableByteChannel ch,
java.nio.charset.CharsetEncoder enc, int minBufferCap);
}
```

ClosedByInterruptException java.nio.channels

Java 1.4 ***serializable checked***

An exception of this type is thrown by a thread blocked in an I/O operation on a channel when another thread calls its `interrupt( )` method. This exception is a subclass of `AsynchronousCloseException` and the channel will be closed as a side-effect of the thread interruption.

Figure 13-18. java.nio.channels.ClosedByInterruptException


```
public class ClosedByInterruptException extends AsynchronousCloseException {
// Public Constructors
     public ClosedByInterruptException( );
}
```

ClosedChannelException java.nio.channels

Java 1.4 ***serializable checked***

Signals an attempt to perform I/O on a channel that has been closed with the `close( )` method, or that is closed for a particular type of I/O operation (a `SocketChannel`, for example, may have its read and write halves shut down independently.) Channels may be closed asynchronously, and threads blocking to complete an I/O operation will throw a subclass of this exception type. See `AsynchronousCloseException` and `ClosedByInterruptException`.

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Figure 13-19. java.nio.channels.ClosedChannelException


```
public class ClosedChannelException extends java.io.IOException {
// Public Constructors
     public ClosedChannelException( );
}
```

Subclasses

`AsynchronousCloseException`

Thrown By

`SelectableChannel.register( )`, `java.nio.channels.spi.AbstractSelectableChannel.register( )`

ClosedSelectorException — java.nio.channels

Java 1.4 — ***serializable unchecked***

Signals an attempt to use a `Selector` object whose `close( )` method has been called.

Figure 13-20. java.nio.channels.ClosedSelectorException


```
public class ClosedSelectorException extends IllegalStateException {
// Public Constructors
     public ClosedSelectorException( );
}
```

ConnectionPendingException — java.nio.channels

Java 1.4 — ***serializable unchecked***

Signals a call to the `connect( )` method of a `SocketChannel` when there is already a connection pending for that channel. See `SocketChannel.isConnectionPending( )`.

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Figure 13-21. java.nio.channels.ConnectionPendingException


```
public class ConnectionPendingException extends IllegalStateException {
// Public Constructors
     public ConnectionPendingException( );
}
```

DatagramChannel java.nio.channels

Java 1.4 ***closeable***

This class implements a communication channel based on network datagrams. Obtain a `DatagramChannel` by calling the static `open( )` method. Call `socket( )` to obtain the `java.net.DatagramSocket` object on which the channel is based if you need to set any socket options to control low-level networking details.

The `send( )` method sends the remaining bytes of the specified `ByteBuffer` to the host and port specified in the `java.net.SocketAddress` in the form of a datagram. `receive( )` does the opposite: it receives a datagram, stores its content into the specified buffer (discarding any bytes that do not fit) and then returns a `SocketAddress` that specifies the sender of the datagram (or returns `null` if the channel was in nonblocking mode and no datagram was waiting).

The `send( )` and `receive( )` methods typically perform security checks on each invocation to see if the application has permissions to communicate with the remote host. If your application will use a `DatagramChannel` to exchange datagrams with a single remote host and port, use the `connect( )` method to connect to a specified `SocketAddress`. The `connect( )` method performs the required security checks once and allows future communication with the specified address without the overhead. Once a `DatagramChannel` is connected, you can use the standard `read( )` and `write( )` methods defined by the `ReadableByteChannel`, `WritableByteChannel`, `GatheringByteChannel` and `ScatteringByteChannel` interfaces. Like the `receive( )` method, the `read( )` methods silently discard any received bytes that do not fit in the specified `ByteBuffer`. The `read( )` and `write( )` methods throw a `NotYetConnected` exception if `connect( )` has not been called.

`DatagramChannel` is a `SelectableChannel`; its `validOps( )` method specifies that read and write operations may be selected. `DatagramChannel` objects are thread-safe.

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Read and write operations may proceed concurrently, but the class ensures that only one thread may read and one thread write at a time.

Figure 13-2. java.nio.channels.DatagramChannel


```
public abstract class DatagramChannel extends java.nio.channels.spi.
AbstractSelectableChannel
implements ByteChannel, GatheringByteChannel, ScatteringByteChannel {
// Protected Constructors
     protected DatagramChannel(java.nio.channels.spi.SelectorProvider provider);
// Public Class Methods
     public static DatagramChannel open( ) throws java.io.IOException;
// Public Instance Methods
     public abstract DatagramChannel connect(java.net.SocketAddress remote)
throws java.io.IOException;
     public abstract DatagramChannel disconnect( ) throws java.io.IOException;
     public abstract boolean isConnected( );
     public abstract java.net.SocketAddress receive(java.nio.ByteBuffer dst)
throws java.io.IOException;
     public abstract int send(java.nio.ByteBuffer src, java.net.SocketAddress
target) throws java.io.IOException;
     public abstract java.net.DatagramSocket socket( );
// Methods Implementing GatheringByteChannel
     public final long write(java.nio.ByteBuffer[ ] srcs)
throws java.io.IOException;
     public abstract long write(java.nio.ByteBuffer[ ] srcs, int offset,
int length) throws java.io.IOException;
// Methods Implementing ReadableByteChannel
     public abstract int read(java.nio.ByteBuffer dst)
throws java.io.IOException;
// Methods Implementing ScatteringByteChannel
     public final long read(java.nio.ByteBuffer[ ] dsts)
throws java.io.IOException;
     public abstract long read(java.nio.ByteBuffer[ ] dsts, int offset,
int length) throws java.io.IOException;
// Methods Implementing WritableByteChannel
     public abstract int write(java.nio.ByteBuffer src)
throws java.io.IOException;
// Public Methods Overriding SelectableChannel
     public final int validOps( );          constant
}
```

Returned By

`java.net.DatagramSocket.getChannel( )`,
`java.nio.channels.spi.SelectorProvider.openDatagramChannel( )`

FileChannel **java.nio.channels**

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Java 1.4 ***closeable***

This class implements a communication channel for efficiently reading and and writing files. It implements the standard `read( )` and `write( )` methods of the `ReadableByteChannel`, `WritableByteChannel`, `GatheringByteChannel` and `ScatteringByteChannel` methods. In addition, however, `FileChannel` provides methods for: random-access to the file, efficient transfer of bytes between the file and another channel, file locking, memory mapping, querying and setting the file size and forcing buffered updates to be written to disk. These important features are described in further detail below. Note that since file operations do not typically block for extended periods the way network operations can, `FileChannel` does not subclass `SelectableChannel` (it is the only channel class that does not) and cannot be used with `Selector` objects.

`FileChannel` has no public constructor and no static factory methods. To obtain a `FileChannel`, first create a `FileInputStream`, `FileOutputStream`, or `RandomAccessFile` object (see the `java.io` package) and then call the `getChannel( )` method of that object. If you use a `FileInputStream`, the resulting channel will allow reading but not writing, and if you use a `FileOutputStream`, the channel will allow writing but not reading. If you obtain a `FileChannel` from a `RandomAccessFile`, then the channel will allow reading, or both reading and writing, depending on the *mode* argument to the `RandomAccessFile` constructor.

A `FileChannel` has a *position* or file pointer that specifies the current point in the file. You can set or query the file position with two methods, both of which share the name `position( )`. The position of a `FileChannel` and of the stream or `RandomAccessFile` from which it is derived are always the same: changing the position of the channel changes the position of the stream, and vice versa. The initial position of a `FileChannel` is the position of the stream or `RandomAccessFile` when the `getChannel( )` method was called. If you create a `FileChannel` from a `FileOutputStream` that was opened in append mode, then any output to the channel always occurs at the end of the file, and sets the file position to the end end of the file.

Once you have a `FileChannel` object, you can use the standard `read( )` and `write( )` methods defined by the various channel interfaces. In addition to updating the buffer position as they read and write bytes, these methods also update the file position to or from which those bytes are written or read. These standard `read( )` methods return the number of bytes actually read, and return -1 if there are no bytes left in the file to read. The `write( )` methods enlarge the file if they write past the current end-of-file.

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`FileChannel` also defines position-independent `read( )` and `write( )` methods that take a file position as an explicit argument: they read or write starting at that position of the file, and although they update the position of the `ByteBuffer`, they do not update the file position of the `FileChannel`. If the specified position is past the end-of-file, the read( ) method does not read any bytes and returns -1, and the `write( )` method enlarges the file, leaving any bytes between the old end-of-file and the specified position undefined.

It is common to read bytes from a `FileChannel` and then immediately write them out to some other channel (such as a `SocketChannel`: think of a web server, for example), or to read bytes from a channel and immediately write them to a `FileChannel` (consider an FTP client). `FileChannel` provides two methods, `transferTo( )` and `transferFrom( )` that do this very efficiently, without the need for a temporary `ByteBuffer`. `transferTo( )` reads up to the specified number of bytes starting at the specified location from this `FileChannel` and writes them to the specified channel. It does not alter the file position of the `FileChannel`, and it returns the number of bytes actually transferred. `transferFrom( )` does the reverse: it reads up to the specified number of available bytes from the specified channel, and writes them to this `FileChannel` at the specified location, without altering the file position of this channel, and returns the actual number of bytes transferred. For both methods, if the destination or source channel is a `FileChannel` itself, then the file position of that channel is updated.

The `size( )` method returns the size (in bytes) of the underlying file. `truncate( )` reduces the file size to the specified value, discarding any file content that exceeds that size. If the specified size is greater than or equal to the current file size, the file is unchanged. If the file position is greater than the new size of the file, it the position is changed to the new size.

Use the `force( )` method to force any buffered modifications to the file to be written to the underlying storage device. If the file resides on a local device, (as opposed to a network filesystem, for example) then `force( )` guarantees that any changes to the file made since the channel was opened or since a previous call to `force( )` will have been written to the device. The argument to this method is a hint as to whether file meta-data (such as last modification time) is to be forced out in addition to file content. If this argument is `true`, the system will force content and meta-data. If `false`, the system may omit updates to meta-data. Note that `force( )` is only required to output change made directly through the `FileChannel`. File updates made through a `MappedByteBuffer` returned by the `map( )` method (described below)y should be forced out with the `force( )` method of `MappedByteBuffer`.

`FileChannel` defines two blocking `lock( )` and two nonblocking `tryLock( )` methods for locking a file or a region of a file against concurrent access by another program.

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(These methods are not suitable for preventing concurrent access to a file by two threads within the same Java virtual machine.) The no-argument versions of these methods attempt to acquire an exclusive lock on the entire file. The three-argument versions of the methods attempt to lock a specified region of the file, and may acquire shared locks in addition to exclusive locks. (A shared lock prevents any other process from acquiring an exclusive lock, but does not prevent other shared locks: typically, you acquire a shared lock when reading a file that should not be concurrently updated, and acquire an exclusive lock before writing file content to ensure that no one else is trying to read it at the same time.) The `tryLock( )` methods return a `FileLock` object, or `null` if there was already a conflicting lock on the file. The `lock( )` methods block if there is already a conflicting lock and never return `null`. See `FileLock` for more information about locks. The `FileChannel` file locking mechanism uses whatever locking capability is provided by the underlying platform. Some operating systems enforce file locking: if one process holds a lock, other processes are prevented by the operating system from accessing the file. Other operating systems merely prevent other processes from acquiring a conflicting lock: in this case, successful file locking requires the cooperation of all processes. Some operating systems do not support shared locks: on these systems an exclusive lock is returned even when a shared lock is requested.

The `map( )` method returns a `MappedByteBuffer` that represents the specified region of the file. File contents can be read directly from the buffer, and (if the mapping is done in read/write mode) bytes placed in the buffer will be written to the file. The mapping represented by a `MappedByteBuffer` remains valid until the buffer is garbage collected; the buffer continues to function even if the `FileChannel` from which it was created is closed. File mappings can be done in three different modes which specify whether bytes can be written into the buffer and what happens when this is done. See `FileChannel.MapMode` for a description of the three modes.

The `map( )` method relies on the memory-mapping facilities provided by the underlying operating system. This means that a number of details may vary from implementation to implementation. In particular, it is not specified whether changes to the underlying file made after the call to `map( )` are visible through the `MappedByteBuffer`. Using a mapped file is typically more efficient that an unmapped file only when the file is a large one.

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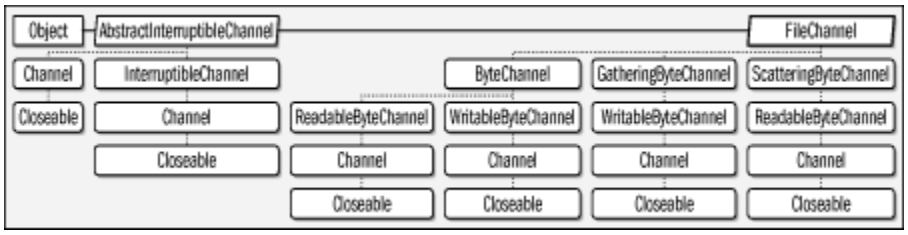
Figure 13-23. java.nio.channels.FileChannel




