RAPID NETWORK APPLICATION DEVELOPMENT WITH APACHE MINA

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Learn how to build:

scalable, stable, maintainable and manageable network applications utilizing any protocol

with Apache MINA

GOAL

Agenda

Before the adventure...

- Presenter
- Introduction
- Core Components
- Management
- Future
- Summary

Presenter

Who is Trustin Lee?

- Founder of Netty framework
- Cofounder and VP of Apache MINA
- JBoss Remoting project lead
- Wrote Java™ New I/O API (NIO)-based massive network applications
  - Distributed SMS gateway – 10M msgs / day
  - OSGi-based asynchronous RPC server with Hessian protocol
- Didn't write a book yet! ;)

Agenda
What, Why and How?

- Presenter
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Introduction
What is Apache MINA?

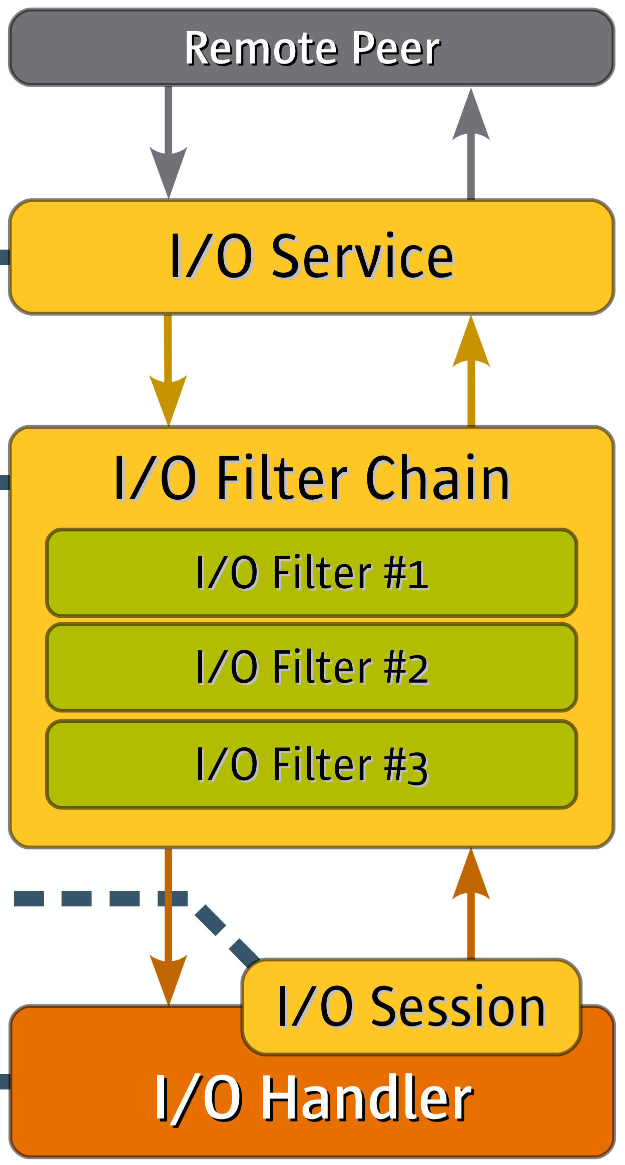
- A Java open-source network application framework
- Abstract API
  - Event-driven
  - Asynchronous
  - Unit-testable
- Implementations
  - Sockets & datagrams – Java NIO & APR via Tomcat Native
  - Serial ports – RXTX.org
  - In-VM pipes
  - *<Your favorite transports here: SCTP, multicast, Infiniband...>*

Introduction
Why should I use it?

- Maintainable and reusable
  - Networking engine – MINA I/O service
  - Protocol codec – MINA codec framework
  - Your business logic
- Extensible
  - Runtime modification of application behavior using 'filters'
- Manageable
  - Introspection of connections and services via JMX™ API
- Unit-testable
  - Abstract API
  - Out-of-the-box mock objects

Introduction
What does it look like?

- Performs actual I/O
- Filters events & requests
- A connection
- *<Your protocol logic>*



Agenda

Let’s learn by looking at examples!

