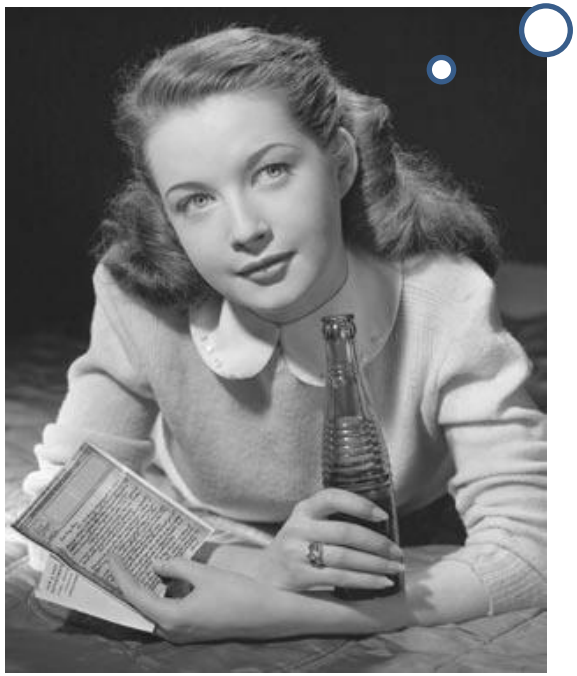
深入浅出Netty

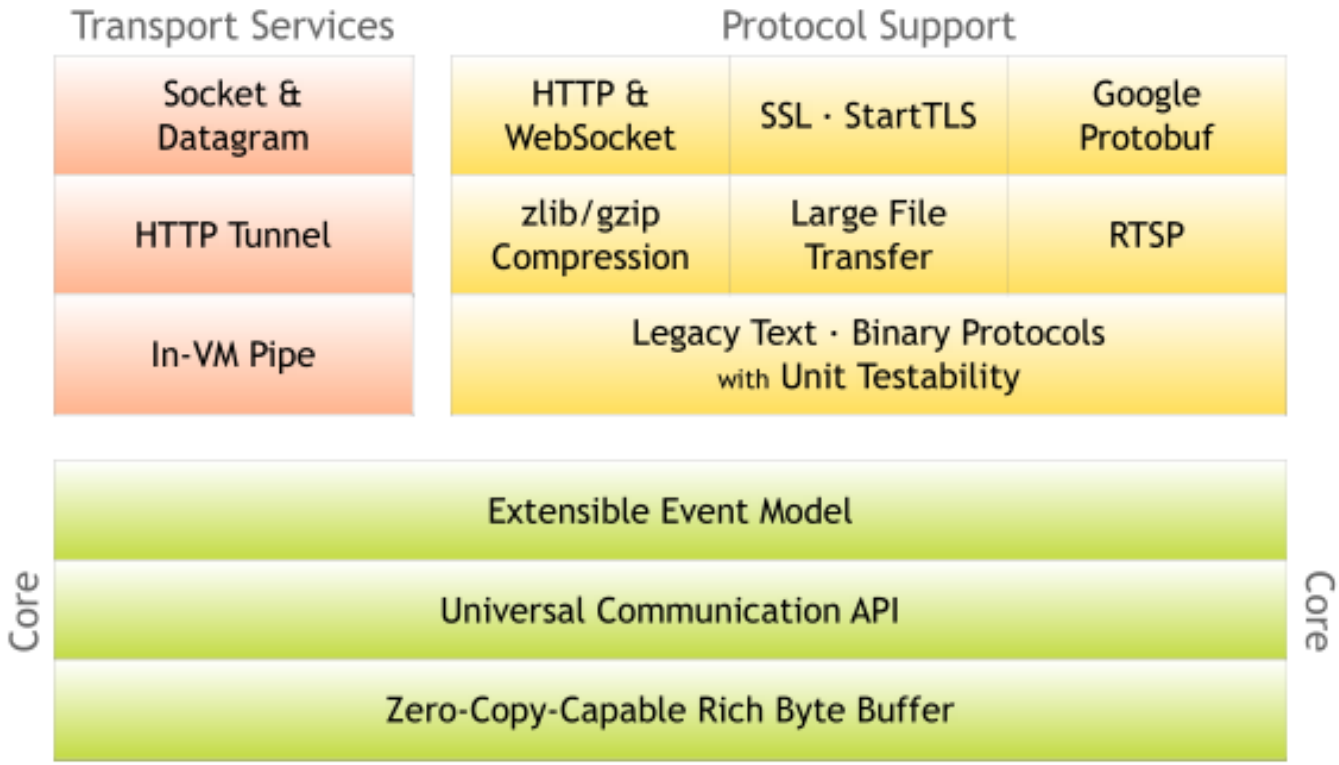
雷腾 L.T - leiteng@taobao.com
搜索算法与技术 – 搜索应用团队

Netty是什么？

Netty 提供异步的、事件驱动的网络应用程序框架和工具，用以快速开发高性能、高可靠性的网络服务器和客户端程序



Netty的架构


Transport Services
Protocol Support
Socket & Datagram
HTTP & WebSocket
SSL · StartTLS
Google Protobuf
HTTP Tunnel
zlib/gzip Compression
Large File Transfer
RTSP
In-VM Pipe
Legacy Text · Binary Protocols with Unit Testability
Core
Extensible Event Model
Universal Communication API
Zero-Copy-Capable Rich Byte Buffer
Core

Netty的特性

Netty 有些什么特性呢？

Netty的特性

- 设计
  - 统一的API，适用于不同的协议（阻塞和非阻塞）
  - 基于灵活、可扩展的事件驱动模型
  - 高度可定制的线程模型
  - 可靠的无连接数据Socket支持（UDP）
- 性能
  - 更好的吞吐量，低延迟
  - 更省资源
  - 尽量减少不必要的内存拷贝

Netty的特性

- 安全
  - 完整的SSL/ TLS和STARTTLS的支持
  - 能在Applet与谷歌Android的限制环境运行良好
- 健壮性
  - 不再因过快、过慢或超负载连接导致OutOfMemoryError
  - 不再有在高速网络环境下NIO读写频率不一致的问题
- 易用
  - 完善的Java doc，用户指南和样例
  - 简洁简单
  - 仅依赖于JDK1.5

深入浅出Netty

But how to use it ?

