



Java and JCA / CAJ

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Slightly Modified for EPICS2006 at VECC
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Outline

- ◆ **Java**
- ◆ **Java and EPICS**
- ◆ **Overview of JCA**
- ◆ **Examples**
 - ❖ **SimpleJCAGet**
 - ❖ **SimpleJCAMonitor**
 - ❖ **JProbe**





Java

◆ **Java is designed to be platform independent**

❖ **Write once, run everywhere**

◆ **Java programs are interpreted by another program, possibly on another machine**

❖ **The Java Virtual Machine (Java VM)**

◆ **Java technology includes**

❖ **J2SE**

Standard Edition

❖ **J2EE**

apps)

Enterprise Edition (Multi-tier business

❖ **J2ME**

Micro Edition (Phones, PDAs, etc.)

◆ **Java is advertised to be all of these**

**Simple
oriented**

Architecture neutral

Object

Portable

Distributed

High performance

Interpreted

Multithreaded

Robust

Dynamic

Secure





Java and EPICS

- ◆ **EPICS Channel Access is native code**
 - ❖ Not platform independent
 - ❖ Build cycle is edit – compile [to machine code] - link - run
- ◆ **Pure Java**
 - ❖ Build cycle is edit – compile [to byte code] – run [anywhere]
- ◆ **Java Native Interface [JNI] is used to access native code**
 - ❖ Not “Pure Java”
 - ❖ No longer platform independent
 - ❖ You generate shared object or DLL libraries that must be used with the Java program
- ◆ **You can write your own JNI**
 - ❖ Not that hard if you know Channel Access
- ◆ **The EPICS build system handles Java projects and JNI**
- ◆ **Ant is an alternative**

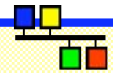




JCA

- ◆ **Stands for Java Channel Access**
- ◆ **JCA is a JNI implementation of an EPICS Channel Access client library for Java**
 - ❖ Provides equivalents to most of the Channel Access API
 - ❖ Developed by Eric Boucher while at the APS
 - ❖ Currently taken over by Cosylab
- ◆ **Available for download at**
 - ❖ <http://jca.cosylab.com/>
- ◆ **Latest version is 2.1.7 at Cosylab**
- ◆ **JCA Version 1 uses EPICS Base 3.13**
- ◆ **JCA Version 2 uses EPICS Base 3.14**
 - ❖ Channel Access is threaded
 - ❖ Allows for preemptive callbacks
 - ✧ Works better with Java, which is inherently threaded





CAJ

- ◆ CAJ is a Java replacement for Channel Access
- ◆ Developed at Cosylab (Control Systems Laboratory)
 - ❖ Located in Ljubljana in Slovenia
 - ❖ Cosylab also develops VDCT
- ◆ Available for download at
 - ❖ <http://caj.cosylab.com/>
- ◆ Latest version is 1.0.5
- ◆ Allows your programs to be “Pure Java”
- ◆ Is used with JCA
 - ❖ Replaces JNI implementation
 - ❖ Requires replacing only one line of code
 - ✧ `jca.createContext(JCALibrary.JNI_THREAD_SAFE);`
 - ✧ `jca.createContext(“com.cosylab.epics.caj.CAJContext”);`





Requirements

◆ **Java J2SE installed (Current [suggested] version is 1.4.2)**

◆ **JCA**

❖ **Java libraries**

✧ **Download source and/or JAR files from the web**

❖ **Native JNI libraries**

✧ **Download from the web or build them**

✧ **Currently found with the 2.1.7 distribution**

◆ **jca.dll** **Windows**

◆ **libjca.so** **Unix (Currently Linux, Solaris, Darwin?)**

◆ **Your project**

❖ **JCA files need to be in your CLASSPATH**

❖ **UNIX: Shared object library needs to be in your LD_LIBRARY_PATH**

❖ **Windows: DLL needs to be in your PATH**





Resources

◆ EPICS web pages

- ❖ <http://www.aps.anl.gov/epics/index.php>
- ❖ Look under Extensions, then JCA

◆ JCA 2.1.7 API

- ❖ <http://jca.cosylab.com/apidocs/index.html>

◆ JCA 2.1.2 API

- ❖ <http://www.aps.anl.gov/xfd/SoftDist/swBCDA/jca/2.1.2/api/index.html>

◆ CAJ 1.0.5

- ❖ <http://caj.cosylab.com/manual.html>

◆ Java Tutorial

- ❖ <http://java.sun.com/learning/tutorial/index.html>

◆ J2SE Documentation

- ❖ <http://java.sun.com/reference/api/index.html>

◆ J2SE 1.4.2 API (Javadoc)