```
public abstract class FileChannel extends java.nio.channels.spi.
AbstractInterruptibleChannel
 implements ByteChannel, GatheringByteChannel, ScatteringByteChannel {
// Protected Constructors
     protected FileChannel( );
// Nested Types
     public static class MapMode;
// Public Instance Methods
     public abstract void force(boolean metaData) throws java.io.IOException;
     public final FileLock lock( ) throws java.io.IOException;
     public abstract FileLock lock(long position, long size, boolean shared)
        throws java.io.IOException;
     public abstract java.nio.MappedByteBuffer map(FileChannel.MapMode mode,
        long position, long size) throws java.io.IOException;
     public abstract long position( ) throws java.io.IOException;
     public abstract FileChannel position(long newPosition)
        throws java.io.IOException;
     public abstract int read(java.nio.ByteBuffer dst, long position)
        throws java.io.IOException;
     public abstract long size( ) throws java.io.IOException;
     public abstract long transferFrom(ReadableByteChannel src, long position,
        long count) throws java.io.IOException;
     public abstract long transferTo(long position, long count,
        WritableByteChannel target) throws java.io.IOException;
     public abstract FileChannel truncate(long size) throws java.io.IOException;
     public final FileLock tryLock( ) throws java.io.IOException;
     public abstract FileLock tryLock(long position, long size, boolean shared)
        throws java.io.IOException;
     public abstract int write(java.nio.ByteBuffer src, long position)
        throws java.io.IOException;
// Methods Implementing GatheringByteChannel
     public final long write(java.nio.ByteBuffer[ ] srcs)
        throws java.io.IOException;
     public abstract long write(java.nio.ByteBuffer[ ] srcs, int offset,
        int length) throws java.io.IOException;
// Methods Implementing ReadableByteChannel
     public abstract int read(java.nio.ByteBuffer dst)
        throws java.io.IOException;
// Methods Implementing ScatteringByteChannel
     public final long read(java.nio.ByteBuffer[ ] dsts)
        throws java.io.IOException;
     public abstract long read(java.nio.ByteBuffer[ ] dsts, int offset,
        int length) throws java.io.IOException;
// Methods Implementing WritableByteChannel
     public abstract int write(java.nio.ByteBuffer src)
        throws java.io.IOException;
}
```

Passed To

`FileLock.FileLock( )`

Returned By

`java.io.FileInputStream.getChannel( ), java.io.FileOutputStream.getChannel( ), java.io.RandomAccessFile.getChannel( ),FileLock.channel( )`

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FileChannel.MapMode java.nio.channels

Java 1.4

This class defines three constants that define the legal values of the *mode* argument to the `map( )` method of the `FileChannel` class. The constants and their meanings are the following:

```
public static class FileChannel.MapMode {
// No Constructor
// Public Constants
     public static final FileChannel.MapMode PRIVATE;
     public static final FileChannel.MapMode READ_ONLY;
     public static final FileChannel.MapMode READ_WRITE;
// Public Methods Overriding Object
     public String toString( );
}
```

Passed To

`FileChannel.map( )`

FileLock java.nio.channels

Java 1.4

A `FileLock` object is returned by the `lock( )` and `tryLock( )` methods of `FileChannel` and represents a lock on a file or a region of a file. See `FileChannel` for more information on file locking with those methods. When a lock is no longer required, it should be released with the `release( )` method. A lock will also be released if the channel is closed, or when the virtual machine terminates. `isValid( )` returns `true` if the lock has not yet been released, and returns `false` if it has been released.

The `channel( )` , `position( )`, `size( )` and `isShared( )` methods return basic information about the lock: the `FileChannel` that was locked, the region of the file that was locked, and whether the lock is shared or exclusive. If the entire file is locked, then the `size( )` method returns a value (`Long.MAX_VALUE`) that is much greater than the actual file size. If the underlying operating system does not support shared locks, then `isShared( )` may return false even if a shared lock was requested. `overlaps( )` is a convenience method that returns `true` if the position and size of this lock overlap the specified position and size.

```
public abstract class FileLock {
// Protected Constructors
```


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```
    protected FileLock(FileChannel channel, long position, long size,
       boolean shared);
// Public Instance Methods
    public final FileChannel channel( );
    public final boolean isShared( );
    public abstract boolean isValid( );
    public final boolean overlaps(long position, long size);
    public final long position( );
    public abstract void release( ) throws java.io.IOException;
    public final long size( );
// Public Methods Overriding Object
    public final String toString( );
}
```

Returned By

`FileChannel.{lock( ),tryLock( )}`

FileLockInterruptionException java.nio.channels

Java 1.4 ***serializable checked***

Signals that the `interrupt( )` method of a thread blocked waiting to acquire a file lock was called. See `FileChannel.lock( )`.

Figure 13-24. java.nio.channels.FileLockInterruptionException


```
public class FileLockInterruptionException extends java.io.IOException {
// Public Constructors
    public FileLockInterruptionException( );
}
```

GatheringByteChannel java.nio.channels

Java 1.4 ***closeable***

This interface extends `WritableByteChannel` and adds two additional `write( )` methods that can "gather" bytes from one or more buffers and write them out to the channel. These methods are passed an array of `ByteBuffer` objects, and, optionally, an offset and length that define the relevant sub-array to be used. The `write( )` method attempts to write all the remaining bytes from all the specified buffers (in the order in which they appear in the buffer array) to the channel. The return value of the method is

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the number of bytes actually written. See `WritableByteChannel` for a discussion of exceptions and thread-safety that apply to these `write( )` methods as well.

Figure 13-25. java.nio.channels.GatheringByteChannel


```
public interface GatheringByteChannel extends WritableByteChannel {
// Public Instance Methods
     long write(java.nio.ByteBuffer[ ] srcs) throws java.io.IOException;
     long write(java.nio.ByteBuffer[ ] srcs, int offset, int length)
        throws java.io.IOException;
}
```

Implementations

`DatagramChannel`, `FileChannel`, `Pipe.SinkChannel`, `SocketChannel`

IllegalBlockingModeException — java.nio.channels

Java 1.4 — ***serializable unchecked***

Signals an attempt to use a channel in the wrong blocking mode. An exception of this type is thrown by `SelectableChannel.register( )` if the channel is not in nonblocking mode.

Figure 13-26. java.nio.channels.IllegalBlockingModeException


```
public class IllegalBlockingModeException extends IllegalStateException {
// Public Constructors
     public IllegalBlockingModeException( );
}
```

IllegalSelectorException — java.nio.channels

Java 1.4 — ***serializable unchecked***

Signals an attempt to register a `SelectableChannel` with a `Selector` when the channel and the selector were not created by the same `java.nio.channels.spi.SelectorProvider`.

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Figure 13-27. java.nio.channels.IllegalSelectorException


```
public class IllegalSelectorException extends IllegalArgumentException {
// Public Constructors
     public IllegalSelectorException( );
}
```

InterruptibleChannel java.nio.channels

Java 1.4 ***closeable***

Channels that implement this marker interface have two important properties that are relevant to multithreaded programs: they are *asynchonously closeable* and *interruptible*. When the `close( )` method of an `InterruptibleChannel` is called, any other thread that is blocked waiting for an I/O operation to complete on that channel will stop blocking and receive an `AsynchronousCloseException`. Furthermore, if a thread is blocked waiting for an I/O operation to complete on an `InterruptibleChannel`, then another thread may call the `interrupt( )` method of the blocked thread. This causes the interrupt status of the blocked thread to be set and causes the thread to wake up and receive an `ClosedByInterruptException` (a subclass of `AsynchronousCloseException`). As the name of this interrupt implies, the channel that the thread was blocked on is closed as a side-effect of the thread interruption. There is no way to interrupt a blocked thread without closing the channel upon which it is blocked. This ability to interrupt a blocked thread is particularly noteworthy because it has never worked reliably with the older `java.io` API.

All the concrete channel implementations that are part of this package implement `InterruptibleChannel`. Note, however, that methods such as `Channels.newChannel( )` may return channel objects that are not interruptible. You can use the `instanceof` to determine whether an unknown channel object implements this interface.