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IoSession & IoBuffer

Writing a message was never easier than this.

```
// Build a string to send.
CharsetEncoder = ...;

IoSession session = ...;

IoBuffer buffer = IoBuffer.allocate(16);

buffer.setAutoExpand(true)
      .putString("It is ", encoder)
      .putString(new Date().toString(), encoder)
      .putString(" now.\r\n", encoder).flip();

// Asynchronous write request.
session.write(buffer);
```

IoSession

Connection, Socket, Channel...

- Abstracts a underlying transport’s connection away
- Provides asynchronous operations to I/O service
  - Write, close...
  - All asynchronous
  - Returns IoFuture (WriteFuture, CloseFuture...)
    - A set of IoFutureListener can be added for notification
- Provides I/O statistics
  - Read bytes, written bytes, last I/O time...

IoBuffer

Why don’t you just use NIO ByteBuffer?

- Rich binary & text manipulation methods
  - Unsigned value, enum, string, Java Object...
- On-demand automatic expansion and shrinkage
- More control over allocation mechanism
- More extensible than ByteBuffer
  - provides all methods in ByteBuffer
  - provides easy wrap · unwrap methods

IoHandler

Let’s write back what’s received.

```
public class EchoHandler implements IoHandler {
  public void messageReceived(IoSession s, Object msg)
  {
    IoBuffer buffer = (IoBuffer) msg;
    s.write(buffer.duplicate());
  }

  public void exceptionCaught(IoSession s, Throwable e)
  {
    s.close();
  }

  public void sessionOpened(IoSession s) {}
  public void messageSent(IoSession s, Object msg) {}
  public void sessionIdle(IoSession s, IdleStatus stat) {}
  public void sessionClosed(IoSession s) {}
}
```

IoService

IoAcceptor is for the server side.

```
public class Main {
  public static void main(String[] args) ...
  {
    IoAcceptor acceptor = new NioSocketAcceptor();
    acceptor.setHandler(new EchoHandler());
    acceptor.bind(new InetSocketAddress(8080));
    ...
    acceptor.unbind(new InetSocketAddress(8080));
  }
}
```

IoService

IoConnector is for the client side.

```
public class Main {
  public static void main(String[] args) ...
  {
    IoConnector connector = new NioSocketConnector();
    connector.setHandler(new MyHandler());
    ConnectFuture future = connector.connect(
        new InetSocketAddress("example.com", 8080));

    IoSession session = future.await().getSession();

    session.write(...).await();      // WriteFuture
    session.close().await();         // CloseFuture
  }
}
```

IoService

Switching to a different transport was never easier than this.

```
~~IoAcceptor acceptor = new NioSocketAcceptor();~~
IoAcceptor acceptor = new AprSocketAcceptor();
...

~~IoConnector connector = new NioSocketConnector();~~
IoConnector connector = new SerialConnector();
...
~~connector.connect(new InetSocketAddress(...));~~
connector.connect(new SerialAddress(...));
...
```

IoFilterChain & IoFilter

Imagine hot-deployable Servlet filters.

```
// Enable logging.
acceptor.getFilterChain().addLast(
        "logger", new LoggingFilter());

// Enable SSL.
acceptor.getFilterChain().addLast(
        "ssl", new SslFilter());

// Enable compression for an individual session.
session.getFilterChain().addBefore(
        "ssl", "compressor",
        new CompressionFilter());

// Zap all of them.
session.getFilterChain().clear();
```

IoFilter

One-stop solution for cross-cutting concerns:

- Logging
- Overload prevention
- Failure injection
- On-demand profiler
- Remote peer blacklisting
- Keep-alive · timeout
- More to come – whatever you want to intercept!