- ❖ <http://java.sun.com/j2se/1.4.2/docs/api/overview-summary.html>





JCA Packages

◆ Five Packages

- ❖ **gov.aps.jca** Channel-Access-like routines
- ❖ **gov.aps.jca.configuration** Configuration
- ❖ **gov.aps.jca.dbr** DBR types
- ❖ **gov.aps.jca.event** Event handling
- ❖ **gov.aps.jca.jni** Native interface functions





gov.aps.jca

◆ This is the package you will use most directly

◆ Classes

❖ CASeverity

Enum

❖ CAStatus

JCALibrary

❖ Channel

Monitor

❖ Channel.ConnectionState
ValuedEnum

❖ Context

◆ Exceptions

❖ CAException

TimeoutException





JCALibrary

◆ Initializes JCA

```
JCALibrary jca=JCALibrary.getInstance();
```

◆ There is only one instance

◆ Used to create contexts and manage JCA configuration info

◆ Properties

- ❖ **JNI_THREAD_SAFE** preemptive
- ✧ Suggested for Java, which is inherently threaded
- ❖ **JNI_SINGLE_THREADED** non-preemptive

◆ Methods

- ❖ createContext
- ❖ getProperty
- ❖ listProperties
- ❖ getVersion, getRevision, getModification





Context

◆ Corresponds to a Channel Access context

◆ Created by `JCALibrary.createContext`

`createContext(JCALibrary.JNI_SINGLE_THREADED)`

`createContext(JCALibrary.JNI_THREAD_SAFE)`

◆ Controls all IO

◆ You can have more than one context

◆ Methods

❖ `createChannel`

❖ `flushIO`, `pendIO`, `pendEvent`, `poll`

❖ `attachCurrentThread`

❖ `addContextExceptionListener`,
`removeContextExceptionListener`

❖ `addContextMessageListener`,
`removeContextMessageListener`

❖ `destroy`





Channel

◆ Represents a Channel Access channel

◆ Created by `Context.createChannel`

```
createChannel(String name, connectionListener l)
```

◆ Properties

❖ CLOSED

CONNECTED

❖ DISCONNECTED

NEVER_CONNECTED

◆ Methods

❖ `get`, many overloads

❖ `put`, many overloads

❖ `getName`, `getConnectionState`, `getElementCount`, etc.

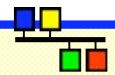
❖ `addMonitor`

❖ `addConnectionListener`, `removeConnectionListener`

❖ `addAccessRightsListener`, `removeAccessRightsListener`

❖ `destroy`





Monitor

◆ Represents a Channel Access monitor

◆ Created by Channel.addMonitor

```
addMonitor(DBRType type, int count, int mask,  
           MonitorListener l)
```

◆ Properties

❖ ALARM LOG VALUE

◆ Methods

❖ addMonitorListener, removeMonitorListener

❖ getMonitorListener, getMonitorListeners

❖ clear

❖ getChannel, getContext

❖ getCount, getMask, getType

❖ isMonitoringAlarm, isMonitoringLog, isMonitoringValue





MonitorListener

- ◆ Part of gov.aps.jca.event

- ◆ One method

 - ❖ monitorChanged

- ◆ Example

```
private class MyMonitorListener implements
    MonitorListener
{
    public void monitorChanged(MonitorEvent ev) {
        // Call my handler
        onValueChanged(ev);
    }
};
```

- ◆ The value and status comes with the MonitorEvent





MonitorEvent

◆ Part of gov.aps.jca.event

◆ Methods

❖ **getDBR** How you get the value

❖ **getStatus** How you determine the
status

◆ Example

```
if(ev.getStatus() == CAsTatus.NORMAL) {  
    DBR dbr=ev.getDBR();  
    double [] value=((DOUBLE)dbr).getDoubleValue();  
}
```