Figure 13-28. java.nio.channels.InterruptibleChannel


```
public interface InterruptibleChannel extends Channel {
// Public Instance Methods
```

```
    void close( ) throws java.io.IOException;
}
```

Implementations

`java.nio.channels.spi.AbstractInterruptibleChannel`

NoConnectionPendingException java.nio.channels

Java 1.4 ***serializable unchecked***

Signals that `SocketChannel.finishConnect( )` was called without a previous call to `SocketChannel.connect( ).`

Figure 13-29. java.nio.channels.NoConnectionPendingException


```
public class NoConnectionPendingException extends IllegalStateException {
// Public Constructors
    public NoConnectionPendingException( );
}
```

NonReadableChannelException java.nio.channels

Java 1.4 ***serializable unchecked***

Signals a call to the `read( )` method of a readable channel that is not open for reading, such as a `FileChannel` created from a `FileOutputStream`.

Figure 13-30. java.nio.channels.NonReadableChannelException


```
public class NonReadableChannelException extends IllegalStateException {
// Public Constructors
    public NonReadableChannelException( );
}
```


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NonWritableChannelException java.nio.channels

Java 1.4 ***serializable unchecked***

Signal a call to a `write( )` method of a writable channel that is not open for writing, such as a `FileChannel` created from a `FileInputStream`.

Figure 13-31. java.nio.channels.NonWritableChannelException


```
public class NonWritableChannelException extends IllegalStateException {
// Public Constructors
     public NonWritableChannelException( );
}
```

NotYetBoundException java.nio.channels

Java 1.4 ***serializable unchecked***

Signals a call to `ServerSocketChannel.accept( )` before the underlying server socket has been bound to a local port. Call `socket( ).bind( )` to bind the `java.net.ServerSocket` that underlies the `ServerSocketChannel`.

Figure 13-32. java.nio.channels.NotYetBoundException


```
public class NotYetBoundException extends IllegalStateException {
// Public Constructors
     public NotYetBoundException( );
}
```

NotYetConnectedException java.nio.channels

Java 1.4 ***serializable unchecked***

Signals an attempt to `read( )` or `write( )` on a `SocketChannel` that is not yet connected to a remote host. See `SocketChannel.connect( )`.

Figure 13-33. java.nio.channels.NotYetConnectedException


```
public class NotYetConnectedException extends IllegalStateException {
// Public Constructors
     public NotYetConnectedException( );
}
```

OverlappingFileLockException **java.nio.channels**

Java 1.4 ***serializable unchecked***

This exception is thrown by the `lock( )` and `tryLock( )` methods of `FileChannel` if the requested lock region overlaps a file lock that is already held by some thread in this JVM, or if there is already a thread in this JVM waiting to lock an overlapping region of the same file. The `FileChannel` file locking mechanism is designed to lock files against concurrent access by two separate processes. Two threads within the same JVM should not attempt to acquire a lock on overlapping regions of the same file, and any attempt to do so causes an exception of this type to be thrown.

Figure 13-34. java.nio.channels.OverlappingFileLockException


```
public class OverlappingFileLockException extends IllegalStateException {
// Public Constructors
     public OverlappingFileLockException( );
}
```

Pipe **java.nio.channels**

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Java 1.4

A pipe is an abstraction that allows the one-way transfer of bytes from one thread to another. A pipe has a "read end" and a "write end" which are represented by objects that implement the `ReadableByteChannel` and `WritableByteChannel` interfaces. Create a new pipe with the static `Pipe.open( )` method. Call the `sink( )` method to obtain the `Pipe.SinkChannel` object that represents the write end of the pipe, and call the `source( )` method to obtain the `Pipe.SourceChannel` object that represents the read end of the pipe.

Programmers familiar with Unix-style pipes may find the names and return values of the `sink( )` and `source( )` methods confusing. A Unix pipe is an interprocess communication mechanism that is tied to two specific processes, one of which is a source of bytes and one of which is a destination, or sink, for those bytes. With this conceptual model of a pipe, you would expect the source to obtain the channel it writes to with the `source( )` method and the sink to obtain the channel it reads from with the `sink( )` method.

This `Pipe` class is not a Unix-style pipe, however. While it can be used for communication between two threads, the ends of the pipe are not tied to those threads, and there need not be a single source thread and a single sink thread. Therefore, in the `Pipe` API it is the pipe itself that serves as the source and the sink of bytes: bytes are read from the source end of the pipe, and are written to the sink end.

```
public abstract class Pipe {
// Protected Constructors
     protected Pipe( );
// Nested Types
     public abstract static class SinkChannel extends java.nio.channels.spi.
        AbstractSelectableChannel implements GatheringByteChannel,
        WritableByteChannel;
     public abstract static class SourceChannel extends java.nio.channels.spi.
        AbstractSelectableChannel implements ReadableByteChannel,
        ScatteringByteChannel;
// Public Class Methods
     public static Pipe open( ) throws java.io.IOException;
// Public Instance Methods
     public abstract Pipe.SinkChannel sink( );
     public abstract Pipe.SourceChannel source( );
}
```

Returned By

`java.nio.channels.spi.SelectorProvider.openPipe( )`

Pipe.SinkChannel **java.nio.channels**

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Java 1.4 ***closeable***

This public inner class is represents the write end of a pipe. Bytes written to a `Pipe.SinkChannel` become available on the corresponding `Pipe.SourceChannel` of the pipe. Obtain a `Pipe.SinkChannel` by creating a `Pipe` object with `Pipe.open( )` and then calling the `sink( )` method of that object. See also the containing `Pipe` class.

`Pipe.SinkChannel` implements `WritableByteChannel` and `GatheringByteChannel` and defines the `write( )` methods of those interfaces. This class subclasses `SelectableChannel`, so that it can be used with a `Selector`. It overrides the abstract `validOps( )` method of `SelectableChannel` to return `SelectionKey.OP_WRITE`, but defines no new methods of its own.

```
public abstract static class Pipe.SinkChannel extends java.nio.channels.spi.
AbstractSelectableChannel implements GatheringByteChannel, WritableByteChannel {
// Protected Constructors
     protected SinkChannel(java.nio.channels.spi.SelectorProvider provider);
// Public Methods Overriding SelectableChannel
     public final int validOps( );        constant
}
```

Returned By

`Pipe.sink( )`

Pipe.SourceChannel **java.nio.channels**

Java 1.4 ***closeable***

This public inner class is represents the read end of a pipe. Bytes that are written to the corresponding write end of the pipe (see `Pipe.SinkChannel`) become available for reading through this channel. Obtain a `Pipe.SourceChannel` by creating a `Pipe` object with `Pipe.open( )` and then calling the `source( )` method of that object. See also the containing `Pipe` class.

`Pipe.SourceChannel` implements `ReadableByteChannel` and `ScatteringByteChannel` and defines the `read( )` methods of those interfaces. This class subclasses `SelectableChannel`, so that it can be used with a `Selector`. It overrides the abstract `validOps( )` method of `SelectableChannel` to return `SelectionKey.OP_READ`, but defines no new methods of its own.

```
public abstract static class Pipe.SourceChannel extends java.nio.channels.spi.
AbstractSelectableChannel implements ReadableByteChannel, ScatteringByteChannel {
// Protected Constructors
     protected SourceChannel(java.nio.channels.spi.SelectorProvider provider);
```


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```
// Public Methods Overriding SelectableChannel
     public final int validOps( );            constant
}
```

Returned By

`Pipe.source( )`

ReadableByteChannel java.nio.channels

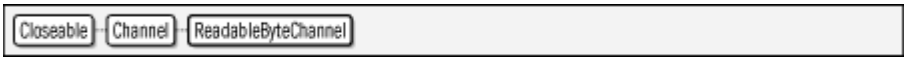
Java 1.4 ***closeable***

This subinterface of `Channel` defines a single key `read( )` method which reads bytes from the channel and stores them in the specified `ByteBuffer`, updating the buffer position as it does so. `read( )` attempts to read as many bytes as will fit in the specified buffer, (see `Buffer.remaining( )`) but may read fewer than this. If the channel is a nonblocking channel, for example, the `read( )` will return immediately, even if there are no bytes available to be read. `read( )` returns the number of bytes actually read (which may be zero in the nonblocking case), or returns -1 if there are no more bytes to be read in the channel (if, for example, the end of a file has been reached, or the other end of a socket has been closed.)

`read( )` is declared to throw an `IOException`. More specifically, it may throw a `ClosedChannelException` if the channel is closed. If the channel is closed asynchronously, or if a blocked thread is interrupted, the `read( )` method may terminate with an `AsynchronousCloseException` or a `ClosedByInterruptException`. `read( )` may also throw an unchecked `NonReadableChannelException` if it is called on a channel that was not opened or configured to allow reading.

`ReadableByteChannel` implementations are required to be thread-safe: only one thread may perform a read operation on a channel at a time. If a read operation is in progress, then any call to `read( )` will block until the in-progress operation completes. Some channel implementations may allow read and write operations to proceed concurrently, but none will allow two read operations to proceed at the same time.

Figure 13-35. java.nio.channels.ReadableByteChannel




```
public interface ReadableByteChannel extends Channel {
// Public Instance Methods
     int read(java.nio.ByteBuffer dst) throws java.io.IOException;
}
```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Implementations

`ByteChannel`, `Pipe.SourceChannel`, `ScatteringByteChannel`

Passed To

`Channels.{newInputStream( ),newReader( )}`, `FileChannel.transferFrom( )`, `java.util.Scanner.Scanner( )`

Returned By

`Channels.newChannel( )`

ScatteringByteChannel java.nio.channels

Java 1.4 ***closeable***

This interface extends `ReadableByteChannel` and adds two additional `read( )` methods that read bytes for a channel and "scatter" them to an array (or subarray) of buffers. These methods are passed an array of `ByteBuffer` objects, and, optionally, an offset and length that define the region of the array to be used. The `read( )` method attempts to read enough bytes from the channel to fill each of the specified buffers in the order in which they appear in the buffer array (the "scattering" process is actually much more orderly and linear than the name implies). The return value of the method is the number of bytes actually read, which may be different than the sum of the remaining bytes in the buffers. See `ReadableByteChannel` for a discussion of exceptions and thread-safety that apply to these `read( )` methods as well.

Figure 13-36. java.nio.channels.ScatteringByteChannel


