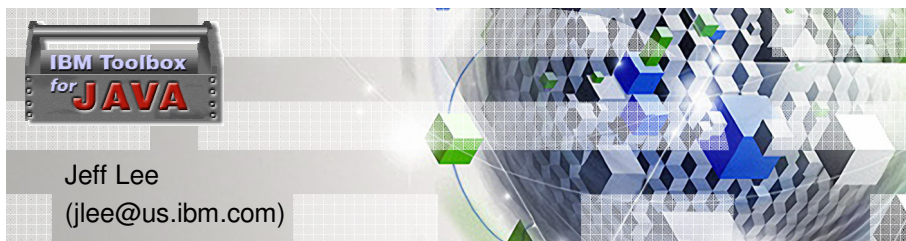




Introducing... The IBM Toolbox for Java™



Jeff Lee
(jlee@us.ibm.com)

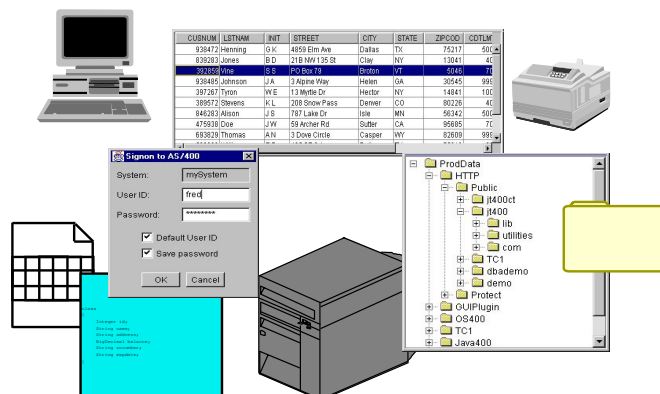
Power your planet.



IBM Toolbox for Java™

What is the Toolbox/JTOpen?

A set of Java classes and utilities which provide access to IBM i® data and resources

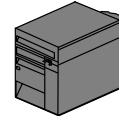
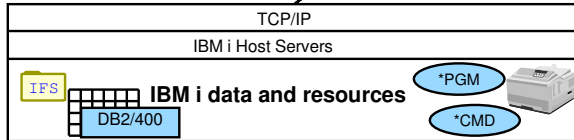
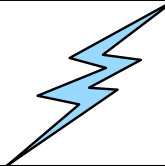
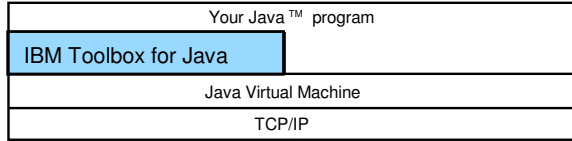


IBM Toolbox for Java

The big picture - Client/Server

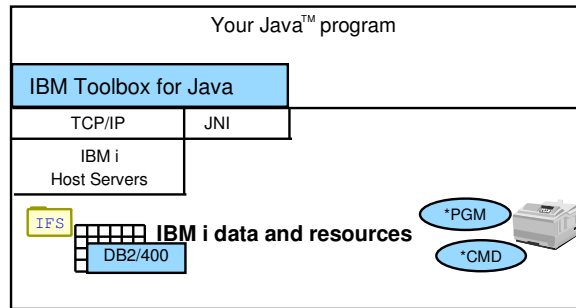


IBM i Access for Windows is not required!



IBM Toolbox for Java

The big picture - Toolbox and data on same IBM i



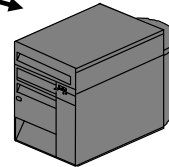
IBM Toolbox for Java

Using the Toolbox in *client/server applications*



- Toolbox installed on client
- Java application runs on client
- IBM i Access for Windows is *not* required
- The same Java application runs on any client with a Java-compatible JVM!

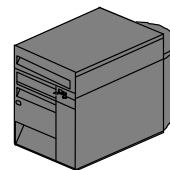
TCP/IP



- Server running IBM i
- Uses existing IBM i host servers
- IBM i Java Virtual Machine (JVM) is *not* required on the server