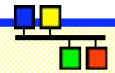




Event Types

- ◆ **MonitorListener** **MonitorEvent**
 - ◆ **GetListener** **GetEvent**
 - ◆ **PutListener** **PutEvent**
 - ◆ **AccessRightsListener** **AccessRightsEvent**
 - ◆ **ConnectionListener** **Connection Event**
 - ◆ **ContextExceptionListener** **ContextExceptionEvent**
 - ◆ **ContextMessageListener** **ContextMessageEvent**
-
- ◆ **Events all inherit from CAEvent**
 - ◆ **They all work similarly to Monitor**
 - ❖ **Call the routine that fires the event when it occurs**
 - ❖ **Add a listener with the appropriate handler**
 - ❖ **Get the data from the event that is passed to your handler**





gov.aps.jca.dbr

- ◆ Implements the EPICS DBR_xxx types
- ◆ Interfaces
 - ❖ DOUBLE, FLOAT, INT, STRING, TIME, CTRL, etc.
- ◆ Primary Class
 - ❖ DBR
- ◆ Subclasses of DBR
 - ❖ DBR_Double, DBR_Float, DBR_Int, DBR_STS_Double, etc.
- ◆ Example: DBR_STS_Double
 - ❖ Interfaces
 - ❏ STS, DOUBLE
 - ❖ Extends
 - ❏ DBR_Double
 - ❖ Subclasses
 - ❏ DBR_GR_Double, DBR_Time_Double



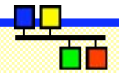


SimpleJCAGet

```
package simplejca;
```

- ➔ `import gov.aps.jca.*;`
- ➔ `import gov.aps.jca.dbr.*;`





SimpleJCAGet

```
public class SimpleJCAGet
{
    ➔ public static void main(String[] args)
    {
        SimpleJCAGet simpleJCAGet = new SimpleJCAGet();
        ➔ JCALibrary jca=null;
        ➔ Context ctxt=null;
        ➔ Channel chan=null;

        // Parse the command line
        if(!simpleJCAGet.parseCommand(args))
        System.exit(1);
        if(!simpleJCAGet.pvSpecified) {
            System.err.println("No PV specified\n");
            System.exit(1);
        }
    }
}
```

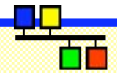




SimpleJCAGet

```
// Initialize and search
try {
    // Get the JCALibrary instance
    ➔ jca=JCALibrary.getInstance();
    // Create a non-preemptive context
    ➔ context=jca.createContext(
        JCALibrary.JNI_SINGLE_THREADED);
    // Search
    ➔ chan=ctxt.createChannel(simpleJCAGet.name);
    // Wait for search
    ➔ ctxt.pendIO(simpleJCAGet.timeout);
} catch(Exception ex) {
    System.err.println("Search failed for " +
        simpleJCAGet.name + ":\n" + ex);
    System.exit(1);
}
```

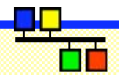




SimpleJCAGet

```
// Get the first value as a String
try {
    // Get the value
    String [] value;
    ➔ value=((STRING)chan.get(DBRType.STRING,1)).
        getStringValue();
    // Wait for the get
    ➔ ctxt.pendIO(simpleJCAGet.timeout);
    // Print the value
    ➔ System.out.println("The value of " +
simpleJCAGet.name
    + " is " + value[0]);
} catch(Exception ex) {
    System.err.println("Get failed for " +
    simpleJCAGet.name + ":\n" + ex);
    System.exit(1);
}
```





SimpleJCAGet

```
// Clean up
try {
    // Clear the channel
    ➔ chan.destroy();
    // Destroy the context
    ➔ ctxt.destroy();
} catch(Exception ex) {
    System.err.println("Clean up failed for " +
        simpleJCAGet.name + ":\n" + ex);
    System.exit(1);
}
// Successful exit
System.exit(0);
}
```





SimpleJCAGet output

```
java.exe -classpath  
  <simplejca-path>\SimpleJCA.jar;  
  <jca-path>\jca-2.1.7.jar  
  simplejca.SimpleJCAGet evans:calc  
The value of evans:calc is 3
```