Hello World in Netty

- HelloWorldServer

```
ServerBootstrap bootstrap = new ServerBootstrap(new
    NioServerSocketChannelFactory(
    Executors.newCachedThreadPool(),
    Executors.newCachedThreadPool()));

bootstrap.setPipelineFactory(new ChannelPipelineFactory() {
    public ChannelPipeline getPipeline()  {
      ChannelPipeline pipeline = Channels.pipeline();
      pipeline.addLast("decoder", new StringDecoder());
      pipeline.addLast("encoder", new StringEncoder());
      pipeline.addLast("handler", new HelloWorldServerHandler());
      return pipeline;
    }
});

bootstrap.bind(new InetSocketAddress(8080));
```

Hello World in Netty

- HelloWorldServerHandler

```
public void channelConnected(ChannelHandlerContext ctx,
    ChannelStateEvent e) throws Exception {
    e.getChannel().write("Hello, World");
}

public void exceptionCaught(ChannelHandlerContext ctx,
    ExceptionEvent e) {
    logger.log(Level.WARNING, "Unexpected exception from
    downstream.", e.getCause());
    e.getChannel().close();
}
```

Hello World in Netty

- HelloWorldClient

```
ClientBootstrap bootstrap = new ClientBootstrap(new NioClientSocketChannelFactory(
Executors.newCachedThreadPool(), Executors.newCachedThreadPool()));

bootstrap.setPipelineFactory(new ChannelPipelineFactory() {
    public ChannelPipeline getPipeline() {
        ChannelPipeline pipeline = pipeline();
        pipeline.addLast("decoder", new StringDecoder());
        pipeline.addLast("encoder", new StringEncoder());
        pipeline.addLast("handler", new HelloWorldClientHandler());
        return pipeline;
    }
});

ChannelFuture future = bootstrap.connect(new InetSocketAddress("localhost", 8080));

future.getChannel().getCloseFuture().awaitUninterruptibly();

bootstrap.releaseExternalResources();
```

Hello World in Netty

- HelloWorldClientHandler

```
public void messageReceived(ChannelHandlerContext ctx,
    MessageEvent e) {
      String message = (String) e.getMessage();
      System.out.println(message);
      e.getChannel().close();
}
public void exceptionCaught(ChannelHandlerContext ctx,
    ExceptionEvent e) {
      logger.log(Level.WARNING, "Unexpected exception from
        downstream.", e.getCause());
      e.getChannel().close();
}
```

深入浅出Netty

刨根问底的勇气？

Netty源码分析

- org.jboss.netty.bootstrap
  - Bootstrap : ChannelFactory , ChannelPipeline , ChannelPipelineFactory
    - 初始化channel的辅助类
    - 为具体的子类提供公共数据结构
  - ServerBootstrap: bind()
    - 创建服务器端channel的辅助类
    - 接收connection请求
  - ClientBootstrap : connect()
    - 创建客户端channel的辅助类
    - 发起connection请求
  - ConnectionlessBootstrap : connect() , bind()
    - 创建无连接传输channel的辅助类（ UDP ）
    - 包括Client 和Server

Netty源码分析

- org.jboss.netty.buffer

  取代nio 中的java.nio.ByteBuffer，相比ByteBuffer

  - 可以根据需要自定义buffer type
  - 内置混合的buffer type, 以实现zero-copy
  - 提供类似StringBuffer的动态dynamic buffer
  - 不需要调用flip方法
  - 更快的性能

  推荐使用ChannelBuffers的静态工厂创建ChannelBuffer

Netty源码分析

- org.jboss.netty.channel
  channel核心api，包括异步和事件驱动等各种传送接口
- org.jboss.netty.channel.group
  channel group，帮助用户维护channel列表
- org.jboss.netty.channel.local
  一种虚拟传输方式，允许同一个虚拟机上的两个部分可以互相通信
- org.jboss.netty.channel.socket
  TCP, UDP接口，继承了核心的channel API
- org.jboss.netty.channel.socket.nio
  基于nio的Socket channel实现
- org.jboss.netty.channel.socket.oio
  基于老io的Socket channel实现
- org.jboss.netty.channel.socket.http
  基于http的客户端和相应的server端的实现，工作在有防火墙的情况

Netty源码分析

- org.jboss.netty.container
  各种容器的兼容
- org.jboss.netty.container.microcontainer
  JBoss Microcontainer 集成接口
- org.jboss.netty.container.osgi
  OSGi framework集成接口
- org.jboss.netty.container.spring
  Spring framework集成接口

Netty源码分析

- org.jboss.netty.handler
  处理器
- org.jboss.netty.handler.codec
  编码解码器
- org.jboss.netty.handler.execution
  基于Executor的实现
- org.jboss.netty.handler.queue
  将event存入内部队列的处理
- org.jboss.netty.handler.ssl
  基于SSLEngine的SSL以及TLS实现
- org.jboss.netty.handler.stream
  异步写入大数据，不会产生outOfMemory 也不会花费很多内存
- org.jboss.netty.handler.timeout
  通过Timer来对读写超时或者闲置链接进行通知