Protocol Codecs

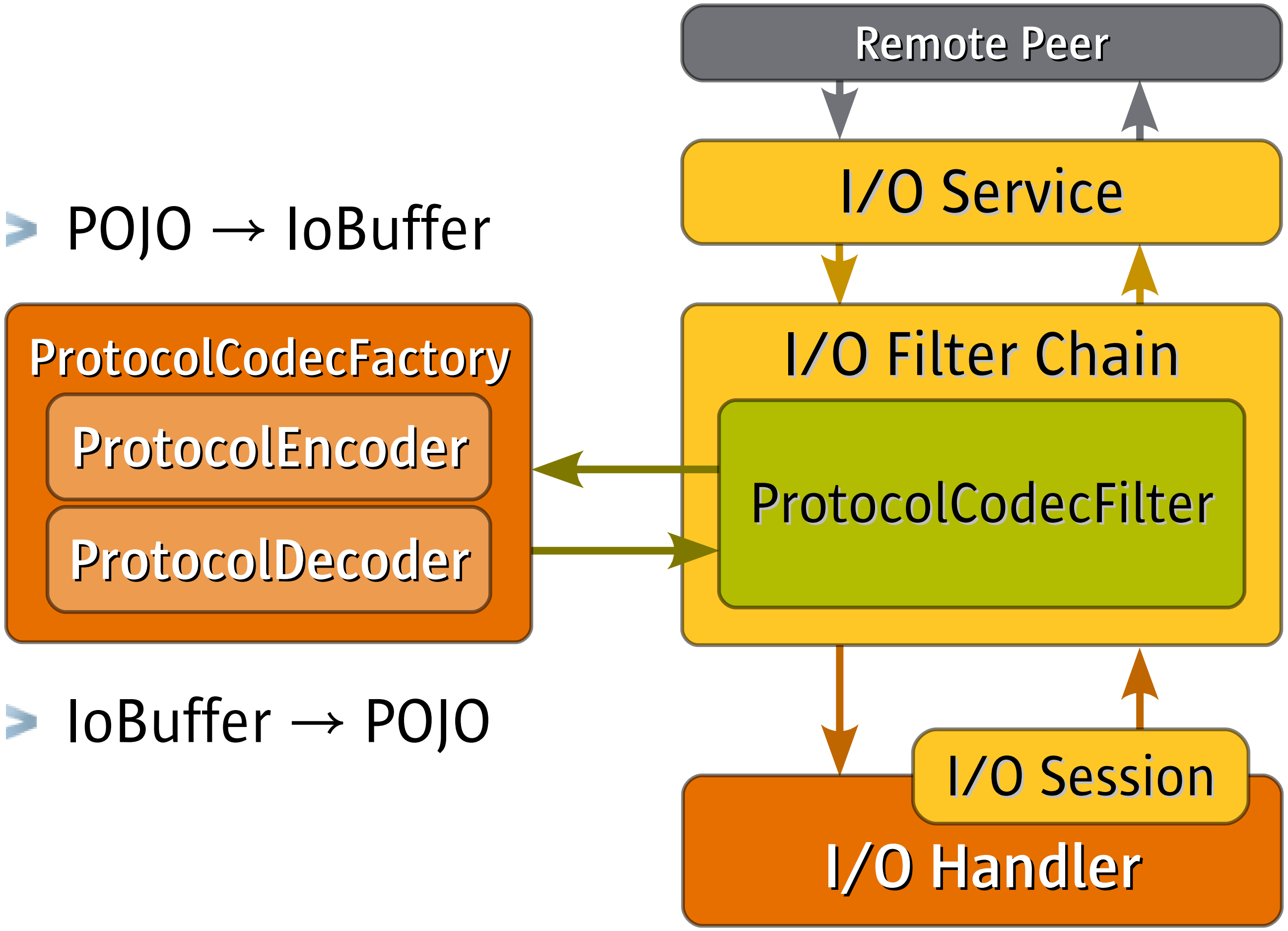
Why do we need a protocol codec?

- It is a bad idea to implement a protocol only with IoBuffers.
  - Packet fragmentation and assembly
  - Separation of concerns
- Codecs are often reusable – MINA provides:
  - Text line codec
  - Object stream codec
  - HTTP codec
- MINA also provides reusable components to build a codec.
  - Solutions for packet fragmentation and assembly issue
  - Finite state machine framework dedicated to codec construction
  - Support for multi-layered protocol (e.g. Kerberos)

Protocol Codecs

What does it look like with a protocol codec?