IBM Toolbox for Java

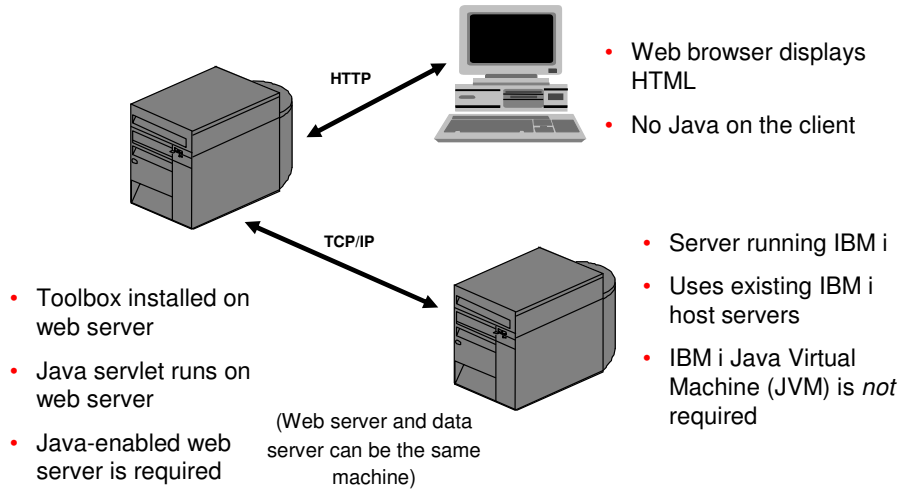
Using the Toolbox in *server applications*



- Toolbox installed on IBM i
- Java application runs on IBM i
- Use Toolbox instead of JNI
- "Local" sockets used to communicate between Toolbox and host servers
- Direct API calls used in some cases to bypass the host servers
- IBM i with Java Virtual Machine (JVM) is required

IBM Toolbox for Java

Using the Toolbox in Internet-based servlets



IBM Toolbox for Java

Supported platforms:

- **IBM i, Linux, Windows, AIX, Solaris, Mozilla Firefox, Microsoft Internet Explorer**

Requires Java 1.1.8 or greater, and supports Java 2

Divided into packages:

- **com.ibm.as400.access** - APIs for accessing IBM i data and resources
- **com.ibm.as400.resource** - Framework for accessing list-based data (*deprecated*)
- **com.ibm.as400.vaccess** - GUI components (*deprecated*)
- **com.ibm.as400.data** - Program call markup language
- **com.ibm.as400.ui.*** - Graphical Toolbox
- **com.ibm.as400.util.*** - HTML, XSL-FO and Servlet components
- **com.ibm.as400.micro.*** - APIs for wireless devices
- **utilities** - utility classes such as JarMaker, JPing, RunJavaApplication, AboutToolbox

IBM Toolbox for Java

Packaging

Licensed program 5722-JC1 (V5R4) or 5761-JC1 (V6R1) (no additional charge)

Downloadable from **JTOpen website** (no charge)

Ships with IBM i – in directory /QIBM/ProdData/HTTP/Public/jt400/lib/

Jar files:

- **jt400.jar** - Base function + GUI components
- **jt400Native.jar** - Base function only, intended for use on IBM i JVM
- **jt400Proxy.jar** - Proxy support, subset of jt400.jar
- **jt400Servlet.jar** - HTML, XSL-FO, and Servlet components
- **jt400Micro.jar** - Wireless support
- **uitools.jar, jui400.jar, util400.jar** - Graphical Toolbox
- **tes.jar** - System Debugger



Use the **JarMaker** utility to reduce the size of jt400.jar or any other jar file

JTOpen (Open Source)

All of the primary Toolbox packages are open source

<http://sourceforge.net/projects/jt400>

- Part of IBM's open source development community
- Use source code as a debug tool
- Submit new function under the IBM Public License (IPL)
- Modify source for your use
- Submit problem reports and bug fixes

Two delivery modes of the Toolbox:

- Licensed program
 - Supported by IBM
 - Fixes are delivered as PTFs
- Open source version
 - Supported by IBM
 - New releases are available as free Web downloads
 - New functions and fixes available here first



IBM Toolbox for Java

Popular Toolbox Functions

- Database access via **JDBC**
- Database access via a **record-level I/O** and **DDS** interface
- **Command Call**
- **Program Call** via both Java code and XML
- Data Queues / User Spaces / Data Areas
- Access files in IBM i **Integrated File System**
- Access **Print** object (spooled files, printers, queues, ...)
- Access other IBM i objects (**Jobs, Users, System Values**, etc.)
- Built-in automatic **data conversion**
- **HTML / Servlet** wrappers
- **Wireless APIs**
- XML-based **GUI Builder**
- Many components are Java Beans

IBM Toolbox for Java

IBM i products that are built on the Toolbox

- IBM i Navigator and Management Central
- IBM i Access for Web
- IBM i Connect (B2B)
- IBM Host On Demand
- *plus many more...*

IBM Toolbox for Java

Access Classes: Low-Level Java APIs to Access Data

- User Authentication and Identification
- Command Call
- Connection Pools
- Clustered Hashtables
- Data Area
- Data Description
- Data Conversion
- Data Queues
- Environment Variables
- FTP
- IFS
- JDBC
- Jobs
- Messages
- NetServer
- Print
- Permissions
- Program Call
- Record-level Database Access
- Save File
- System Status
- System Values
- Users and Groups
- User Space

Infrastructure

"The AS400 object"

Represents a **connection** to the IBM i

Provides a **sign-on GUI**

- Password caching available
- Change password GUI when appropriate

Controls conversations with server jobs

- Multiple users and multiple conversations
- Implicit and explicit connections

Provides Secure Sockets Layer (**SSL**) communication

- Encryption and server authentication

Most Toolbox classes use the AS400 object



```
AS400 sys = new AS400();
AS400 sys2 = new AS400("mySystem");
AS400 sys3 = new AS400("mySystem",
    "myUID", "myPWD");
```

```
CommandCall cc = new CommandCall(sys);
```



JDBC

The Java standard for database access

Write Java programs in terms of standard JDBC interfaces, then plug in *any* JDBC driver - to work with *any* database!