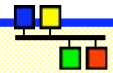




SimpleJCAMonitor

- ◆ **Similar to SimpleJCAGet**
 - ❖ Imports, parsing the command line, etc. are the same
- ◆ **We will have listeners**
- ◆ **We will use JNI_THREAD_SAFE (preemptive)**
- ◆ **We will use flushIO and not pendIO, etc.**





SimpleJCAMonitor

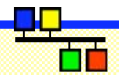
```
/** Implementation of Connection Listener class  
 */
```

```
→ private class SJCAConnectionListener implements  
    ConnectionListener {  
    public void connectionChanged(ConnectionEvent ev) {  
→     onConnectionChanged(ev);  
    }  
};
```

```
/** Implementation of MonitorListener class  
 */
```

```
→ private class SJCAMonitorListener implements  
    MonitorListener {  
    public void monitorChanged(MonitorEvent ev) {  
→     onValueChanged(ev);  
    }  
};
```



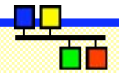


SimpleJCAMonitor

```
// Instance of SimpleJCAMonitor
➔ SimpleJCAMonitor sjcam=new SimpleJCAMonitor();

// Initialize JCA
try {
    // Get the JCALibrary instance
    ➔ jca=JCALibrary.getInstance();
    // Create a preemptive context, default configuration
    ➔ ctxt=jca.createContext(JCALibrary.JNI_THREAD_SAFE);
} catch(Exception ex) {
    System.err.println("Initialization failed for " +
        sjcam.name + ":\n" + ex);
    System.exit(1);
}
```





SimpleJCAMonitor

```
// Search
```

```
try {
```

```
    // Search
```

```
    ➔ chan=ctxt.createChannel(sjcam.name,  
        sjcam.new SJCAConnectionListener());
```

```
    ➔ ctxt.flushIO();
```

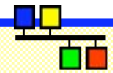
```
    } catch(Exception ex) {
```

```
        System.err.println("Search failed for " +  
            sjcam.name + ":\n" + ex);
```

```
        System.exit(1);
```

```
    }
```

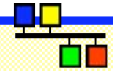




SimpleJCAMonitor

```
private void onConnectionChanged(ConnectionEvent ev) {  
    ➔ Channel ch=(Channel)ev.getSource();  
    ➔ Context ctxt=ch.getContext();  
    // Start a monitor on the first connection  
    if(connectionCounter == 0 &&  
        ch.getConnectionState() == Channel.CONNECTED) {  
        try {  
            // Add a monitor listener and flush  
            ➔ ch.addMonitor(DBRType.STRING,1,  
                Monitor.VALUE|Monitor.LOG|Monitor.ALARM,  
                new SJCAMonitorListener());  
            ➔ ctxt.flushIO();  
        } catch(Exception ex) {  
            ex.printStackTrace();  
        }  
    }  
}
```





SimpleJCAMonitor

```
// Print connection state
    if(ch.getConnectionState() == Channel.CONNECTED) {
        System.out.println(ch.getName() + " is
connected");
    } else if(ch.getConnectionState() ==
Channel.CLOSED) {
        System.out.println(ch.getName() + " is closed");
    } else if(ch.getConnectionState() ==
Channel.DISCONNECTED) {
        System.out.println(ch.getName() + " is
disconnected");
    } else if(ch.getConnectionState() ==
Channel.NEVER_CONNECTED) {
        System.out.println(ch.getName() + " is never
connected");
    }
}
```

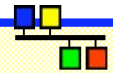




SimpleJCAMonitor

```
private void onValueChanged(MonitorEvent ev) {  
    → Channel ch=(Channel)ev.getSource();  
    → Context ctxt=ch.getContext();  
    // Check the status  
    → if (ev.getStatus() != CAStatus.NORMAL) {  
        System.err.println("monitorChanged: Bad status");  
    }  
    // Get the value from the DBR  
    try {  
        → DBR dbr=ev.getDBR();  
        → String [] value=((STRING)dbr).getStringValue();  
        → System.out.print(SJCAUtils.timeStamp() + " " +  
            getName() + ": " + value[0]);  
    } catch(Exception ex) {  
        ...  
    }  
}
```