- POJO → IoBuffer



- IoBuffer → POJO

Protocol Codecs

Echo server redux – TextLineProtocolCodecFactory kicks in!

```
public class EchoHandler extends IoHandlerAdapter
{
  public void messageReceived(IoSession s, Object m)
  {
    s.write((String) m);
  }
  ...
}
...
acceptor.getFilterChain().addLast(
      "codec", new ProtocolCodecFilter(
                      new TextLineCodecFactory()));
...
```

Protocol Codecs

Custom AJAX-ready HTTP server in 10 minutes!?

```
public class HttpHandler extends IoHandlerAdapter {
  public void messageReceived(IoSession s, Object msg)
  {
    HttpRequest req = (HttpRequest) msg;
    MutableHttpResponse res = new DefaultHttpResponse();
    IoBuffer content = ...;
    res.setContent(content);
    res.normalize(req);
    s.write(res);
  }
}
...
acceptor.getFilterChain().addLast(
       "codec", new ProtocolCodecFilter(
              new HttpProtocolCodecFactoryFactory()));
...
```

Thread Models

It's as easy as inserting an IoFilter.

```
// Single thread model by default.
...

// One thread pool – suitable for typical servers.

//// Place CPU-bound tasks first,
acceptor.getFilterChain().addLast("compression", ...);
acceptor.getFilterChain().addLast("codec", ...);

//// And then thread pool.
acceptor.getFilterChain().addLast(
       "executor", new ExecutorFilter(
              new OrderedThreadPoolExecutor(16)));

//// Use UnorderedThreadPoolExecutor or your favorite
//// Executor instance if you don't want event ordering.
```

Agenda

JMX integration – brain-dead easy!

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- **Management**
- Future
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Management

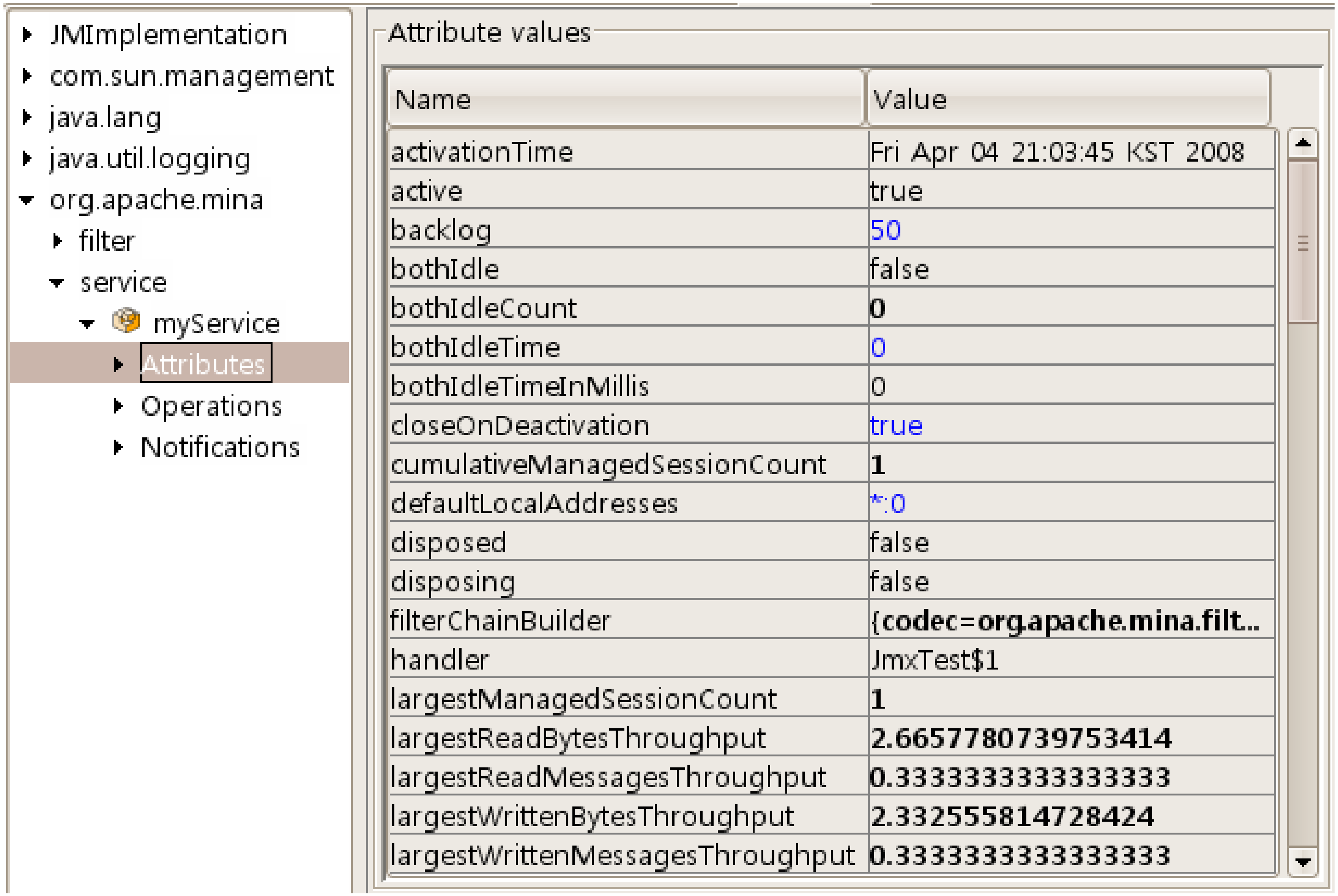
IoService, IoSession and IoFilter are exposed as JMX MBean.

```
MBeanServer mbs = ...;

mbs.registerMBean(new IoServiceMBean(acceptor),
                  new ObjectName(...));

mbs.registerMBean(new IoSessionMBean(session),
                  new ObjectName(...));

mbs.registerMBean(new IoFilterMBean(executorFilter),
                  new ObjectName(...));
```