```
public interface ScatteringByteChannel extends ReadableByteChannel {
// Public Instance Methods
     long read(java.nio.ByteBuffer[ ] dsts) throws java.io.IOException;
     long read(java.nio.ByteBuffer[ ] dsts, int offset, int length)
throws java.io.IOException;
}
```

Implementations

`DatagramChannel`, `FileChannel`, `Pipe.SourceChannel`, `SocketChannel`

SelectableChannel java.nio.channels

Java 1.4 ***closeable***

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This abstract class defines the API for channels that can be used with a `Selector` object to allow a thread to block while waiting for activity on any of a group of channels. All channel classes in the `java.nio.channels` package except for `FileChannel` are subclasses of `SelectableChannel`.

A selectable channel may only be registered with a `Selector` if it is nonblocking, so this class defines the `configureBlocking( )` method. Pass `false` to this method to put a channel into nonblocking mode, or pass `true` to make calls to its `read( )` and/or `write( )` methods block. Use `isBlocking( )` to determine the current blocking mode of a selectable channel.

Register a `SelectableChannel` with a `Selector` by calling the `register( )` method of the channel (not of the selector). There are two versions of this method: both take a `Selector` object and a bitmask that specifies the set of channel operations that are to be "selected" on that channel. (see `SelectionKey` for the constants that can be OR-ed together to form this bitmask). Both methods return a `SelectionKey` object that represents the registration of the channel with the selector. One version of the `register( )` method also takes an arbitrary object argument which serves as an "attachment" to the `SelectionKey` and allows you to associate arbitrary data with it. The `validOps( )` method returns a bitmask that specifies the set of operations that a particular `channel` object allows to be selected. The bitmask passed to `register( )` may only contain bits that are set in this `validOps( )` value.

Note that `SelectableChannel` does not define a `deregister( )` method. Instead, to remove a channel from the set of channels being monitored by a `Selector`, you must call the `cancel( )` method of the `SelectionKey` returned by `register( )`.

Call `isRegistered( )` to determine whether a `SelectableChannel` is registered with any `Selector`. (Note that a single channel may be registered with more than one `Selector`.) If you did not keep track of the `SelectionKey` returned by a call to `register( )`, you can query it with the `keyFor( )` method.

See `Selector` and `SelectionKey` for further details on multiplexing selectable channels.

Figure 13-37. java.nio.channels.SelectableChannel


```
public abstract class SelectableChannel extends java.nio.channels.spi.
AbstractInterruptibleChannel implements Channel {
// Protected Constructors
```


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```
    protected SelectableChannel( );
// Public Instance Methods
    public abstract Object blockingLock( );
    public abstract SelectableChannel configureBlocking(boolean block)
       throws java.io.IOException;
    public abstract boolean isBlocking( );
    public abstract boolean isRegistered( );
    public abstract SelectionKey keyFor(Selector sel);
    public abstract java.nio.channels.spi.SelectorProvider provider( );
    public final SelectionKey register(Selector sel, int ops)
       throws ClosedChannelException;
    public abstract SelectionKey register(Selector sel, int ops, Object att)
       throws ClosedChannelException;
    public abstract int validOps( );
}
```

Subclasses

`java.nio.channels.spi.AbstractSelectableChannel`

Returned By

`SelectionKey.channel( )`, `java.nio.channels.spi.AbstractSelectableChannel.configureBlocking( )`

SelectionKey java.nio.channels

Java 1.4

A `SelectionKey` represents the registration of a `SelectableChannel` with a `Selector`, and serves to identify a selected channel and the operations that are ready to be performed on that channel. After a call to the `select( )` method of a selector, the `selectedKeys( )` method of the selector returns a `Set` of `SelectionKey` objects to identify the channel or channels that are ready for reading, for writing, or for another operation.

Create a `SelectionKey` by passing a `Selector` object to the `register( )` method of a `SelectableChannel`. The `channel( )` and `selector( )` methods of the returned `SelectionKey` return the `SelectableChannel` and `Selector` objects associated with that key.

When you no longer wish the channel to be registered with the selector, call the `cancel( )` method of the `SelectionKey`. `isValid( )` determines whether a `SelectionKey` is still "valid"—it returns `true` unless the `cancel( )` method has been called, the channel has been closed or the selector has been closed.

The main purpose of a `SelectionKey` is to hold the "interest set" of channel operations that the selector should monitor for the channel, and also the "ready set" of operations that

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the selector has determined are ready to proceed on the channel. Both sets are represented as integer bitmasks (not `java.util.Set` objects) formed by OR-ing together any of the `OP_` constants defined by this class. Those constants are the following:

The no-argument version of the `interestOps( )` method allows you to query the interest set. The inital value of the interest set the bitmask that was passed to the `register( )` method of the channel. It can be changed, however, by passing a new bitmask to the one-argument version of `interestOps( )`. (Note that the same method name is used to both query and set the interest set.) The current state of the ready set can be queried with `readyOps( )`. You can also use the convenience methods `isReadable( )`, `isWritable( ) isConnectable( )` and `isAcceptable( )` to test whether individual operation bits are set in the ready set bitmask. There is no way to explicitly set the state of the ready set—each call to `select( )` method updates the ready set for you. Note, however, that you must remove a `SelectionKey` object from the `Set` returned by `Selector.selectedKeys( )` for the bits of the ready set to be cleared at the start of the next selection operation. If you never remove the `SelectionKey` from the set of selected keys, the `Selector` assumes that none of the I/O readyness conditions represented by the ready set have been handled yet, and leaves their bits set.

Use `attach( )` to associate an arbitrary object with a `SelectionKey`, and call `attachment( )` to query that object. This ability to associate data with a selection key is often useful when using a `Selector` with multiple channels: it can provide the context necessary to process a `SelectionKey` that has been selected.

```
public abstract class SelectionKey {
// Protected Constructors
     protected SelectionKey( );
// Public Constants
     public static final int OP_ACCEPT;    =16
     public static final int OP_CONNECT;   =8
     public static final int OP_READ;      =1
     public static final int OP_WRITE;     =4
// Public Instance Methods
     public final Object attach(Object ob);
     public final Object attachment( );
     public abstract void cancel( );
     public abstract SelectableChannel channel( );
     public abstract int interestOps( );
     public abstract SelectionKey interestOps(int ops);
     public final boolean isAcceptable( );
     public final boolean isConnectable( );
     public final boolean isReadable( );
     public abstract boolean isValid( );
     public final boolean isWritable( );
     public abstract int readyOps( );
     public abstract Selector selector( );
}
```

Subclasses

`java.nio.channels.spi.AbstractSelectionKey`

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Returned By

`SelectableChannel.{keyFor( ),register( )}, java.nio.channels.spi.AbstractSelectableChannel.{keyFor( ), register( )},java.nio.channels.spi.AbstractSelector.register( )`

Selector java.nio.channels

Java 1.4

A `Selector` is an object that monitors multiple nonblocking `SelectableChannel` objects and (after blocking if necessary) "selects" the channel that is (or the channels that are) ready for I/O. Create a new `Selector` with the static `open( )` method. Next register the channels that it is to monitor: a channel is registered by passing the `Selector` to the `register( )` method of the channel (`register( )` is defined by the abstract `SelectableChannel` class). In addition to the `Selector` you must also pass a bitmask that specifies which I/O operations (reading, writing, connecting, and accepting) that the `Selector` is to monitor for that channel. Each call to this `register( )` method returns a `SelectionKey` object. (The `SelectionKey` class also defines the constants that are used to form the bitmask of I/O operations.) Note that before a `SelectableChannel` can be registered, it must be in nonblocking mode, which can be accomplished with the `configureBlocking( )` method of `SelectableChannel`.

Once the channels are registered with the `Selector`, call `select( )` to block until one or more of the channels is ready for I/O. One version of `select( )` takes a timeout value and returns if the specified number of milliseconds elapses without any channels becoming ready for I/O. These methods also return if any of the channels is closed, if an error occurs on any channel, if the `wakeup( )` method of the `Selector` is called, or if the `interrupt( )` method of the blocked thread is called. There is also a `selectNow( )` method which is like `select( )` except that it does not block: it simply polls each of the channels and determines which have become ready for I/O. The return value of `selectNow( )` and of both `select( )` methods is the number of channels ready for I/O. It is possible for this return value to be zero.

The `select( )` and `selectNow( )` methods returns the number of channels that are ready for I/O; they do not return the channels themselves. To obtain this information, you must call the `selectedKeys( )` method, which returns a `java.util.Set` containing `SelectionKey` objects. After calling `select( )` and `selectedKeys( )`, applications typically obtain a `java.util.Iterator` for the `Set` and use it to loop through the `SelectionKey` objects that represent the channels that are ready for I/O. Use the

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`channel( )` method of the `SelectionKey` to determine which channel is ready, and call `readyOps( )`, `isReadable( )`, `isWritable( )` or related methods of the `SelectionKey` to determine what kind of I/O operation is ready on the channel. `SelectionKey` objects remain in the `selectedKeys( )` set until explicitly removed, so after performing the I/O operation for a given `SelectionKey`, you should remove that key from the `Set` returned by `selectedKeys( )` (use the `remove( )` method of the `Set` of its `Iterator`).

In addition to the `selectedKeys( )` method, `Selector` also defines a `keys( )` method, which also returns a `Set` of `SelectionKey` objects. This set represents the complete set of channels that are being monitored by the `Selector` and may not be modified, except by closing the channel or deregistring the channel by calling the `cancel( )` method of the associated `SelectionKey`. Cancelled keys are removed from the `keys( )` set on the next call to `select( )` or `selectNow( )`.

Call `wakeup( )` to cause another thread blocked in a call to `select( )` to wake up and return immediately. If `wakeup( )` is called but no thread is currently blocked in a `select( )` call, then the next call to `select( )` or `selectNow( )` will return immediately.

When a `Selector` object is no longer needed, close it by calling `close( )`. If any thread is blocked in a `select( )` call, it will return immediately as if `wakeup( )` had been called. After calling `close( )`, you should not call any other methods of a `Selector`. `isOpen( )` returns `true` if a `Selector` is still open, and returns `false` if it has been closed.