- Java gives you platform independence, JDBC gives you database independence

java.sql package in Java Developers Kit

SQL is used extensively

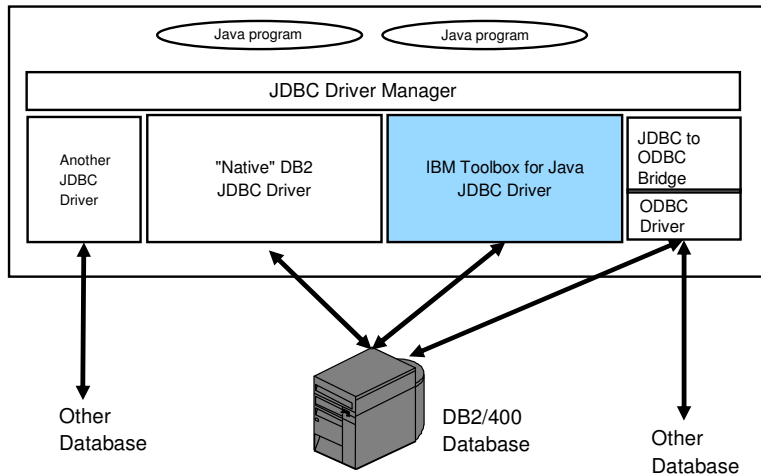
- Based on X/Open SQL Call Level Interface

Also supports:

- Database definitions, manipulations, and queries
- Stored procedures
- Catalog methods
- Transactions (commit, rollback, isolation levels, distributed)

JDBC

The Java standard for SQL database access



JDBC

IBM i JDBC driver choices

Toolbox JDBC driver (*com.ibm.as400.access.AS400JDBCDriver*)

- Communicates with the database using TCP/IP
- Great for:
 - client/server applications
 - applets
 - servlets, where the web server and data are not on the same IBM i

JDBC 4.0 support in JOpen – requires Java 6.0

DB2/400 JDBC driver (*com.ibm.db2.jdbc.app.DB2Driver*)

- Communicates with the database using direct CLI calls
- Great for:
 - server applications
 - servlets, where the web server and data on same IBM i

```

DriverManager.registerDriver(...);
Connection c = DriverManager.getConnection(...);
Statement select = c.createStatement();
ResultSet rs = select.executeQuery("SELECT * FROM ...");
while (rs.next())
    System.out.println(rs.getString(column));
    
```

Record-level database access

Fast access to IBM i database files

Provides access to database files:

- Access records sequentially, by record number, or by key
- Physical and logical file members are described by a RecordFormat
- Support for locking
- Support for transactions
- Familiar paradigm for RPG programmers
- Limited System/36 SSP file capability, too!

```
AS400 system = new AS400("mySystem");
SequentialFile file = new SequentialFile(system, "/QSYS.LIB/MYLIB.LIB/MYFILE.FILE");
file.setRecordFormat(...);
file.open(...);
Record r = file.readNext();
```

Integrated file system

File input, output, and more

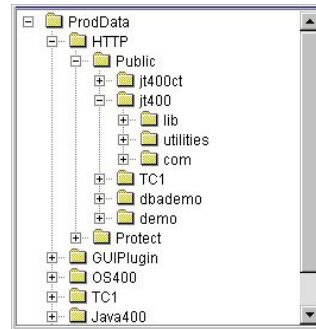
Implements standard Java input/output (*java.io*) classes:

- Read and write data sequentially or via random access
- Create, delete, and rename files and directories
- List the contents of a directory

```
AS400 system = new AS400();

IFSFileOutputStream s = new
    IFSFileOutputStream(system, "/a.a");
byte[] data = new byte[n];
s.write(data);

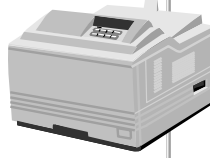
IFSTextFileOutputStream s2 = new
    IFSTextFileOutputStream(system, "/b.b", 37);
s2.write("Hi Mom in EBCDIC");
```