Management

What you can do in runtime with MINA MBeans:

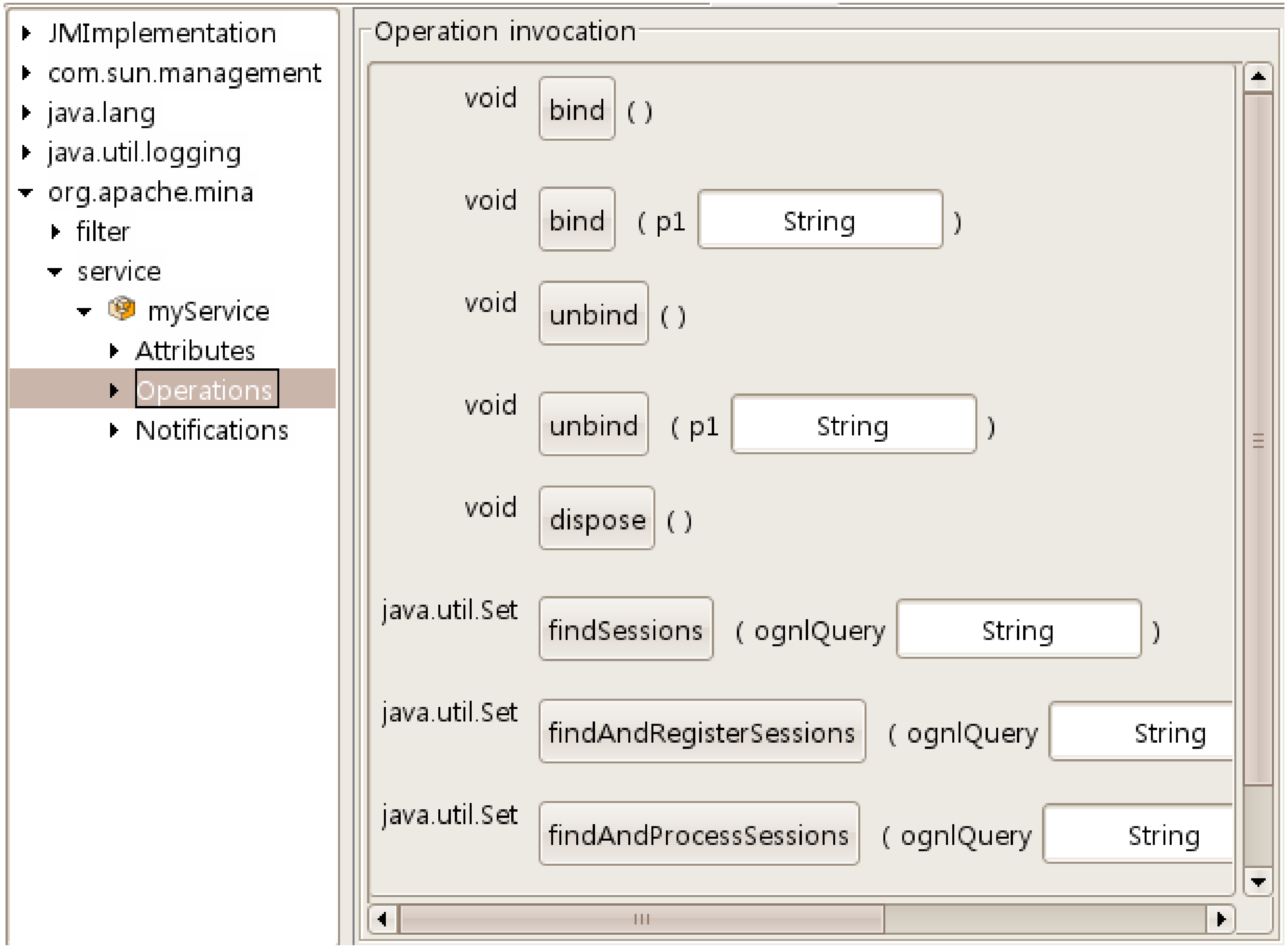
- Monitor various performance counters
- Adjust all socket parameters
- Start · stop an IoService
- Modify an IoSession based on OGNL expression
  - Find all session originating from '192.168.0.x' and close them all!
- Insertion and removal of an IoFilter
  - Enable or disable whatever on demand!
    - Logging
    - Profiling
    - Changing thread model