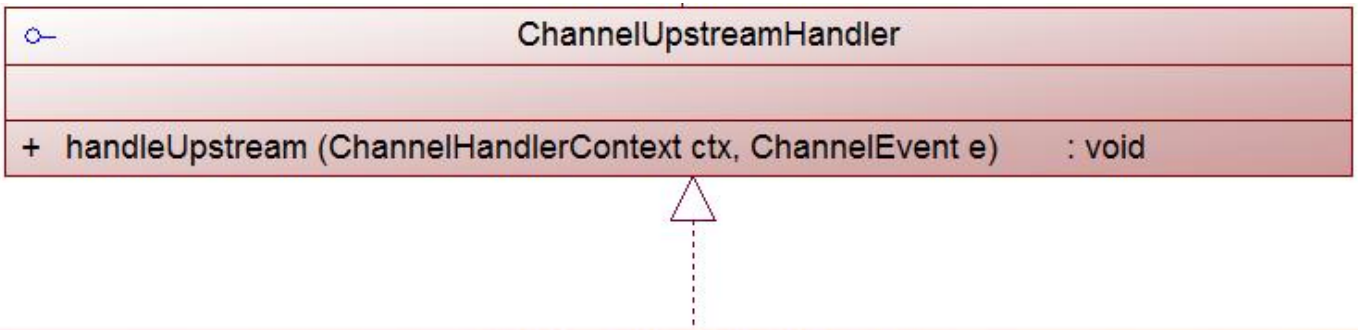
Netty源码分析

- org.jboss.netty.handler.codec.base64 Base64 编码
- org.jboss.netty.handler.codec.compression 压缩格式
- org.jboss.netty.handler.codec.embedder 嵌入模式下编码和解码
- org.jboss.netty.handler.codec.frame 评估流的数据的排列和内容
- org.jboss.netty.handler.codec.http.websocket websocket编码解码
- org.jboss.netty.handler.codec.http http的编码解码以及类型信息
- org.jboss.netty.handler.codec.oneone 对象到对象编码解码
- org.jboss.netty.handler.codec.protobuf Protocol Buffers的编码解码
- org.jboss.netty.handler.codec.replay 在阻塞io中实现非阻塞解码
- org.jboss.netty.handler.codec.rtsp RTSP的编码解码
- org.jboss.netty.handler.codec.serialization 序列化对象到bytebuffer实现
- org.jboss.netty.handler.codec.string 字符串编码解码，继承oneone

Netty源码分析

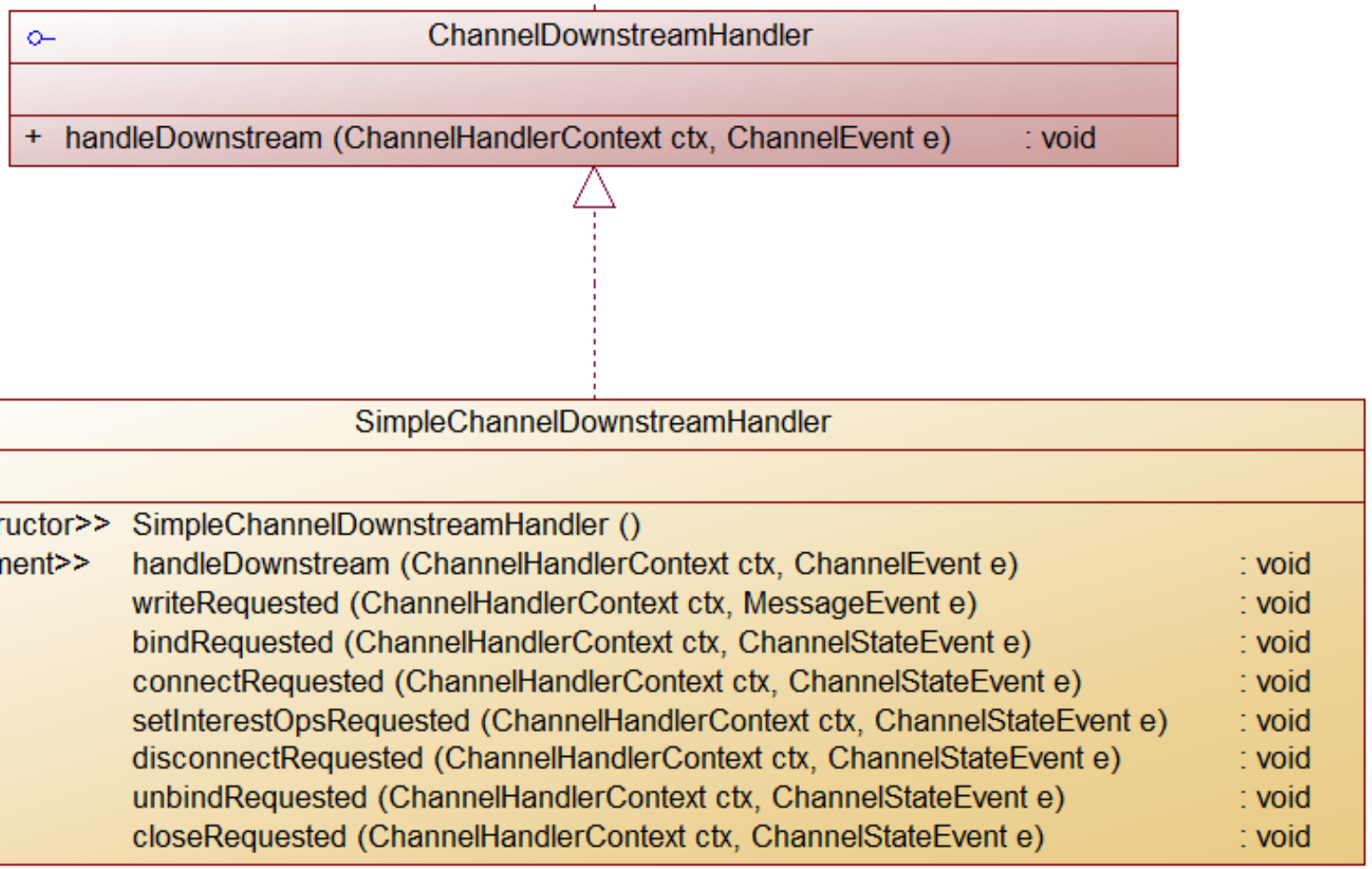
- org.jboss.netty.logging
  根据不同的log framework 实现的类
- org.jboss.netty.util
  netty util类
- org.jboss.netty.util.internal
  netty内部util类，不被外部使用