Network print

Access print objects and spooled files

- List printers, output queues, writers and spooled files
- Manage printers, output queues and writers
- Read and write spooled files
- Spooled file viewer



```

5769SS1 V4P4M0 99D021          Print Key Output  RCHASLF1
Display Device . . . . . : QPADEV00GA
User . . . . . : EGLEDM

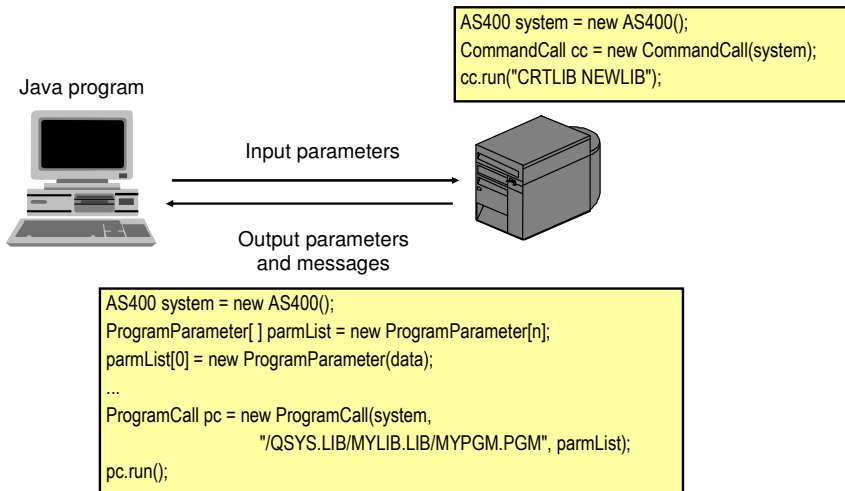
Work with Output Queue
Queue: JTPRT      Library: QUSRSYS      Sts
Type options, press Enter:
1=Send 2=Change 3=Hold 4>Delete 5=Display
8=Attributes 9=Work with printing status
Opt File      User      User Data  Sts      Pages
QMPSPRPF     JAVA      User Data  RDY      1

Parameters for options 1, 2, 3 or command
==>
F3=Exit  F11=View 2  F12=Cancel  F20=Writers  F24=More keys
    
```

Printers	Printer	Status	Description
JAVABLDA	JAVABLDA	Powered off or not yet available	DEVICE CREATED FC
JAVABLDB	JAVABLDB	Powered off or not yet available	DEVICE CREATED FC
OS2VPRT	OS2VPRT	Stopped	DEVICE CREATED FC

Command call and program call

Make use of legacy code and system APIs

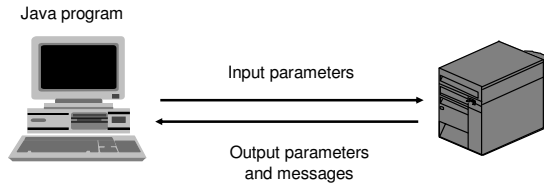


Program Call Markup Language (PCML)

Describe program calls using XML

Automates program call parameter and structure definition

Simplifies data description and conversion



```
<pcml>
<program name="rtvsts" path="/QSYS.lib/MYLIB.lib/RTVSTS.pgm">
<data name="custid" usage="input" type="int">
<data name="status" usage="output" type="char" length="20">
</program>
</pcml>
```

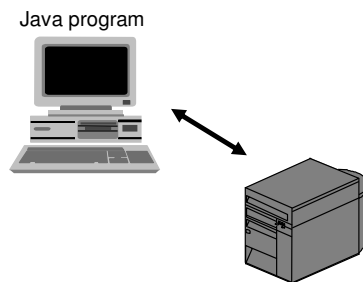
Interprogram Communication

Data Queues, Data Areas, User Spaces, ...

Transfer data between programs using:

- Data areas
- Data queues (keyed or sequential)
- User spaces

Partner can be Java program, traditional IBM i program, on IBM i or another client



```
AS400 system = new AS400();
UserSpace us = new UserSpace(system, "/QSYS.LIB/MYLIB.LIB/MYDATA.USRSPC");
byte[] data = new byte[1024];
us.read(data, 0);
```

RFML (Record Format Markup Language)

Very similar to **PCML** (Program Call Markup Language)

While PCML is designed specifically for Program Parameters, RFML is generally useful for **parsing and composing**:

- Physical file records
- Data queue entries
- User spaces
- Data buffers

Specify record formats using XML; get/set field values

Segregate the data layout from the program logic

RFML vs. FieldDescription

Example: Composing a customer record

Using RFML:

```
import com.ibm.as400.data.RecordFormatDocument;

RecordFormatDocument rfmldoc =
    new RecordFormatDocument("customer");
```

(In a separate file named "customer.rfml":)

```
<rfml version="4.0" ccsid="37">
<recordformat name="cusrec">
  <data name="cusnum" type="int" length="2" precision="16"/>
  <data name="lstnam" type="char" length="8"/>
  <data name="baldue" type="zoned" length="6" precision="2"/>
</recordformat>
</rfml>
```