The `Selector` class is thread-safe. Note, however, that the `Set` object returnd by `selectedKeys( )` is not: it should be used by only one thread at a time.

```
public abstract class Selector {
// Protected Constructors
     protected Selector( );
// Public Class Methods
     public static Selector open( ) throws java.io.IOException;
// Public Instance Methods
     public abstract void close( ) throws java.io.IOException;
     public abstract boolean isOpen( );
     public abstract java.util.Set<SelectionKey> keys( );
     public abstract java.nio.channels.spi.SelectorProvider provider( );
     public abstract int select( ) throws java.io.IOException;
     public abstract int select(long timeout) throws java.io.IOException;
     public abstract java.util.Set<SelectionKey> selectedKeys( );
     public abstract int selectNow( ) throws java.io.IOException;
     public abstract Selector wakeup( );
}
```

Subclasses

`java.nio.channels.spi.AbstractSelector`

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Passed To

`SelectableChannel.{keyFor( ),register( )}`,
`java.nio.channels.spi.AbstractSelectableChannel.{keyFor( ), register( )}`

Returned By

`SelectionKey.selector( )`

ServerSocketChannel java.nio.channels

Java 1.4 ***closeable***

This class is the `java.nio` version of `java.net.ServerSocket`. It is a selectable channel that can be used by servers to accept connections from clients. Unlike other channel classes in this package, this class cannot be used for reading or writing bytes: it does not implement any of the `ByteChannel` interfaces, and exists only to accept and establish connections with clients, not to communicate with those clients. `ServerSocketChannel` differs from `java.net.ServerSocket` in two important ways: it can put into nonblocking mode and used with a `Selector`, and its `accept( )` method returns a `SocketChannel` rather than a `Socket`, so that communication with the client whose connection was just accepted can be done using the `java.nio` APIs.

Create a new `ServerSocketChannel` with the static `open( )` method. Next, call `socket( )` to obtain the associated `ServerSocket` object, and use its `bind( )` method to bind the server socket to a specific port on the local host. You can also call any other `ServerSocket` methods to configure other socket options at this point.

To accept a new connection through this `ServerSocketChannel`, simply call `accept( )`. If the channel is in blocking mode, this method will block until a client connects, and will then return a `SocketChannel` that is connected to the client. In nonblocking mode, (see the inherited `configureBlocking( )` method) `accept( )` returns a `SocketChannel` only if there is a client currently waiting to connect, and otherwise immediately returns `null`. To be notified when a client is waiting to connect, use the inherited `register( )` method to register nonblocking a `ServerSocketChannel` with a `Selector` and specify an interest in accept operations with the `SelectionKey.OP_ACCEPT` constant. See `Selector` and `SelectionKey` for further details.

Note that the `SocketChannel` object returned by the `accept( )` method is always in nonblocking mode, regardless of the blocking mode of the `ServerSocketChannel`.

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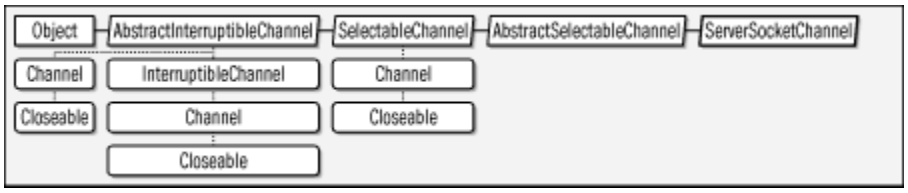
`ServerSocketChannel` is thread-safe; only one thread may call the `accept( )` method at a time. When a `ServerSocketChannel` is no longer required, close it with the inherited `close( )` method.

Figure 13-38. java.nio.channels.ServerSocketChannel




```
public abstract class ServerSocketChannel extends java.nio.channels.spi.
AbstractSelectableChannel {
// Protected Constructors
     protected ServerSocketChannel(java.nio.channels.spi.SelectorProvider
        provider);
// Public Class Methods
     public static ServerSocketChannel open( ) throws java.io.IOException;
// Public Instance Methods
     public abstract SocketChannel accept( ) throws java.io.IOException;
     public abstract java.net.ServerSocket socket( );
// Public Methods Overriding SelectableChannel
     public final int validOps( );
}
```

Returned By

`java.net.ServerSocket.getChannel( )`, `java.nio.channels.spi.SelectorProvider.openServerSocketChannel( )`

SocketChannel — java.nio.channels

Java 1.4 — ***closeable***

This class is a channel for communicating over a `java.net.Socket`. It implements `ReadableByteChannel` and `WriteableByteChannel` as well as `GatheringByteChannel` and `ScatteringByteChannel`. It is a subclass of `SelectableChannel` and can be used with a `Selector`.

Create a new `SocketChannel` with one of the static `open( )` methods. The no-argument version of `open( )` creates a new `SocketChannel` but does not connect it to a remote host. The other version of `open( )` opens a new channel and connects it to the specified `java.net.SocketAddress`. If you create an unconnected socket, you can explictly connect it with the `connect( )` method. The main reason to open the channel and connect to the remote host in separate steps is if you want to do a nonblocking connect. To do this, first put the channel into nonblocking mode with the inherited

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`configureBlocking( )` method. Then, call `connect( )`: it will return immediately, without waiting for the connection to be established. Then register the channel with a `Selector` specifying that you are interested in `SelectionKey.OP_CONNECT` operations. When you are notified that your channel is ready to connect (see `Selector` and `SelectionKey` for details) simply call the nonblocking `finishConnect( )` method to complete the connection. `isConnected( )` returns `true` once a connection is established, and `false` otherwise. `isConnectionPending( )` returns `true` if `connect( )` has been called in blocking mode and has not yet returned, or if `connect( )` has been called in nonblocking mode, but `finishConnect( )` has not been called yet.

Once you have opened and connected a `SocketChannel`, you can read and write bytes to it with the various `read( )` and `write( )` methods. `SocketChannel` is thread-safe: read and write operations may proceed concurrently, but `SocketChannel` will not allow more than one read operation and more than one write operation to proceed at the same time. If you place a `SocketChannel` into nonblocking mode, you can register it with a `Selector` using the `SelectionKey` constants `OP_READ` and `OP_WRITE`, to have the `Selector` tell you when the channel is ready for reading or writing.

The `socket( )` method returns the `java.net.Socket` that is associated with the `SocketChannel`. You can use this `Socket` object to configure socket options, bind the socket to a specific local address, close the socket, or shutdown its input or output sides. See `java.net.Socket`. Note that although all `SocketChannel` objects have associated `Socket` objects, the reverse is not true: you cannot obtain a `SocketChannel` from a `Socket` unless the `Socket` was created along with the `SocketChannel` by a call to `SocketChannel.open( )`.

When you are done with a `SocketChannel`, close it with the `close( )` method. You can also independently shut down the read and write portions of the channel with `socket( ).shutdownInput( )` and `socket( ).shutdownOutput( )`. When the input is shut down, any future reads (and any blocked read operation) will return -1 to indicate that the end-of-stream has been reached. When the output is shut down, any future writes throw a `ClosedChannelException`, and any write operation that was blocked at the time of shut down throws a `AsynchronousCloseException`.

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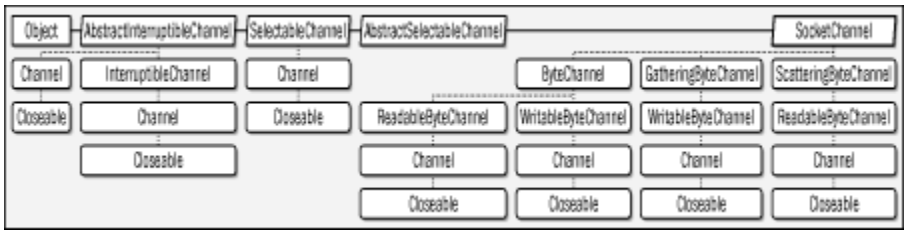
Figure 13-39. java.nio.channels.SocketChannel




```
public abstract class SocketChannel extends java.nio.channels.spi.
AbstractSelectableChannel
implements ByteChannel, GatheringByteChannel, ScatteringByteChannel {
// Protected Constructors
     protected SocketChannel(java.nio.channels.spi.SelectorProvider provider);
// Public Class Methods
     public static SocketChannel open( ) throws java.io.IOException;
     public static SocketChannel open(java.net.SocketAddress remote)
        throws java.io.IOException;
// Public Instance Methods
     public abstract boolean connect(java.net.SocketAddress remote)
        throws java.io.IOException;
     public abstract boolean finishConnect( ) throws java.io.IOException;
     public abstract boolean isConnected( );
     public abstract boolean isConnectionPending( );
     public abstract java.net.Socket socket( );
// Methods Implementing GatheringByteChannel
     public final long write(java.nio.ByteBuffer[ ] srcs)
        throws java.io.IOException;
     public abstract long write(java.nio.ByteBuffer[ ] srcs, int offset,
        int length) throws java.io.IOException;
// Methods Implementing ReadableByteChannel
     public abstract int read(java.nio.ByteBuffer dst)
        throws java.io.IOException;
// Methods Implementing ScatteringByteChannel
     public final long read(java.nio.ByteBuffer[ ] dsts)
        throws java.io.IOException;
     public abstract long read(java.nio.ByteBuffer[ ] dsts, int offset,
        int length) throws java.io.IOException;
// Methods Implementing WritableByteChannel
     public abstract int write(java.nio.ByteBuffer src)
        throws java.io.IOException;
// Public Methods Overriding SelectableChannel
     public final int validOps( );
}
```

Returned By

`java.net.Socket.getChannel( )`, `ServerSocketChannel.accept( )`, `java.nio.channels.spi.SelectorProvider.openSocketChannel( )`

UnresolvedAddressException — java.nio.channels

Java 1.4 — ***serializable unchecked***

Signals the use of a `java.net.SocketAddress` that could not be resolved: for example a `java.net.InetSocketAddress` that contains an unknown hostname.

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Figure 13-40. java.nio.channels.UnresolvedAddressException


```
public class UnresolvedAddressException extends IllegalArgumentException {
// Public Constructors
     public UnresolvedAddressException( );
}
```

UnsupportedAddressTypeException java.nio.channels

Java 1.4 ***serializable unchecked***

Signals the use of a `java.net.SocketAddress` subclass that is unknown to or not supported by the implementation. It is safe to assume that addresses of the type `java.net.InetSocketAddress` are universally supported.

Figure 13-41. java.nio.channels.UnsupportedAddressTypeException


```
public class UnsupportedAddressTypeException extends IllegalArgumentException {
// Public Constructors
     public UnsupportedAddressTypeException( );
}
```

WritableByteChannel java.nio.channels

Java 1.4 ***closeable***

This subinterface of `Channel` defines a single key `write( )` method which writes bytes from a specified `ByteBuffer` (updating the buffer position as it goes) to the channel. If possible, it writes all remaining bytes in the buffer (see `Buffer.remaining( )`). This is not always possible (with nonblocking channels, for example) so the `write( )` method returns the number of bytes that it was actually able to write to the channel.