Simple JCAMonitor output

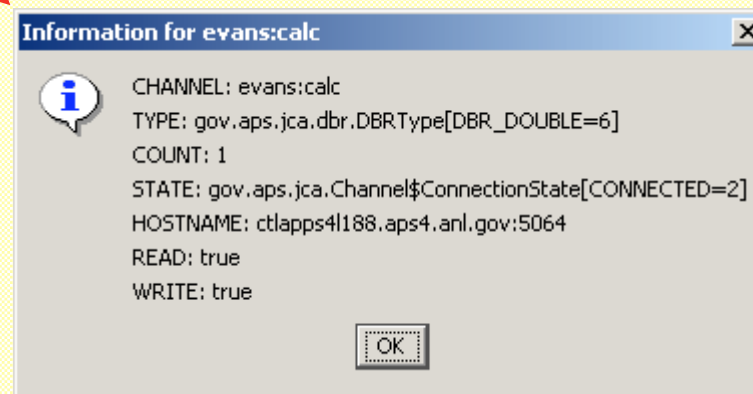
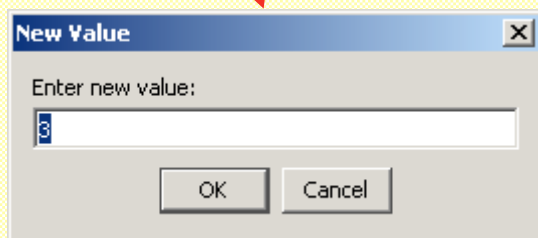
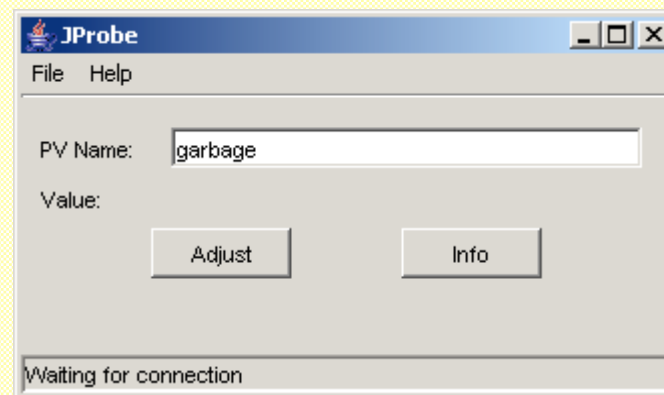
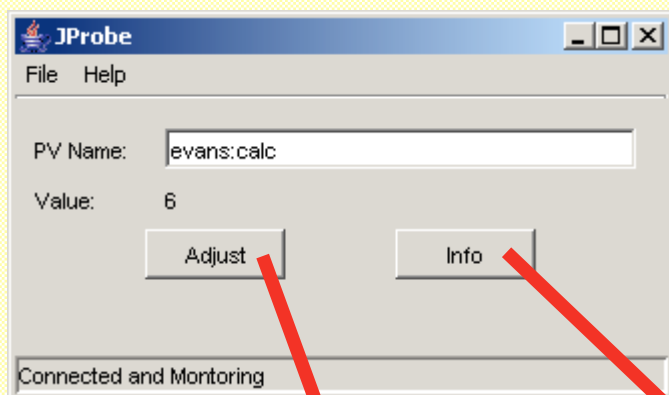
```
Oct 11, 2004 10:36:43.661 Starting Simple JCA Monitor
Oct 11, 2004 10:36:44.083 Search successful for:
evans:calc
CHANNEL      : evans:calc
TYPE         : gov.aps.jca.dbr.DBRTyp[e][DBR_DOUBLE=6 ]
COUNT       : 1
STATE        :
gov.aps.jca.Channel$ConnectionState[CONNECTED=2 ]
HOSTNAME     : ctlapps41188.aps4.anl.gov:5064
READ         : true
WRITE        : true
Oct 11, 2004 10:36:44.208 evans:calc is connected
Oct 11, 2004 10:36:44.224 evans:calc: 2
Oct 11, 2004 10:36:44.224 evans:calc: 3
...
Oct 11, 2004 10:36:53.240 evans:calc: 3
Oct 11, 2004 10:36:53.740 evans:calc: 4
Oct 11, 2004 10:36:54.036 All Done
```