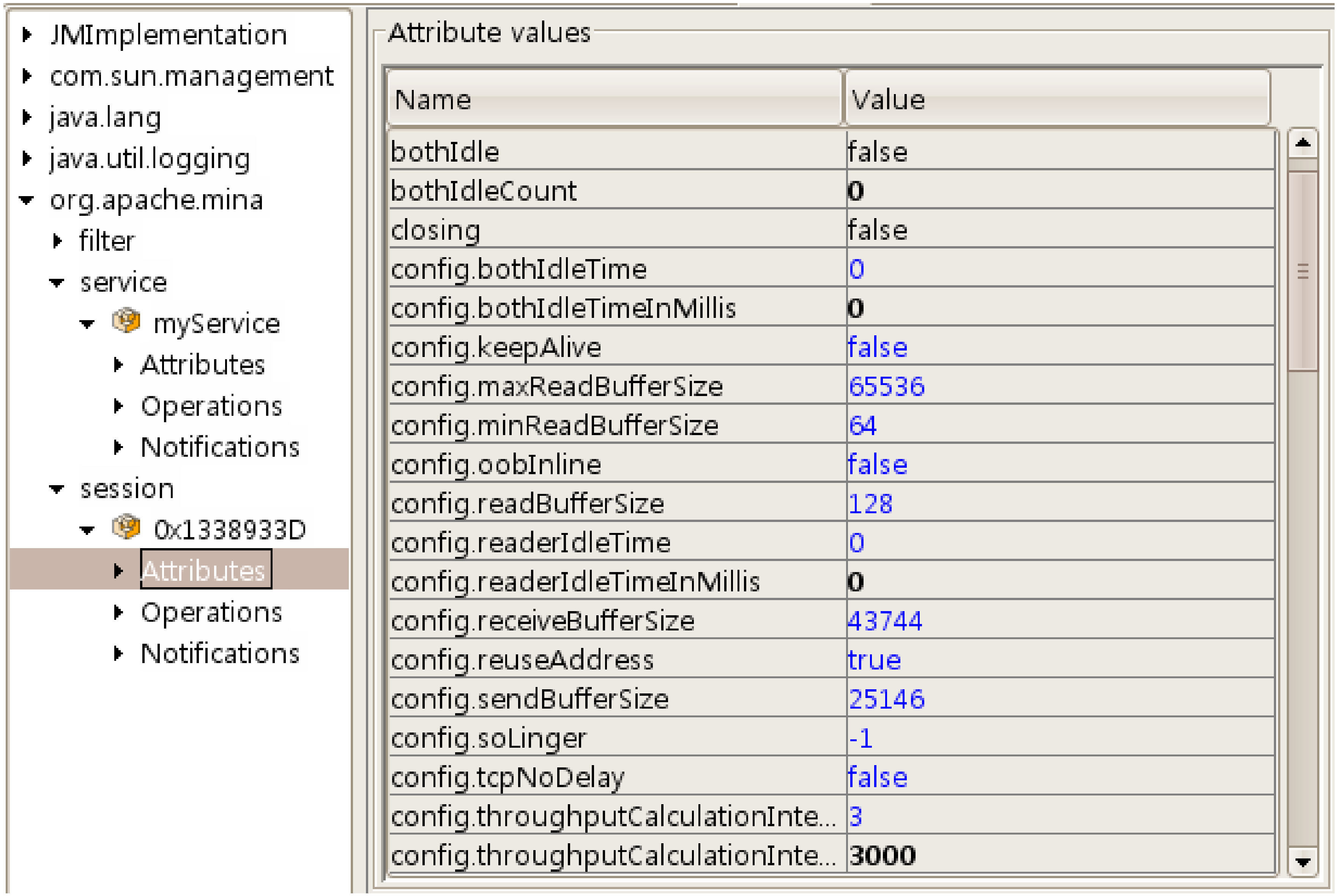
- JMImplementation
- com.sun.management
- java.lang
- java.util.logging
- org.apache.mina
  - filter
  - service
    - myService
      - Attributes
      - Operations
      - Notifications