`write( )` is declared to throw an `IOException`. More specifically, it may throw a `ClosedChannelException` if the channel is closed. If the channel is closed

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asynchronously, or if a blocked thread is interrupted, the `write( )` method may terminate with an `AsynchronousCloseException` or a `ClosedByInterruptException`. `write( )` may also throw an unchecked `NonWritableChannelException` if it is called on a channel (such as a `FileChannel`) that was not opened or configured to allow writing.

`WritableByteChannel` implementations are required to be thread-safe: only one thread may perform a write operation on a channel at a time. If a write operation is in progress, then any call to `write( )` will block until the in-progress operation completes. Some channel implementations may allow read and write operations to proceed concurrently; some may not.

Figure 13-42. java.nio.channels.WritableByteChannel


```
public interface WritableByteChannel extends Channel {
// Public Instance Methods
     int write(java.nio.ByteBuffer src) throws java.io.IOException;
}
```

Implementations

`ByteChannel`, `GatheringByteChannel`, `Pipe.SinkChannel`

Passed To

`Channels.{newOutputStream( ),newWriter( )}`, `FileChannel.transferTo( )`

Returned By

`Channels.newChannel( )`

Package java.nio.channels.spi

Java 1.4

This package defines four classes that are used by implementors of channels and selector classes of `java.nio.channels`. It also defines the `SelectorProvider` class which allows a custom implementation of channels and selectors to be specified for use instead of the default implementation. Application programmers should never need to use this package, except in rare circumstances to explicitly install a `SelectionProvider` implementation with the `SelectionProvider.provider( )` method.

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Classes

```
public abstract class AbstractInterruptibleChannel
    implements java.nio.channels.Channel, java.nio.channels.
    InterruptibleChannel;
public abstract class AbstractSelectableChannel extends java.nio.channels.
    SelectableChannel;
public abstract class AbstractSelectionKey extends java.nio.channels.
    SelectionKey;
public abstract class AbstractSelector extends java.nio.channels.Selector;
public abstract class SelectorProvider;
```

AbstractInterruptibleChannel java.nio.channels.spi

Java 1.4 ***closeable***

This class exists as a convenience for implementors of new Channel classes. Application programmers should never need to subclass or use it.

Figure 13-43. java.nio.channels.spi.AbstractInterruptibleChannel


```
public abstract class AbstractInterruptibleChannel
implements java.nio.channels.Channel, java.nio.channels.InterruptibleChannel {
// Protected Constructors
     protected AbstractInterruptibleChannel( );
// Methods Implementing Channel
     public final void close( ) throws java.io.IOException;
     public final boolean isOpen( );
// Protected Instance Methods
     protected final void begin( );
     protected final void end(boolean completed)
         throws java.nio.channels.AsynchronousCloseException;
     protected abstract void implCloseChannel( ) throws java.io.IOException;
}
```

Subclasses

`java.nio.channels.FileChannel`, `java.nio.channels.SelectableChannel`

AbstractSelectableChannel java.nio.channels.spi

Java 1.4 ***closeable***

This class exists as a convenience for implementors of new selectable channel classes: it defines common methods of `SelectableChannel` in terms of protected methods whose

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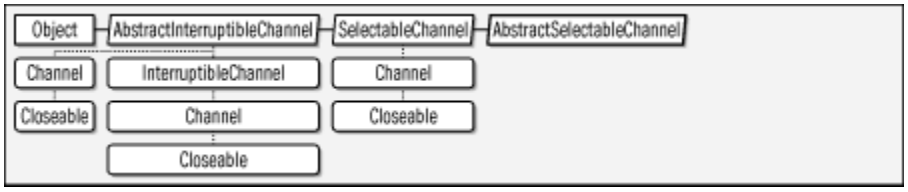
names begin with `impl`. Application programmers should never need to use or subclass this class.

Figure 13-44. java.nio.channels.spi.AbstractSelectableChannel




```
public abstract class AbstractSelectableChannel extends java.nio.channels.
SelectableChannel {
// Protected Constructors
     protected AbstractSelectableChannel(SelectorProvider provider);
// Public Methods Overriding SelectableChannel
     public final Object blockingLock( );
     public final java.nio.channels.SelectableChannel configureBlocking(boolean
       block) throws java.io.IOException;
     public final boolean isBlocking( );
     public final boolean isRegistered( );
     public final java.nio.channels.SelectionKey keyFor(java.nio.channels.
       Selector sel);
     public final SelectorProvider provider( );
     public final java.nio.channels.SelectionKey register(java.nio.channels.
Selector sel, int ops, Object att)
throws java.nio.channels.ClosedChannelException;
// Protected Methods Overriding AbstractInterruptibleChannel
     protected final void implCloseChannel( ) throws java.io.IOException;
// Protected Instance Methods
     protected abstract void implCloseSelectableChannel( )
       throws java.io.IOException;
     protected abstract void implConfigureBlocking(boolean block)
       throws java.io.IOException;
}
```

Subclasses

`java.nio.channels.DatagramChannel`,
`java.nio.channels.Pipe.SinkChannel`,
`java.nio.channels.Pipe.SourceChannel`,
`java.nio.channels.ServerSocketChannel`,
`java.nio.channels.SocketChannel`

Passed To

`AbstractSelector.register( )`

AbstractSelectionKey — java.nio.channels.spi

Java 1.4

This class exists as a convenience for implementors of new `SelectionKey` classes. Application programmers should never need to use or subclass this class.

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Figure 13-45. java.nio.channels.spi.AbstractSelectionKey


```
public abstract class AbstractSelectionKey extends java.nio.channels
.SelectionKey {
// Protected Constructors
     protected AbstractSelectionKey( );
// Public Methods Overriding SelectionKey
     public final void cancel( );
     public final boolean isValid( );
}
```

Passed To

`AbstractSelector.deregister( )`

AbstractSelector — java.nio.channels.spi

Java 1.4

This class exists as a convenience for implementors of new `Selector` classes. Application programmers should never need to use or subclass this class.

Figure 13-46. java.nio.channels.spi.AbstractSelector


```
public abstract class AbstractSelector extends java.nio.channels.Selector {
// Protected Constructors
     protected AbstractSelector(SelectorProvider provider);
// Public Methods Overriding Selector
     public final void close( ) throws java.io.IOException;
     public final boolean isOpen( );
     public final SelectorProvider provider( );
// Protected Instance Methods
     protected final void begin( );
     protected final java.util.Set<java.nio.channels.SelectionKey>
       cancelledKeys( );
     protected final void deregister(AbstractSelectionKey key);
     protected final void end( );
     protected abstract void implCloseSelector( ) throws java.io.IOException;
     protected abstract java.nio.channels.SelectionKey register
      (AbstractSelectableChannel ch, int ops, Object att);
}
```

Returned By

`SelectorProvider.openSelector( )`

SelectorProvider — java.nio.channels.spi

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Java 1.4

This class is the central service-provider class for the channels and selectors of the `java.nio.channels` API. A concrete subclass of `SelectorProvider` implements factory methods that return open socket channels, server socket channels, datagram channels, pipes (with their two internal channels) and `Selector` objects. There is one default `SelectorProvider` object per JVM: this object can be obtained with the static `SelectorProvider.provider( )` method.

You can specify a custom `SelectorProvider` implementation by setting its class name as the value of the system property `java.nio.channels.spi.SelectorProvider`. Or, you can put the class name in a file named *META-INF/services/java.nio.channels.spi.SelectorProvider*, in your application's JAR file. The `provider( )` method first looks for the system property, then looks for the JAR file entry. If it finds neither, it instantiates the implementation's default `SelectorProvider`.

Applications are not required to use the default `SelectorProvider` exclusively. It is legal to instantiate other `SelectorProvider` objects and explictly invoke their `open( )` methods to create channels in that way.

```
public abstract class SelectorProvider {
// Protected Constructors
     protected SelectorProvider( );
// Public Class Methods
     public static SelectorProvider provider( );
// Public Instance Methods
5.0  public java.nio.channels.Channel inheritedChannel( ) throws java.io.
        IOException;     constant
     public abstract java.nio.channels.DatagramChannel openDatagramChannel( )
        throws java.io.IOException;
     public abstract java.nio.channels.Pipe openPipe( )
        throws java.io.IOException;
     public abstract AbstractSelector openSelector( )
        throws java.io.IOException;
     public abstract java.nio.channels.ServerSocketChannel
        openServerSocketChannel( ) throws java.io.IOException;
     public abstract java.nio.channels.SocketChannel openSocketChannel( )
        throws java.io.IOException;
}
```

Passed To

`java.nio.channels.DatagramChannel.DatagramChannel( )`,
`java.nio.channels.Pipe.SinkChannel.SinkChannel( )`,
`java.nio.channels.Pipe.SourceChannel.SourceChannel( )`,
`java.nio.channels.ServerSocketChannel.ServerSocketChannel( )`,
`java.nio.channels.SocketChannel.SocketChannel( )`,
`AbstractSelectableChannel.AbstractSelectableChannel( )`,
`AbstractSelector.AbstractSelector( )`

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Returned By

`java.nio.channels.SelectableChannel.provider( )`,
`java.nio.channels.Selector.provider( )`,
`AbstractSelectableChannel.provider( )`,
`AbstractSelector.provider( )`

Package java.nio.charset

Java 1.4

This package contains classes that represent character sets or encodings, and defines methods that encode characters into bytes and decode bytes into characters. The key class is `Charset`, and you can obtain a `Charset` object for a named character encoding with the static `forName( )` method. `Charset` defines `encode( )` and `decode( )` convenience methods, but for full control over the encoding and decoding process, you can also obtain a `CharsetEncoder` or `CharsetDecoder` object from the `Charset`.

The Java platform has had a character encoding and decoding facility since Java 1.1, and defines a number of classes and methods that perform character encoding or decoding. Some of these classes and methods are specified to use the default charset for the locale; others take the name of a charset as a method or constructor argument. See, for example, the `String( )`, `java.io.InputStreamReader( )` and `java.io.OutputStreamWriter( )` constructors. In Java 1.4, the `java.nio.charset` package defines a public API to the character encoding and decoding facility and allows applications to work with it explicitly. Most applications will not have to do this, however, and can simply continue to rely on the default charset, or can continue to supply charset names where needed. Even applications that use the `java.nio.channels` package can avoid explicit character encoding and decoding by passing the name of a desired charset to the `newReader( )` and `newWriter( )` methods of `java.nio.channels.Channels`.