Without RFML:

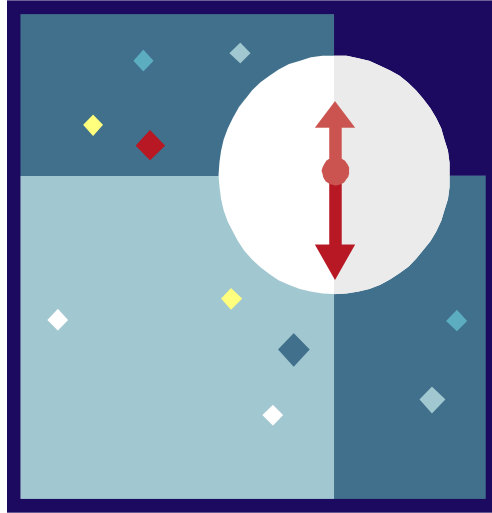
```
import com.ibm.as400.access.AS400Text;
import com.ibm.as400.access.AS400UnsignedBin2;
import com.ibm.as400.access.AS400ZonedDecimal;
import com.ibm.as400.access.BinaryFieldDescription;
import com.ibm.as400.access.CharacterFieldDescription;
import com.ibm.as400.access.RecordFormat;
import com.ibm.as400.access.ZonedDecimalFieldDescription;

RecordFormat recFmt = new RecordFormat("cusrec");

AS400UnsignedBin2 conv1 = new AS400UnsignedBin2();
BinaryFieldDescription desc1 = new BinaryFieldDescription(conv1, "cusnum");
recFmt.addFieldDescription(desc1);

AS400Text conv2 = new AS400Text(8, 37);
CharacterFieldDescription desc2 = new CharacterFieldDescription(conv2, "lstnam");
recFmt.addFieldDescription(desc2);

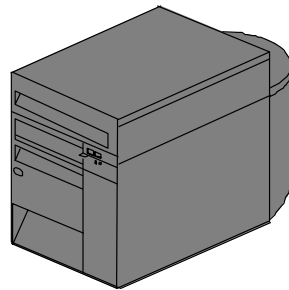
AS400ZonedDecimal conv3 = new AS400ZonedDecimal(6, 2);
ZonedDecimalFieldDescription desc3 = new ZonedDecimalFieldDescription(conv3,
    "baldue");
recFmt.addFieldDescription(desc3);
```



Server Objects

Jobs, Users, System Values, ...

- List IBM i jobs
- List IBM i users and groups
- Display and change system values
- Manage message queues
- Manage user permissions to objects



```
AS400 system = new AS400();  
SystemValue sv = new SystemValue(system, "QDATE");  
System.out.println(sv.getValue());
```

Data description and conversion

Converts between Java data and IBM i data

Java data type		IBM i data type
Object[]	↔	Array
short	↔	2 byte binary
int	↔	2 byte unsigned binary
Int	↔	4 byte binary
long	↔	4 byte unsigned binary
long	↔	8 byte binary
byte[]	↔	Byte array
float	↔	4 byte floating point
double	↔	8 byte floating point
BigDecimal	↔	Packed decimal
BigDecimal	↔	Zoned decimal
Object[]	↔	Structure
String	↔	Text

Handles all code page, byte order, and data conversion issues

Data description and conversion

Record formats

Access data in the record by **field name**

Convert data automatically for:

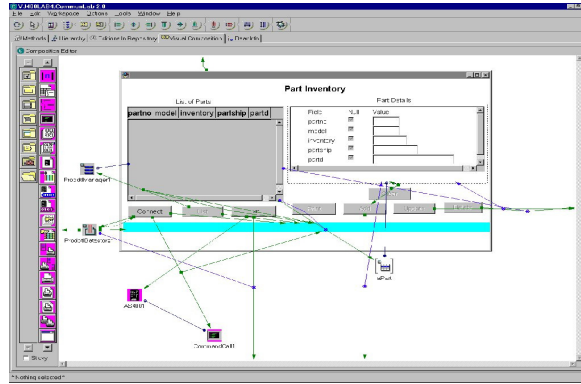
- Program calls
- Data queues
- Record-level database access; IFS text file access

```
BinaryFieldDescription customerNumber = new BinaryFieldDescription(new AS400Bin4(),
                                                                    "CUSTOMER_NUMBER");
CharacterFieldDescription customerName = new CharacterFieldDescription
    (new AS400Text(20, system), "CUSTOMER_NAME");
RecordFormat recordFormat = new RecordFormat();
recordFormat.addFieldDescription(customerNumber);
recordFormat.addFieldDescription(customerName);
Record data = recordFormat.getNewRecord(dataQueue.read().getData());
Integer I = (INTEGER) data.getField("CUSTOMER_NUMBER");
String name = (String) data.getField("CUSTOMER_NAME");
```

IBM Toolbox for Java

Visual development environments

Most Toolbox public classes are *Java Beans*. With visual development tools like WDS (WebSphere Developer Studio client), no coding necessary!