Netty事件驱动模型



SimpleChannelUpstreamHandler			
- logger : InternalLogger = InternalLoggerFactory.getInstance(SimpleChannelUpstreamHandler.class.getName())			
+	<<Constructor>>	SimpleChannelUpstreamHandler ()	
+	<<Implement>>	handleUpstream (ChannelHandlerContext ctx, ChannelEvent e)	: void
+		messageReceived (ChannelHandlerContext ctx, MessageEvent e)	: void
+		exceptionCaught (ChannelHandlerContext ctx, ExceptionEvent e)	: void
+		channelOpen (ChannelHandlerContext ctx, ChannelStateEvent e)	: void
+		channelBound (ChannelHandlerContext ctx, ChannelStateEvent e)	: void
+		channelConnected (ChannelHandlerContext ctx, ChannelStateEvent e)	: void
+		channelInterestChanged (ChannelHandlerContext ctx, ChannelStateEvent e)	: void
+		channelDisconnected (ChannelHandlerContext ctx, ChannelStateEvent e)	: void
+		channelUnbound (ChannelHandlerContext ctx, ChannelStateEvent e)	: void
+		channelClosed (ChannelHandlerContext ctx, ChannelStateEvent e)	: void
+		writeComplete (ChannelHandlerContext ctx, WriteCompletionEvent e)	: void
+		childChannelOpen (ChannelHandlerContext ctx, ChildChannelStateEvent e)	: void
+		childChannelClosed (ChannelHandlerContext ctx, ChildChannelStateEvent e)	: void

Netty事件驱动模型



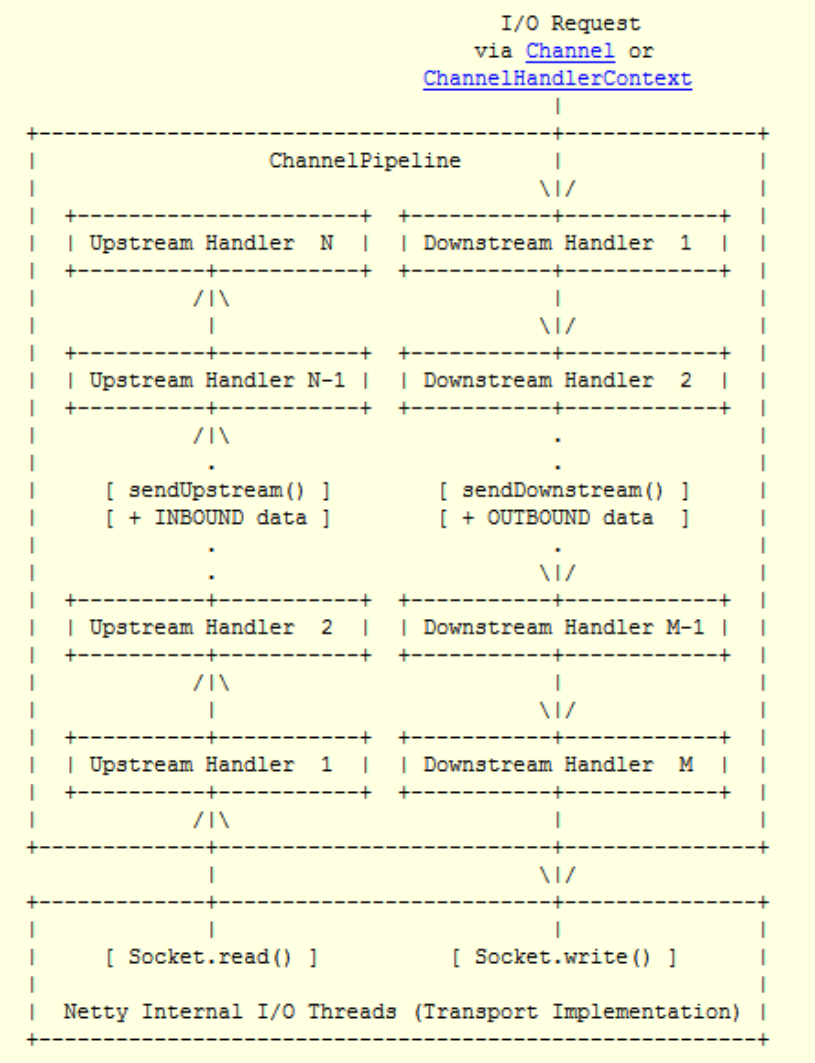
Netty Pipeline 流处理

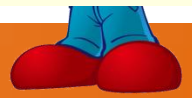
- Upstream 接收请求
- Downstream 发送请求

```
ChannelPipeline p = Channels.pipeline();
p.addLast("1", new UpstreamHandlerA());
p.addLast("2", new UpstreamHandlerB());
p.addLast("3", new DownstreamHandlerA());
p.addLast("4", new DownstreamHandlerB());
p.addLast("5", new UpstreamHandlerX());
```