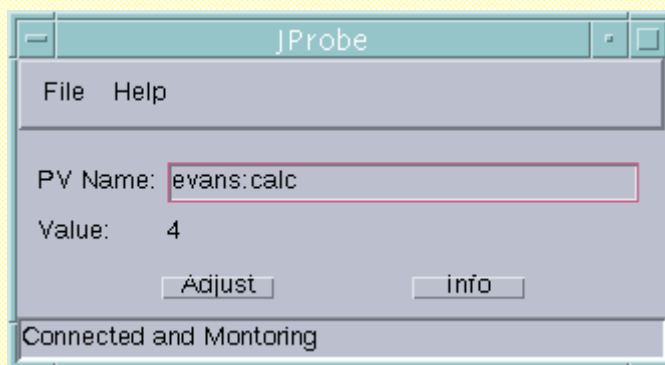
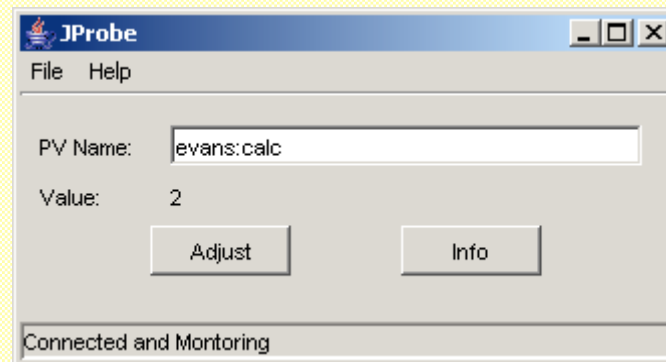
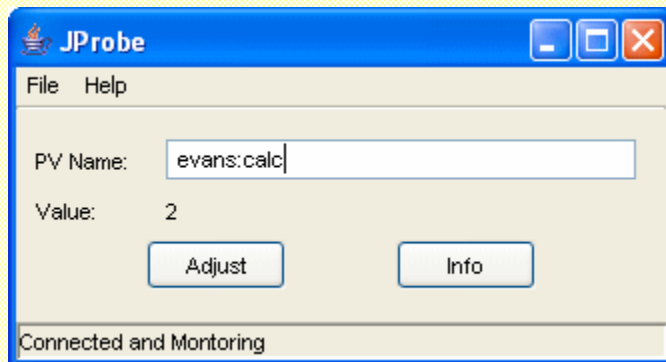
JProbe

◆ JProbe is a simple example that demonstrates using JCA in a Swing GUI





Write once, run everywhere?





Source files for Simple JCA routines

◆ All the source and JAR files should be available with the presentation

❖ LICENSE

❖ SimpleJCA.jar

❖ simplejca

✧ SimpleJCAMonitor.java

✧ SimpleJCAGet.java

✧ SJCAUtils.java

❖ JProbe.jar

❖ jprobe

✧ JProbe.java

✧ MainFrame.java

✧ AboutBoxPanel.java

◆ Stored as SimpleJCA.zip





Some Pointers to Documents

◆ Example files

- ❖ <http://www.aps.anl.gov/epics/>
- ❖ Documents - Training - Developing Client Tools
 - Java and JCA
 - Example Files

◆ Build examples of EPICS-Base, etc on several Platforms

- ❖ <http://www-linac.kek.jp/jk/win32/>
- ❖ <http://www-linac.kek.jp/jk/linux/>
- ❖ <http://www-linac.kek.jp/jk/darwin/>





Acknowledgements

- ◆ JCA was developed by Eric Boucher while at the APS
- ◆ Matej Sekoranja [Cosylab] has taken over JCA and is developing CAJ
- ◆ Both of these people were very helpful in getting JCA working for me





Thank You

This has been an
APS Controls Presentation
By Kenneth Evans, Jr.
Modified for EPICS2006 at VECC
By Kazuro Furukawa