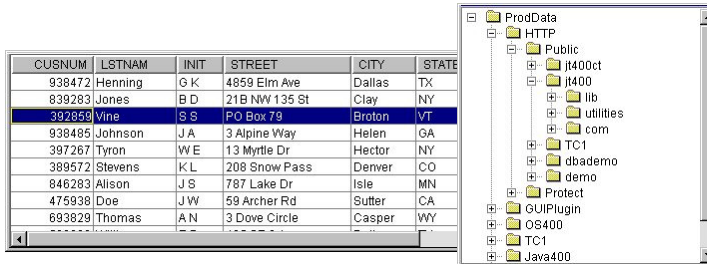
IBM Toolbox for Java

Graphical user interface components

A set of Java **GUI components** which present IBM i data and resources

Usable where a Java **Swing** GUI component (JComponent) is allowed

Toolbox requires Swing 1.1 via either the 1.1.x add-on, or Java 2.



HTML and Servlet classes

*Web components create **tables and forms***

Provides **access** to database files:

- Access database file with Record Level Access or SQL via JDBC
- Includes Meta Data

Provides classes to **display data**:

- Display data in tables or forms
- Toolbox provides converters that will produce HTML tables or forms based on the row data

```
HTMLTableConverter converter = new HTMLTableConverter();

ResultSet resultSet = statement.getResultSet();
SQLResultSetRowData rowdata = new SQLResultSetRowData(resultSet);

String[] html = converter.convert(rowdata);
out.println(html[0]);
```

HTML and Servlet classes

*Web components create **tables and forms***

The screenshot shows two overlapping browser windows. The top window, titled 'JDBC Example - Netscape', displays a table with the following data:

ID	Last Name	Initial	Address	City	State	Zip Code
938472	Henning	G K	4859 Elm Ave	Dallas	TX	75217
				Clay	NY	13041
				79 Broton	VT	5046

The bottom window, titled 'JDBC Example - Netscape', shows a web form with the title 'JDBC Example'. It contains a text input field labeled 'Enter SQL Statement:' with the text 'SELECT * FROM QIWS.QCUSTCDT' entered. A 'Submit' button is located at the bottom right of the form.

HTML and Servlet classes

Web components create tree hierarchy

Provides classes to display the **Integrated File System**:

- **Display contents** of the Integrated File System
- Toolbox provides classes to create and display a customized and **traversable** tree

```
HTMLTree tree = new HTMLTree(HTTPrequest)

IFSJavaFile root = new IFSJavaFile(systemObject, "/QIBM");

DirFilter filter = new DirFilter();

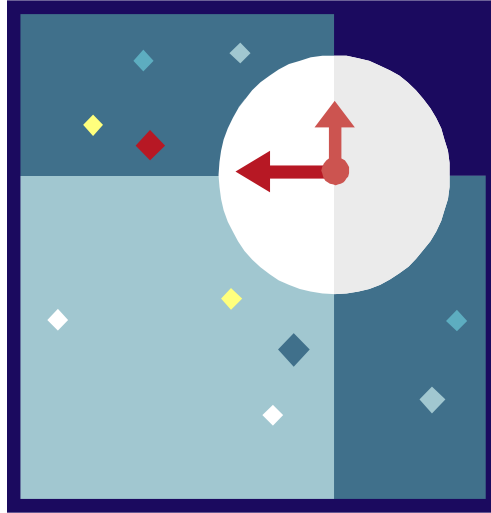
File[] dirList = root.listFiles(filter);

for (int i=0; i<dirList.length; i++)
{
    FileTreeElement node = new FileTreeElement(dirList[i]);
    tree.addElement(node);
}
```

HTML and Servlet classes

Web components create tree hierarchy

Name	Size	Type	Modified
../ (Parent Directory)			
Protect		Directory	02/02/2001 01:18:44 PM
Public		Directory	05/03/2001 01:02:49 PM



Toolbox Micro Edition

Terms

What is ToolboxME?