Upstream: 1 → 2 → 5 顺序处理

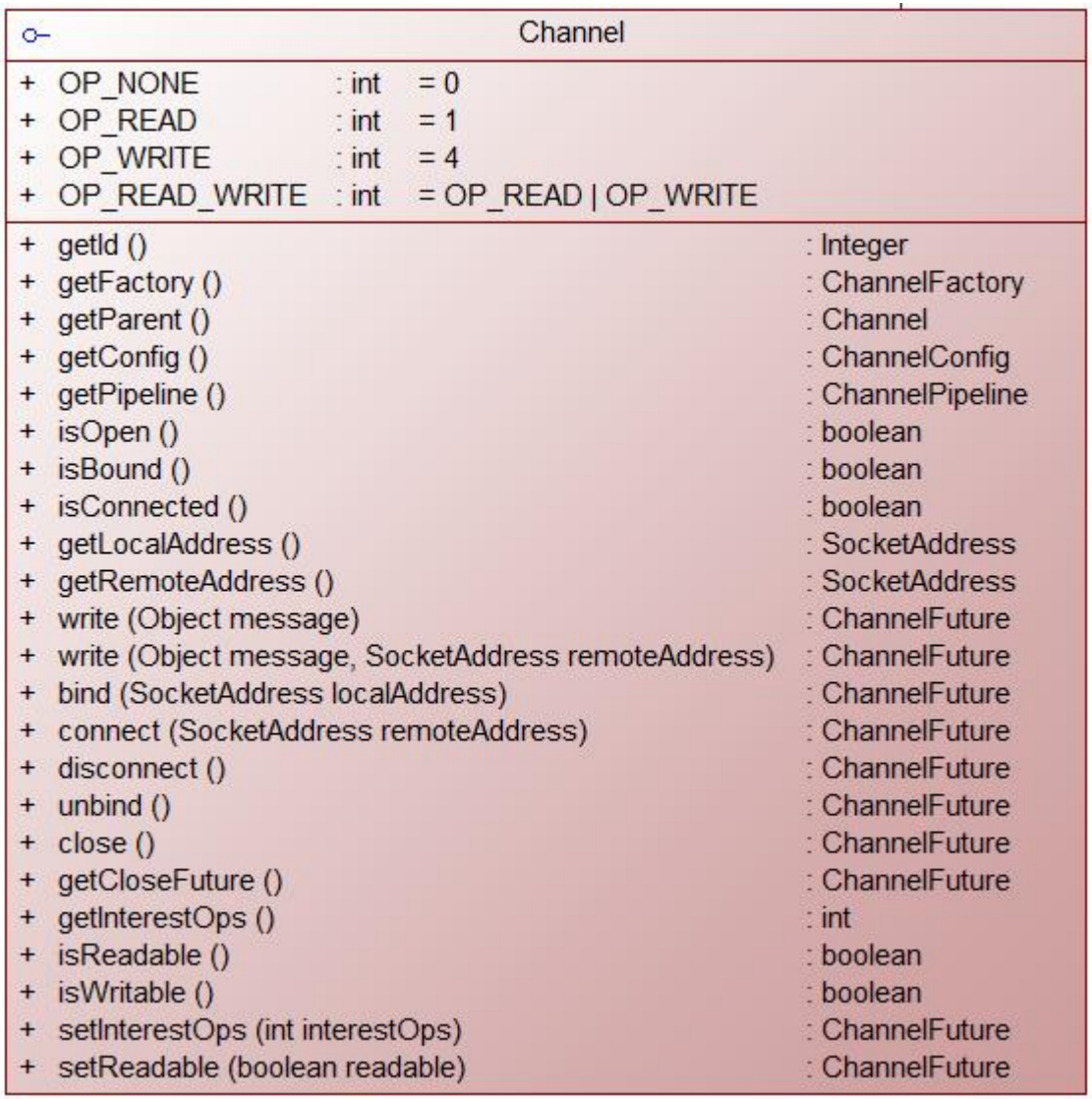
Downstream: 4 → 3 逆序处理





Netty 通用通信API

- connect
- bind
- write
- close
- disconnect
- unbind
- isOpen
- isBound
- isConnected
- isReadable
- isWrita ble



Netty Zero-Copy-Capable Buffer

- 序列访问索引

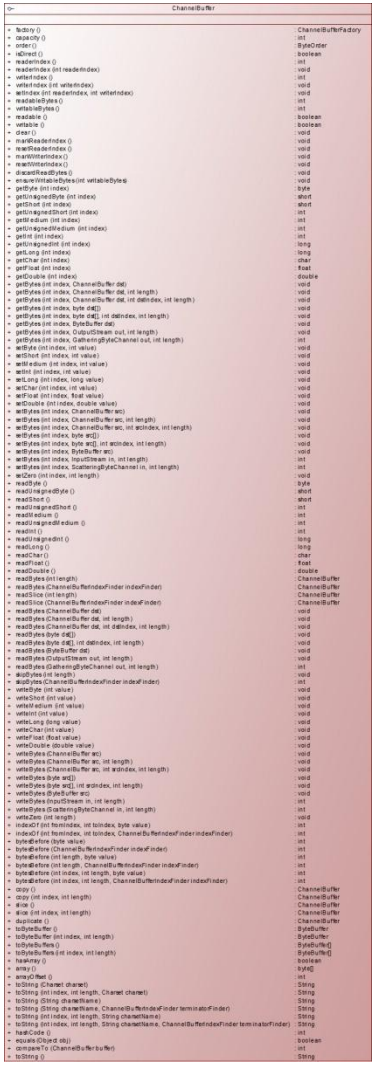
```
+-------------------+------------------+------------------+
| discardable bytes | readable bytes   | writable bytes   |
+-------------------+------------------+------------------+
|                   |                  |                  |
```

0 <= readerIndex <= writerIndex <= capacity

- get & set : not modify the readerIndex or writerIndex
- read & write : modify the readerIndex or writerIndex