Classes

```
public abstract class Charset implements Comparable<Charset>;
public abstract class CharsetDecoder;
public abstract class CharsetEncoder;
public class CoderResult;
public class CodingErrorAction;
```

Exceptions

```
public class CharacterCodingException extends java.io.IOException;
   public class MalformedInputException extends CharacterCodingException;
   public class UnmappableCharacterException extends CharacterCodingException;
public class IllegalCharsetNameException extends IllegalArgumentException;
public class UnsupportedCharsetException extends IllegalArgumentException;
```


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Errors

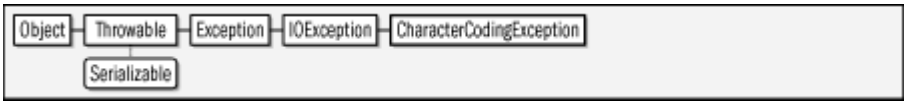
```
public class CoderMalfunctionError extends Error;
```

CharacterCodingException java.nio.charset

Java 1.4 ***serializable checked***

Signals a problem encoding or decoding characters or bytes. This is a generic superclass for more-specific exception types. Note that the one-argument versions of `CharsetEncoder.encode( )` and `CharsetDecoder.decode( )` may throw an exception of this type, but that the three-argument versions of the same method instead report encoding problems through their `CoderResult` return value. Note also that the `encode( )` and `decode( )` convenience methods of `Charset` do not throw this exception because they specify that malformed input and unmappable characters or bytes should be replaced. (See `CodingErrorAction`.)

Figure 13-47. java.nio.charset.CharacterCodingException




```
public class CharacterCodingException extends java.io.IOException {
// Public Constructors
     public CharacterCodingException( );
}
```

Subclasses

`MalformedInputException`, `UnmappableCharacterException`

Thrown By

`CharsetDecoder.decode( )`, `CharsetEncoder.encode( )`, `CoderResult.throwException( )`

Charset java.nio.charset

Java 1.4 ***comparable***

A `Charset` represents a character set or encoding. Each `Charset` has a cannonical name, returned by `name( )`, and a set of aliases, returned by `aliases( )`. You can look up a `Charset` by name or alias with the static `Charset.forName( )` method, which throws an `UnsupportedCharsetException` if the named charset is not installed on the system.

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In Java 5.0, you can obtain the default `Charset` used by the Java VM with the static `defaultCharset( )` method. Check whether a charset specified by name or alias is supported with the static `isSupported( )`. Obtain the complete set of installed charsets with `availableCharsets( )` which returns a sorted map from canonical names to `Charset` objects. Note that charset names are not case-sensitive, and you can use any capitialization for charset names you pass to `isSupported( )` and `forName( )`. Note that there are a number of classes and methods in the Java platform that specify charsets by name rather than by `Charset` object. See, for example, `java.io.InputStreamReader`, `java.io.OutputStreamWriter`, `String.getBytes( )`, and `java.nio.channels.Channels.newWriter( )`. When working with classes and methods such as these, there is no need to use a `Charset` object.

All implementations of Java are required to support at least the following 6 charsets:

Canonical name	Description
US-ASCII	seven-bit ASCII
ISO-8859-1	The 8-bit superset of ASCII which includes the characters used in most Western-European languages. Also known as ISO-LATIN-1.
UTF-8	An 8-bit encoding of Unicode characters that is compatible with US-ASCII.
UTF-16BE	A 16-bit encoding of Unicode characters, using big-endian byte order.
UTF-16LE	A 16-bit encoding of Unicode characters, using little-endian byte order.
UTF-16	A 16-bit encoding of Unicode characters, with byte order specified by a byte order mark character. Assumes big-endian when decoding if there is no byte order mark. Encodes using big-endian byte order and outputs an appropriate byte order mark.

Once you have obtained a `Charset` with `forName( )` or `availableCharsets( )`, you can use the `encode( )` method to encode a `String` or `CharBuffer` of text into a `ByteBuffer`, or you can use the `decode( )` method to convert the bytes in a `ByteBuffer` into characters in a `CharBuffer`. These convenience methods create a new `CharsetEncoder` or `CharsetDecoder`, specify that malformed input or unmappable characters or bytes should be replaced with the default replacement string or bytes, and then invoke the `encode( )` or `decode( )` method of the encoder or decoder. For full control over the encoding and decoding process, you may prefer to obtain your own `CharsetEncoder` or `CharsetDecoder` object with `newEncoder( )` or `newDecoder( )`. See `CharsetDecoder` for details.

Instead of using a `Charset`, `CharsetEncoder`, or `CharsetDecoder` directly, you may also pass an encoder or decoder to the static methods of `java.nio.channels.Channels` to obtain a `java.io.Reader` or `java.io.Writer` that you can use to read or write characters from or to a byte-oriented `Channel`.

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Note that not all `Charset` objects support encoding ("auto-detect" charsets can determine the source charset when decoding, but have no way to encode). Use `canEncode( )` to determine whether a given `Charset` can encode.

`Charset` also defines, implements, or overrides various other methods. `displayName( )` returns a localized name for the charset, or returns the cannonical name if there is no localization. `toString( )` returns an implementation-dependent textual representation of the charset. The `equals( )` method compares two charsets by comparing their canonical names. `Charset` implements `Comparable`, and its `compareTo( )` method orders charsets by their canonical name. `contains( )` returns `true` if a specified charset is "contained in" this charset. That is, if every character that can be represented in the specified charset can also be represented in this charset. Note that those representations need not be the same, however. `isRegistered( )` returns `true` if the charset is registered with the IANA charset registry (see http://www.iana.org/assignments/character-sets.)

Figure 13-48. java.nio.charset.Charset


```
public abstract class Charset implements Comparable<Charset> {
// Protected Constructors
     protected Charset(String canonicalName, String[ ] aliases);
// Public Class Methods
     public static java.util.SortedMap<String,Charset> availableCharsets( );
5.0  public static Charset defaultCharset( );
     public static Charset forName(String charsetName);
     public static boolean isSupported(String charsetName);
// Public Instance Methods
     public final java.util.Set<String> aliases( );
     public boolean canEncode( );        constant
     public abstract boolean contains(Charset cs);
     public final java.nio.CharBuffer decode(java.nio.ByteBuffer bb);
     public String displayName( );
     public String displayName(java.util.Locale locale);
     public final java.nio.ByteBuffer encode(java.nio.CharBuffer cb);
     public final java.nio.ByteBuffer encode(String str);
     public final boolean isRegistered( );
     public final String name( );
     public abstract CharsetDecoder newDecoder( );
     public abstract CharsetEncoder newEncoder( );
// Methods Implementing Comparable
5.0  public final int compareTo(Charset that);
// Public Methods Overriding Object
     public final boolean equals(Object ob);
     public final int hashCode( );
     public final String toString( );
}
```

Passed To

`java.io.InputStreamReader.InputStreamReader( )`, `java.io.OutputStreamWriter.OutputStreamWriter( )`, `CharsetDecoder.CharsetDecoder( )`, `CharsetEncoder.CharsetEncoder( )`

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Returned By

`CharsetDecoder.{charset( ),detectedCharset( )}`,
`CharsetEncoder.charset( )`,
`java.nio.charset.spi.CharsetProvider.charsetForName( )`

CharsetDecoder java.nio.charset

Java 1.4

A `CharsetDecoder` is a "decoding engine" that converts a sequence of bytes into a sequence of characters based on the encoding of some charset. Obtain a `CharsetDecoder` from the `Charset` that represents the charset to be decoded. If you have a complete sequence of bytes to be decoded in a `ByteBuffer` you can pass that buffer to the one-argument version of `decode( )`. This convenience method decodes the bytes and stores the resulting characters into a newly allocated `CharBuffer`, resetting and flushing the decoder as necessary. It throws an exception if there are problems with the bytes to be decoded.

Typically, however, the three-argument version of `decode( )` is used in a multistep decoding process:

The `decode( )` method returns a `CoderResult` that indicates the state of the decoding operation. If the return value is `CoderResult.UNDERFLOW`, then it means that `decode( )` returned because all bytes from the input buffer have been read, and more input is required. If the return value is `CoderResult.OVERFLOW`, then it means that `decode( )` returned because the output `CharBuffer` is full, and no more characters can be decoded into it. Otherwise, the reurn value is a `CoderResult` whose `isError( )` method returns `true`. There are two basic types of decoding errors. If `isMalformed( )` returns `true` then the input included bytes that are not legal for the charset. These bytes start at the position of the input buffer, and continue for `length( )` bytes. Otherwise, if `isUnmappable( )` returns `true`, then the input bytes include a character for which there is no representation in Unicode. The relevant bytes start at the position of the input buffer and continue for `length( )` bytes.

By default a `CharsetDecoder` reports all malformed input and unmappable character errors by returning a `CoderResult` object as described above. This behavior can be altered, however, by passing a `CodingErrorAction` to `onMalformedInput( )` and `onUnmappableCharacter( )`. (Query the current action for these types of errors with `malformedInputAction( )` and `unmappableCharacterAction( )`.) `CodingErrorAction` defines three constants that represent the three possible actions.

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The default action is `REPORT`. The action `IGNORE` tells the `CharsetDecoder` to ignore (i.e. skip) malformed input and unmappable charaters. The `REPLACE` action tells the `CharsetDecoder` to replace malformed input and unmappable characters with the replacement string. This replacement string can be set with `replaceWith( )`, and can be queried with `replacement( )`.

`averageCharsPerByte( )` and `maxCharsPerByte( )` return the average and maximum number of characters that are produced by this decoder per decoded byte. These values can be used to help you choose the size of the `CharBuffer` to allocate for decoding.

`CharsetDecoder` is not a thread-safe class. Only one thread should use an instance at a time.