Attribute values

Name	Value
activationTime	Fri Apr 04 21:03:45 KST 2008
active	true
backlog	50
bothIdle	false
bothIdleCount	**0**
bothIdleTime	0
bothIdleTimeInMillis	0
closeOnDeactivation	true
cumulativeManagedSessionCount	**1**
defaultLocalAddresses	*:0
disposed	false
disposing	false
filterChainBuilder	{**codec=org.apache.mina.filt...**
handler	JmxTest$1
largestManagedSessionCount	**1**
largestReadBytesThroughput	**2.6657780739753414**
largestReadMessagesThroughput	**0.3333333333333333**
largestWrittenBytesThroughput	**2.332555814728424**
largestWrittenMessagesThroughput	**0.3333333333333333**



```
void           bind ( )
void           bind ( p1 String )
void           unbind ( )
void           unbind ( p1 String )
void           dispose ( )
java.util.Set  findSessions ( ognlQuery String )
java.util.Set  findAndRegisterSessions ( ognlQuery String
java.util.Set  findAndProcessSessions ( ognlQuery String
```



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    - 0x1338933D
      - Attributes
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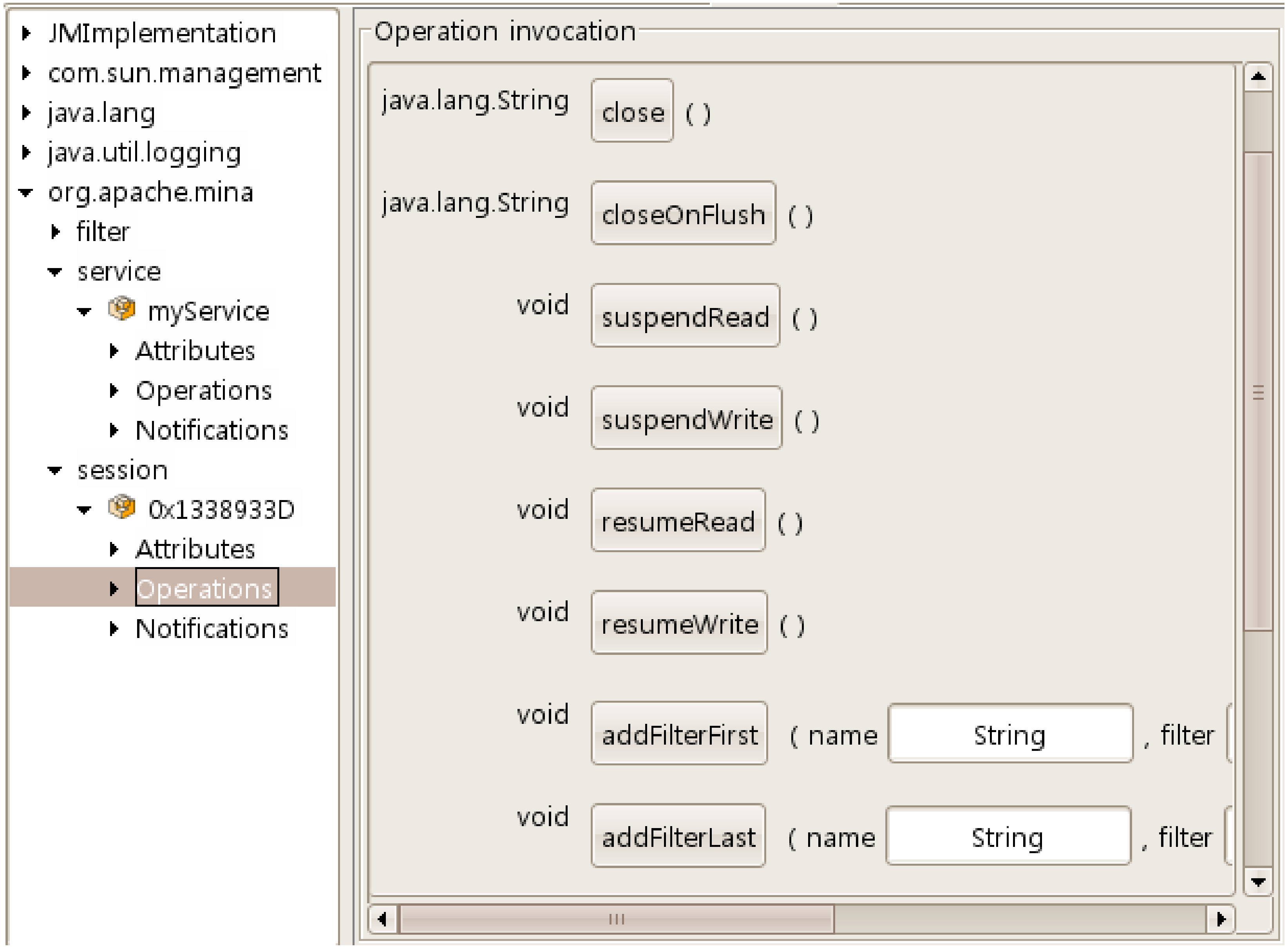
Attribute values

Name	Value
bothIdle	false
bothIdleCount	0
closing	false
config.bothIdleTime	0
config.bothIdleTimeInMillis	0
config.keepAlive	false
config.maxReadBufferSize	65536
config.minReadBufferSize	64
config.oobInline	false
config.readBufferSize	128
config.readerIdleTime	0
config.readerIdleTimeInMillis	0
config.receiveBufferSize	43744
config.reuseAddress	true
config.sendBufferSize	25146