Netty Zero-Copy-Capable Buffer

- ChannelBuffer
  - 定义接口
- ChannelBuffers
  - 静态工厂
  - 隐藏具体类型



ChannelBuffers

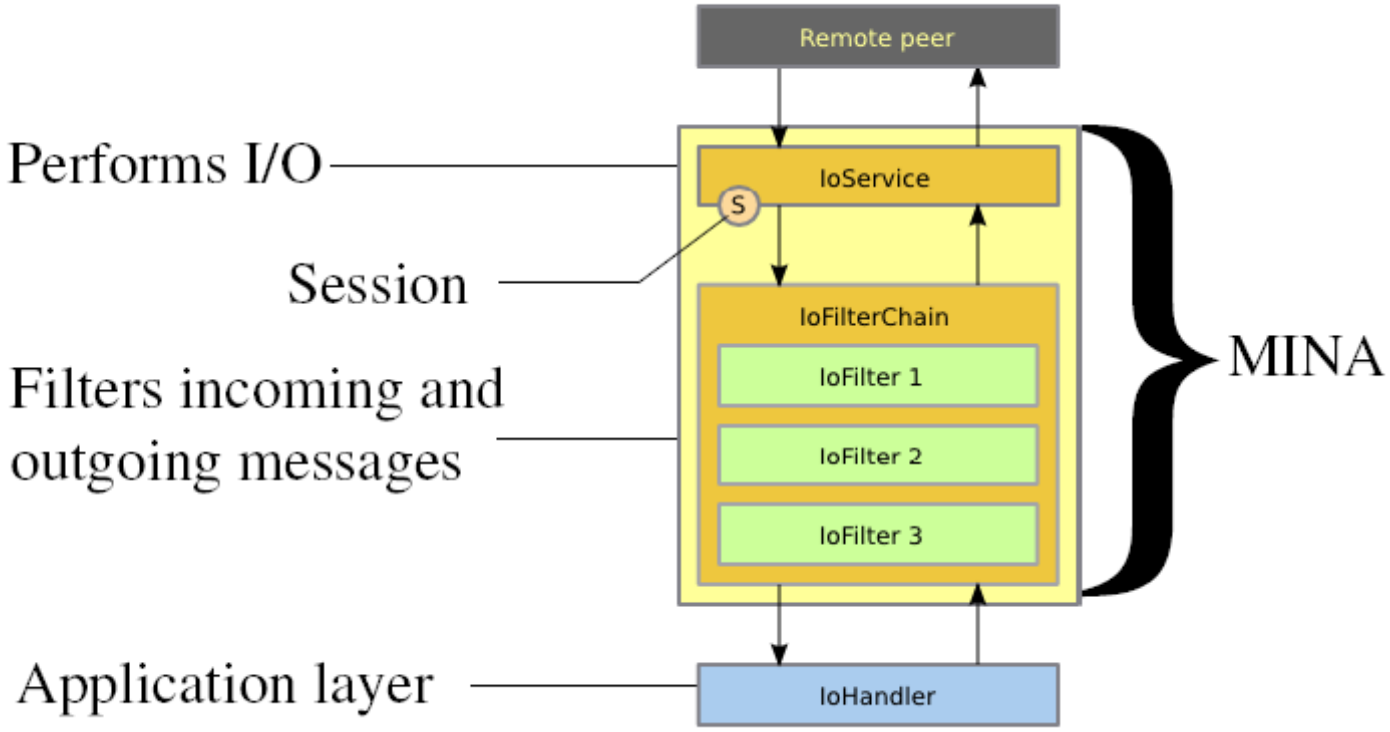
+	BIG_ENDIAN	: ByteOrder	= ByteOrder.BIG_ENDIAN
+	LITTLE_ENDIAN	: ByteOrder	= ByteOrder.LITTLE_ENDIAN
+	EMPTY_BUFFER	: ChannelBuffer	= new BigEndianHeapChannelBuffer(0)
-	HEXDUMP_TABLE	: char[]	= new char[256 * 4]
-	<<staticInitializer>>	_STATIC_INITIALIZER ()	: void
+		buffer (int capacity)	: ChannelBuffer
+		buffer (ByteOrder endianness, int capacity)	: ChannelBuffer
+		directBuffer (int capacity)	: ChannelBuffer
+		directBuffer (ByteOrder endianness, int capacity)	: ChannelBuffer
+		dynamicBuffer ()	: ChannelBuffer
+		dynamicBuffer (ChannelBufferFactory factory)	: ChannelBuffer
+		dynamicBuffer (int estimatedLength)	: ChannelBuffer
+		dynamicBuffer (ByteOrder endianness, int estimatedLength)	: ChannelBuffer
+		dynamicBuffer (int estimatedLength, ChannelBufferFactory factory)	: ChannelBuffer
+		dynamicBuffer (ByteOrder endianness, int estimatedLength, ChannelBufferFactory factory)	: ChannelBuffer
+		wrappedBuffer (byte array[])	: ChannelBuffer
+		wrappedBuffer (ByteOrder endianness, byte array[])	: ChannelBuffer
+		wrappedBuffer (byte array[], int offset, int length)	: ChannelBuffer
+		wrappedBuffer (ByteOrder endianness, byte array[], int offset, int length)	: ChannelBuffer
+		wrappedBuffer (ByteBuffer buffer)	: ChannelBuffer
+		wrappedBuffer (ChannelBuffer buffer)	: ChannelBuffer
+		wrappedBuffer (byte... arrays[])	: ChannelBuffer
+		wrappedBuffer (ByteOrder endianness, byte... arrays[])	: ChannelBuffer
-		compositeBuffer (ByteOrder endianness, List<ChannelBuffer> components)	: ChannelBuffer
+		wrappedBuffer (ChannelBuffer... buffers)	: ChannelBuffer
+		wrappedBuffer (ByteBuffer... buffers)	: ChannelBuffer
+		copiedBuffer (byte array[])	: ChannelBuffer
+		copiedBuffer (ByteOrder endianness, byte array[])	: ChannelBuffer
+		copiedBuffer (byte array[], int offset, int length)	: ChannelBuffer
+		copiedBuffer (ByteOrder endianness, byte array[], int offset, int length)	: ChannelBuffer
+		copiedBuffer (ByteBuffer buffer)	: ChannelBuffer
+		copiedBuffer (ChannelBuffer buffer)	: ChannelBuffer
+		copiedBuffer (byte... arrays[])	: ChannelBuffer
+		copiedBuffer (ByteOrder endianness, byte... arrays[])	: ChannelBuffer