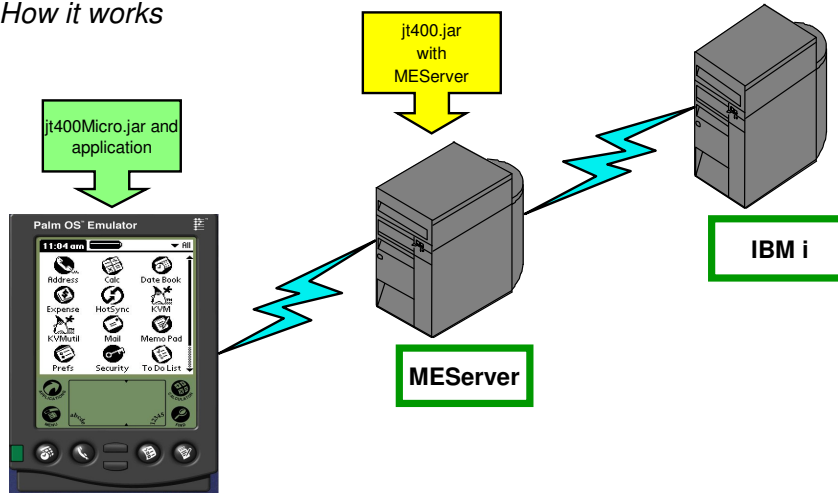
A subset of the Toolbox for Java classes which will provide access to IBM i data and resources from a **Tier 0 device**

What is a Tier 0 device?

- **Tier 3:** the IBM i server
- **Tier 2:** the application or web server
- **Tier 1:** the client desktop or laptop
- **Tier 0:** refers to the next level down. Tier 0 devices are predominantly thought of as web-enabled **cell phones** and personal digital assistants (**PDA**s).

Toolbox Micro Edition

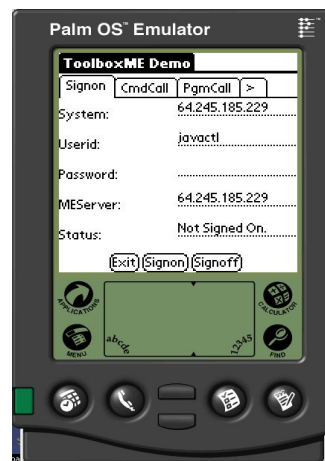
How it works



Toolbox Micro Edition

Supported Components

- AS400
- Command Call
- Program Call via PCML
- Data Queues
- JdbcMe



Graphical Toolbox

Describe GUI panels using XML

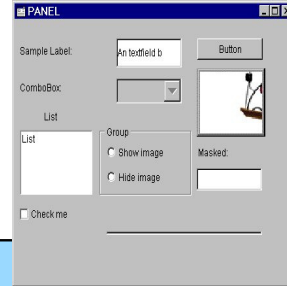
Panel Definition Markup Language (PDML)

- Simplifies GUI panel definition and layout

Resource script (RC) converter

- Converts Windows GUIs to Java

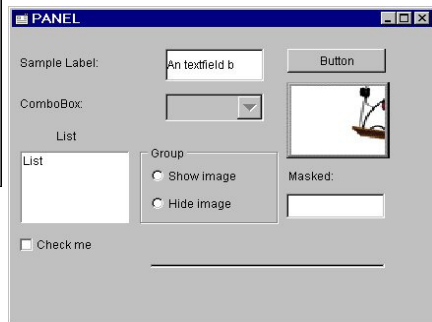
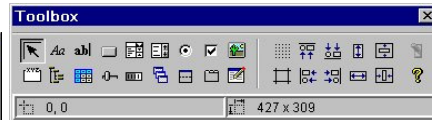
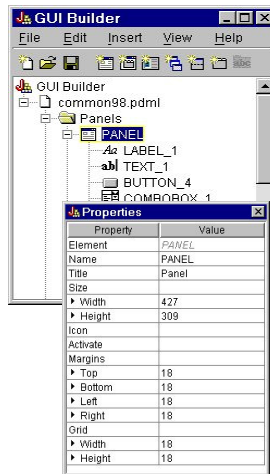
```
<pdml>
<panel name="order_entry" path="/QSYS.lib/MYLIB.lib/RTVSTS.pgm">
<title>Order Entry</title>
<button name="Ok" disabled="no">
<title>Ok</title>
<location>125,100</location>
<size>100,26</size>
<action>COMMIT</action>
</button>
</pdml>
```



Graphical Toolbox

GUI builder

- WYSIWYG panel definition
- Generates PDML code
- Now supports JavaHelp™



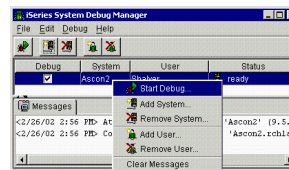
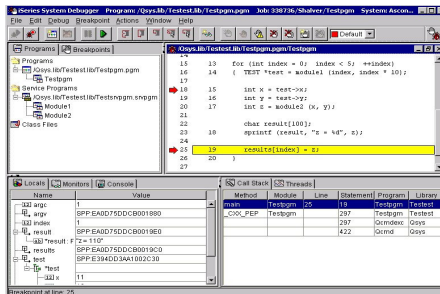
Some other components

The list keeps growing!