`CharsetDecoder` is an abstract class. Implementors defining new charsets will need to subclass `CharsetDecoder` and define the abstract `decodeLoop( )` method, which is invoked by `decode( )`.

```
public abstract class CharsetDecoder {
// Protected Constructors
     protected CharsetDecoder(Charset cs,
     float averageCharsPerByte, float maxCharsPerByte);
// Public Instance Methods
     public final float averageCharsPerByte( );
     public final Charset charset( );
     public final java.nio.CharBuffer decode(java.nio.ByteBuffer in)
        throws CharacterCodingException;
     public final CoderResult decode(java.nio.ByteBuffer in, java.nio.
        CharBuffer out, boolean endOfInput);
     public Charset detectedCharset( );
     public final CoderResult flush(java.nio.CharBuffer out);
     public boolean isAutoDetecting( );           constant
     public boolean isCharsetDetected( );
     public CodingErrorAction malformedInputAction( );
     public final float maxCharsPerByte( );
     public final CharsetDecoder onMalformedInput(CodingErrorAction newAction);
     public final CharsetDecoder onUnmappableCharacter(CodingErrorAction
        newAction);
     public final String replacement( );
     public final CharsetDecoder replaceWith(String newReplacement);
     public final CharsetDecoder reset( );
     public CodingErrorAction unmappableCharacterAction( );
// Protected Instance Methods
     protected abstract CoderResult decodeLoop(java.
        nio.ByteBuffer in, java.nio.CharBuffer out);
     protected CoderResult implFlush(java.nio.CharBuffer out);
     protected void implOnMalformedInput(CodingErrorAction
        newAction);     empty
     protected void implOnUnmappableCharacter(CodingErrorAction
        newAction);     empty
     protected void implReplaceWith(String
        newReplacement);            empty
     protected void implReset( );                                    empty
}
```

Passed To

`java.io.InputStreamReader.InputStreamReader( )`, `java.nio.channels.Channels.newReader( )`

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Returned By

`Charset.newDecoder( )`

CharsetEncoder java.nio.charset

Java 1.4

A `CharsetEncoder` is an "encoding engine" that converts a sequence of characters into a sequence of bytes using some character encoding. Obtain a `CharsetEncoder` with the `newEncoder( )` method of the `Charset` that represents the desired encoding.

A `CharsetEncoder` works like a `CharsetDecoder` in reverse. Use the `encode( )` method to encode characters read from a `CharBuffer` into bytes stored in a `ByteBuffer`. Please see `CharsetDecoder`, which is documented in detail.

```
public abstract class CharsetEncoder {
// Protected Constructors
     protected CharsetEncoder(Charset cs,
        float averageBytesPerChar, float maxBytesPerChar);
     protected CharsetEncoder(Charset cs,
        float averageBytesPerChar, float maxBytesPerChar, byte[ ] replacement);
// Public Instance Methods
     public final float averageBytesPerChar( );
     public boolean canEncode(CharSequence cs);
     public boolean canEncode(char c);
     public final Charset charset( );
     public final java.nio.ByteBuffer encode(java.nio.CharBuffer in)
        throws CharacterCodingException;
     public final CoderResult encode(java.nio.CharBuffer in,
        java.nio.ByteBuffer out, boolean endOfInput);
     public final CoderResult flush(java.nio.ByteBuffer out);
     public boolean isLegalReplacement(byte[ ] repl);
     public CodingErrorAction malformedInputAction( );
     public final float maxBytesPerChar( );
     public final CharsetEncoder onMalformedInput(CodingErrorAction
        newAction);
     public final CharsetEncoder onUnmappableCharacter(CodingErrorAction
        newAction);
     public final byte[ ] replacement( );
     public final CharsetEncoder replaceWith(byte[ ] newReplacement);
     public final CharsetEncoder reset( );
     public CodingErrorAction unmappableCharacterAction( );
// Protected Instance Methods
     protected abstract CoderResult encodeLoop(java.nio.CharBuffer in,
        java.nio.ByteBuffer out);
     protected CoderResult implFlush(java.nio.ByteBuffer out);
     protected void implOnMalformedInput(CodingErrorAction
         newAction);     empty
     protected void implOnUnmappableCharacter(CodingErrorAction
         newAction);     empty
     protected void implReplaceWith(byte[ ] newReplacement);     empty
     protected void implReset( );                    empty
}
```


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Passed To

`java.io.OutputStreamWriter.OutputStreamWriter( ), java.nio.channels.Channels.newWriter( )`

Returned By

`Charset.newEncoder( )`

CoderMalfunctionError java.nio.charset

Java 1.4 ***serializable error***

Signals a malfunction—typically an unknown and unrecoverable error—in a `CharsetEncoder` or `CharsetDecoder`. An error of this type is thrown by the `encode( )` and `decode( )` methods when the protected `encodeLoop( )` or `decodeLoop( )` methods upon which they are implemented throws an exception of an unexpected type.

Figure 13-49. java.nio.charset.CoderMalfunctionError


```
public class CoderMalfunctionError extends Error {
// Public Constructors
     public CoderMalfunctionError(Exception cause);
}
```

CoderResult java.nio.charset

Java 1.4

A `CoderResult` object specifies the results of a call to `CharsetDecoder.decode( )` or `CharsetEncoder.encode( )`. There are four possible reasons why a call to the `decode( )` or `encode( )` would return:

```
public class CoderResult {
// No Constructor
// Public Constants
     public static final CoderResult OVERFLOW;
     public static final CoderResult UNDERFLOW;
// Public Class Methods
     public static CoderResult malformedForLength(int length);
     public static CoderResult unmappableForLength(int length);
// Public Instance Methods
     public boolean isError( );
     public boolean isMalformed( );
```


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```
        public boolean isOverflow( );
        public boolean isUnderflow( );
        public boolean isUnmappable( );
        public int length( );
        public void throwException( ) throws CharacterCodingException;
    // Public Methods Overriding Object
        public String toString( );
    }
```

Returned By

`CharsetDecoder.{decode( ),decodeLoop( ),flush( ),implFlush( )},`
`CharsetEncoder.{encode( ),encodeLoop( ),flush( ),implFlush( )}`

CodingErrorAction java.nio.charset

Java 1.4

This class is a typesafe enumeration that defines three constants that serve as the legal argument values to the `onMalformedInput( )` and `onUnmappableCharacter( )` methods of `CharsetDecoder` and `CharsetEncoder`. These constants specify how malformed input and unmappable error conditions should be handled. The values are:

See `CharsetDecoder` for more information.

```
public class CodingErrorAction {
// No Constructor
// Public Constants
    public static final CodingErrorAction IGNORE;
    public static final CodingErrorAction REPLACE;
    public static final CodingErrorAction REPORT;
// Public Methods Overriding Object
    public String toString( );
}
```

Passed To

`CharsetDecoder.{implOnMalformedInput( ),`
`implOnUnmappableCharacter( ),onMalformedInput( ),`
`onUnmappableCharacter( )},CharsetEncoder.`
`{implOnMalformedInput( ),implOnUnmappableCharacter( ),`
`onMalformedInput( ),onUnmappableCharacter( )}`

Returned By

`CharsetDecoder.{malformedInputAction( ),`
`unmappableCharacterAction( )},CharsetEncoder.`
`{malformedInputAction( ),unmappableCharacterAction( )}`

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IllegalCharsetNameException java.nio.charset

Java 1.4 ***serializable unchecked***

Signals that a charset name (for example one passed to `Charset.forName( )` or `Charset.isSupported( )`) is not legal. Charset names may contain only the characters A-Z (in upper- and lowercase), the digits 0-9, and hyphens, underscores, colons, and periods. They must begin with a letter or a digit, not with a punctuation character.

Figure 13-50. java.nio.charset.IllegalCharsetNameException

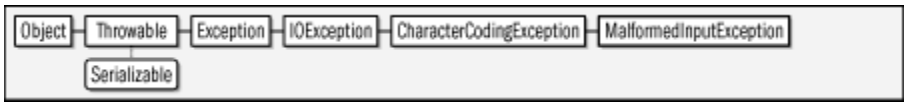

```
public class IllegalCharsetNameException extends IllegalArgumentException {
// Public Constructors
     public IllegalCharsetNameException(String charsetName);
// Public Instance Methods
     public String getCharsetName( );
}
```

MalformedInputException java.nio.charset

Java 1.4 ***serializable checked***

Signals that input to the `CharsetDecoder.decode( )` or `CharsetEncoder.encode( )` method was malformed.

Figure 13-51. java.nio.charset.MalformedInputException




```
public class MalformedInputException extends CharacterCodingException {
// Public Constructors
     public MalformedInputException(int inputLength);
// Public Instance Methods
     public int getInputLength( );
// Public Methods Overriding Throwable
     public String getMessage( );
}
```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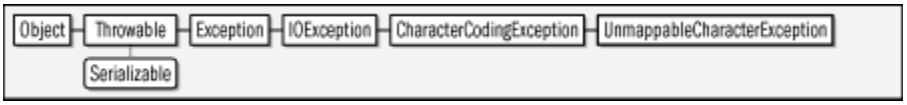
UnmappableCharacterException java.nio.charset

Java 1.4 ***serializable checked***

Signals that input to the `CharsetDecoder.decode( )` or `CharsetEncoder.encode( )` method contained a character or byte sequence that is not mappable in the specified charset.

Figure 13-52. java.nio.charset.UnmappableCharacterException




```
public class UnmappableCharacterException extends CharacterCodingException {
// Public Constructors
     public UnmappableCharacterException(int inputLength);
// Public Instance Methods
     public int getInputLength( );
// Public Methods Overriding Throwable
     public String getMessage( );
}
```

UnsupportedCharsetException java.nio.charset

Java 1.4 ***serializable unchecked***

Signals that the requested charset is not supported on the current platform. This exception is thrown by `Charset.forName( )` when no `Charset` object can be obtained for the named charset. See also `Charset.isSupported( )`.

Figure 13-53. java.nio.charset.UnsupportedCharsetException


```
public class UnsupportedCharsetException extends IllegalArgumentException {
// Public Constructors
     public UnsupportedCharsetException(String charsetName);
// Public Instance Methods
     public String getCharsetName( );

}
```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Package java.nio.charset.spi

Java 1.4

This package defines a "provider" class for system developers who are defining new `Charset` implementations and want to make them available to the system. Application programmers never need to us this package or the class it defines.

Classes

```
public abstract class CharsetProvider;
```

CharsetProvider java.nio.charset.spi

Java 1.4

System programmers developing new `Charset` implementations should implement this class to make those charsets available to the system. `charsetForName( )` should return a `Charset` instance for the given name. `charsets( )` should return a `java.util.Iterator` that allows the caller to iterate through the set of `Charset` objects defined by the provider.

A `CharsetProvider` and its associated `Charset` implementations should be packaged in a JAR file and made available to the system in the *jre/lib/ext/* extensions directory (or some other extensions location.) The JAR file should contain a file named *META-INF/services/java.nio.charset.spi.CharsetProvider* which contains the class name of the `CharsetProvider` implementation.

```
public abstract class CharsetProvider {
// Protected Constructors
     protected CharsetProvider( );
// Public Instance Methods
     public abstract java.nio.charset.Charset charsetForName(String charsetName);
     public abstract java.util.Iterator<java.nio.charset.Charset> charsets( );
}
```


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