+		copiedBuffer (ChannelBuffer... buffers)	: ChannelBuffer
+		copiedBuffer (ByteBuffer... buffers)	: ChannelBuffer
+		copiedBuffer (CharSequence string, Charset charset)	: ChannelBuffer
+		copiedBuffer (CharSequence string, int offset, int length, Charset charset)	: ChannelBuffer
+		copiedBuffer (ByteOrder endianness, CharSequence string, Charset charset)	: ChannelBuffer
+		copiedBuffer (ByteOrder endianness, CharSequence string, int offset, int length, Charset charset)	: ChannelBuffer
+		copiedBuffer (char array[], Charset charset)	: ChannelBuffer
+		copiedBuffer (char array[], int offset, int length, Charset charset)	: ChannelBuffer
+		copiedBuffer (ByteOrder endianness, char array[], Charset charset)	: ChannelBuffer
+		copiedBuffer (ByteOrder endianness, char array[], int offset, int length, Charset charset)	: ChannelBuffer
-		copiedBuffer (ByteOrder endianness, CharBuffer buffer, Charset charset)	: ChannelBuffer
+		copiedBuffer (String string, String charsetName)	: ChannelBuffer
+		copiedBuffer (ByteOrder endianness, String string, String charsetName)	: ChannelBuffer
+		unmodifiableBuffer (ChannelBuffer buffer)	: ChannelBuffer
+		hexDump (ChannelBuffer buffer)	: String
+		hexDump (ChannelBuffer buffer, int fromIndex, int length)	: String
+		hashCode (ChannelBuffer buffer)	: int
+		equals (ChannelBuffer bufferA, ChannelBuffer bufferB)	: boolean
+		compare (ChannelBuffer bufferA, ChannelBuffer bufferB)	: int
+		indexOf (ChannelBuffer buffer, int fromIndex, int toIndex, byte value)	: int
+		indexOf (ChannelBuffer buffer, int fromIndex, int toIndex, ChannelBufferIndexFinder indexFinder)	: int
+		swapShort (short value)	: short
+		swapMedium (int value)	: int
+		swapInt (int value)	: int
+		swapLong (long value)	: long
-		firstIndexOf (ChannelBuffer buffer, int fromIndex, int toIndex, byte value)	: int
-		lastIndexOf (ChannelBuffer buffer, int fromIndex, int toIndex, byte value)	: int
-		firstIndexOf (ChannelBuffer buffer, int fromIndex, int toIndex, ChannelBufferIndexFinder indexFinder)	: int
-		lastIndexOf (ChannelBuffer buffer, int fromIndex, int toIndex, ChannelBufferIndexFinder indexFinder)	: int
*		encodeString (CharBuffer src, Charset charset)	: ByteBuffer
*		decodeString (ByteBuffer src, Charset charset)	: String
-	<<Constructor>>	ChannelBuffers ()	