config.soLinger	-1
config.tcpNoDelay	false
config.throughputCalculationInte...	3
config.throughputCalculationInte...	3000



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Operation invocation

```
java.lang.String  close ( )
java.lang.String  closeOnFlush ( )
void  suspendRead ( )
void  suspendWrite ( )
void  resumeRead ( )
void  resumeWrite ( )
void  addFilterFirst ( name String , filter
void  addFilterLast ( name String , filter
```

Agenda

A lot more to come!

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Future

Major tasks ahead:

- Zero copy I/O
  - Looking for better alternative to IoBuffer
- IoConnector improvements
  - Proxy support – patch pending
  - Automatic reconnection
- Better documentation
- Protocol codec generator
  - Rapid legacy & new protocol implementation
- Tools based on a protocol codec implementation
  - Protocol analyzing proxy
  - Intelligent L7 switch & firewall

Agenda

So, what's the verdict?

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Summary

Apache MINA is designed exactly for:

- Any kind of network applications
  - Stable
  - Scalable
  - Extensible
  - Manageable
  - Unit-testable
- Simple, complex, text, binary, legacy and evolving protocols
- You got to try it now! ;)

For More Information

Vibrant community – that's what we are.

- WWW – **MINA.apache.org**
- E-mail – **users@mina.apache.org**

  trustin@apache.org (me)

- Please talk to me right after this session.

THANK YOU

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