Netty数据流分析

- 服务器启动
- 服务器主通道监听
- 服务器子通道开通
- 客户端启动
- 客户端主通道监听
- 客户端子通道开通

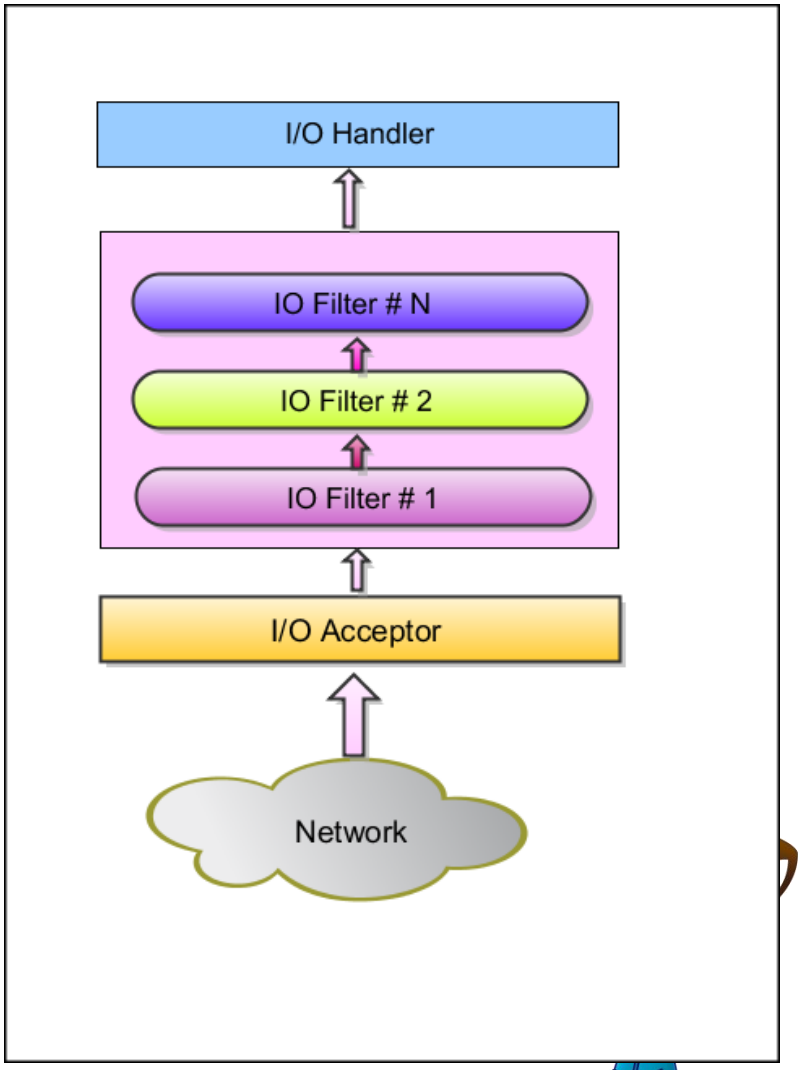
Netty VS Mina

Mina 架构


Remote peer
Performs I/O
IoService
S
Session
IoFilterChain
IoFilter 1
Filters incoming and
outgoing messages
IoFilter 2
IoFilter 3
MINA
Application layer
IoHandler

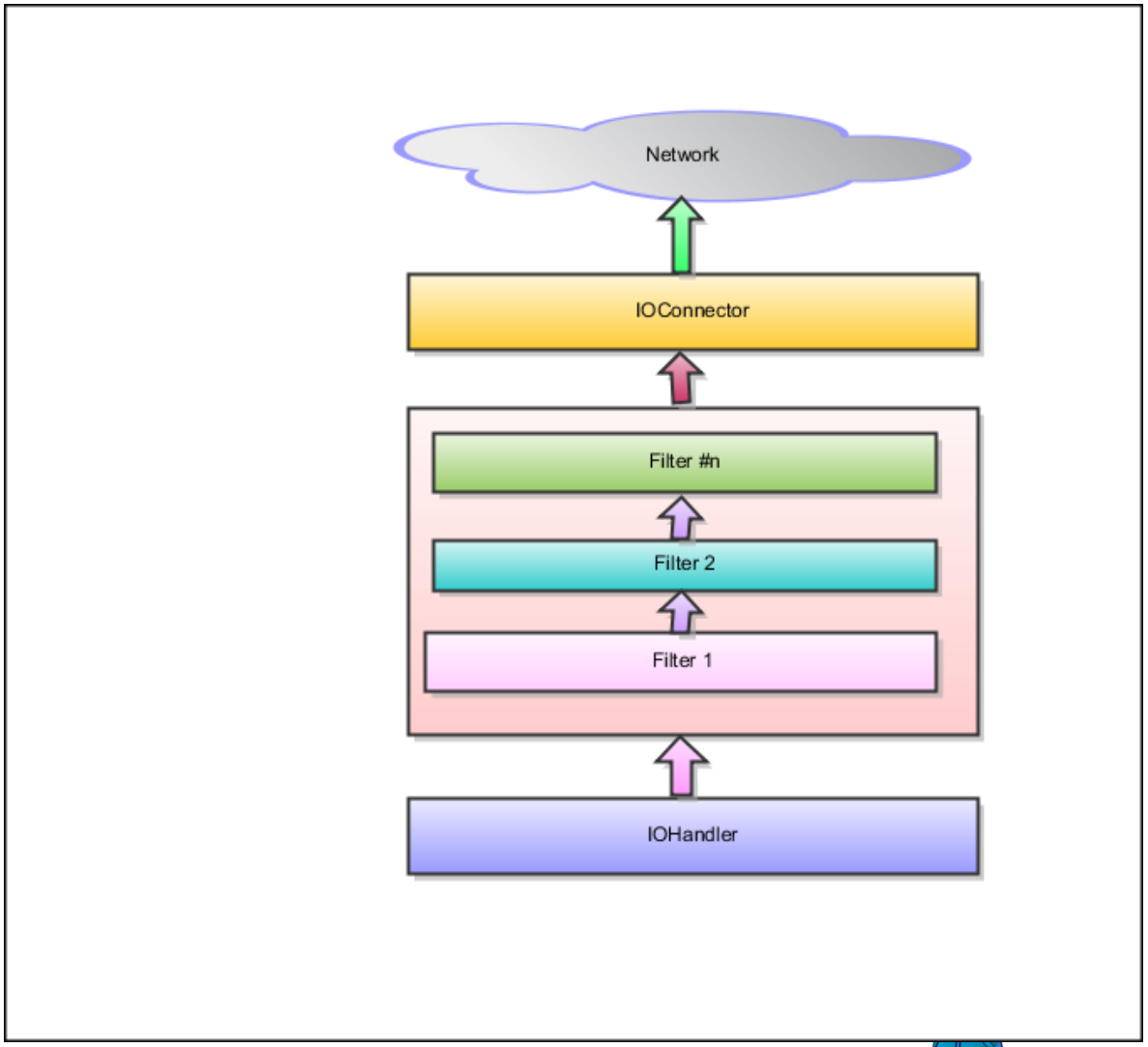
Mina 服务器端架构

- IO Acceptor
  - 实现了IoService
  - 监听网络请求或数据包
  - 新连接，创建session
- IO Filter
  - 过滤和传输
  - 编码解码
- IO Handler
  - 实现业务逻辑



Mina 客户架构

- IO Connector
  - 实现IO Server
  - 连接到Socket
  - bind到Server
  - 创建session
- IO Filter
  - 过滤和传输
  - 编码解码
- IO Handler
  - 实现业务逻辑



Netty VS Mina

- Netty基于Pipeline处理，Mina基于Filter过滤
- Netty的事件驱动模型具有更好的扩展性和易用性
- Https，SSL，PB，RSTP，Text &Binary等协议支持
- Netty中UDP传输有更好的支持
- 官方测试Netty比Mina性能更好

Q & A

雷腾 L.T

Email：leiteng@taobao.com