- NetServer
- JarMaker
- IBM i Messages
- Message Files
- System Status
- Proxy Support
- Save File
- Report Writer
- Servlets
- System Properties



System Debugger and Debug Manager



- Supports **all ILE languages**: C, C++, RPG, Java, COBOL, CL
- Point and click **breakpoint** manipulation in source code
- Automatic **variable evaluation** with mouse and **local variable display**
- Program **call stack** and **thread display**
- Requires JDK1.3 and `tes.jar`, `jt400.jar`, and `jhall.jar`
- Invoke with following: `java utilities.DebugMgr` or `java utilities.Debug -s system -u user`

New in JTOpen as of V6R1

Now available at www.ibm.com/systems/i/software/toolbox

Other classes and features added in V6R1:

- JDBC enhancements including **generated key support**
- **JDBC 4.0** support (download from JTOpen)
- JDBC **performance** improvements
- AS400JDBCManagedConnectionPoolDataSource
- FileAttributes
- HistoryLog
- ObjectReferences
- UDFS (user defined file system)

Plus:

- CL command documentation generator
- Kerberos authentication is now supported through the use of JGSS
- Performance improvements in list processing (users, jobs, etc.)
- Unicode-enabled CL commands

What's new since V6R1

- **"JC1" LPP eliminated as of IBM i 7.1**
 - Integrated into **SS1** (product ID 5770-SS1) **Option 3**
 - Same JAR files available in **same IFS directories** as in prior releases
- **New classes added**
 - Package `com.ibm.as400.access`
 - AS400JDBCArray, AS400JDBCArrayResultSet
 - ErrorCodeParameter
 - ObjectLockListEntry
 - UserObjectsOwnedList, UserObjectsOwnedListEntry
 - Package `com.ibm.as400.security.auth`
 - ProfileTokenProvider
 - DefaultProfileTokenProvider

What's new since V6R1 - continued

- **Significantly *enhanced* classes**

- Package `com.ibm.as400.access`

- Many of the JDBC classes
- CommandCall and ProgramCall - new thread-safety behavior, new methods
- IFSFile, IFSJavaFile - new methods
- AS400 - new system properties, new methods
- AS400ConnectionPool
- Trace
- DataArea
- SpooledFile

- For complete details, refer to the IBM i Information Center

- <http://publib.boulder.ibm.com/infocenter/iserics/v7r1m0/topic/rzahh/page1.htm>

Top 5 Good Things About the Toolbox

1. It's free, no strings attached.
2. Fully supported by IBM Service.
 - User forum on Web is monitored daily by IBM developers.
3. Lets any Java app, anywhere on your LAN,
 - Access and exploit your IBM i resources.
4. Thoroughly documented on the Web.
5. In use by IBM and customers since V4R2 (1998).
 - Used under-the-covers in many other IBM products.

That's it!

References

Where can I get more information?

www.ibm.com/systems/i/software/toolbox

- Toolbox for Java: News, downloads, FAQs, articles, COMMON labs

<http://sourceforge.net/projects/jt400>

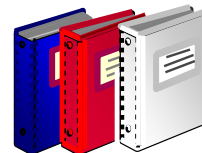
- JTOpen - open source, bug reporting, feature requests

www.ibm.com/systems/support/i/forums

- IBM i Technical Forums - including IBM Toolbox for Java/JTOpen Forum

IBM Toolbox for Java Programmers Guide

- Shipped with the IBM Toolbox for Java
- Contains overview, full API documentation (javadoc), and code examples
- Available in the IBM i Information Center
 - <http://publib.boulder.ibm.com/infocenter/iseri/v7r1m0/topic/rzahh/page1.htm>





Questions



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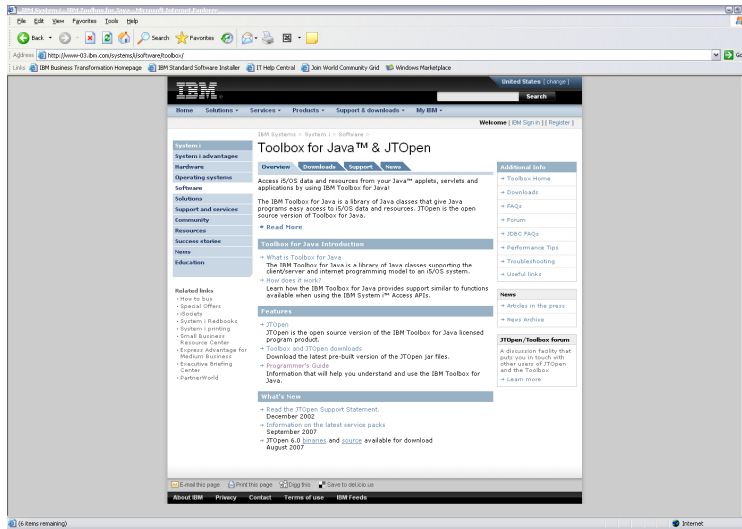
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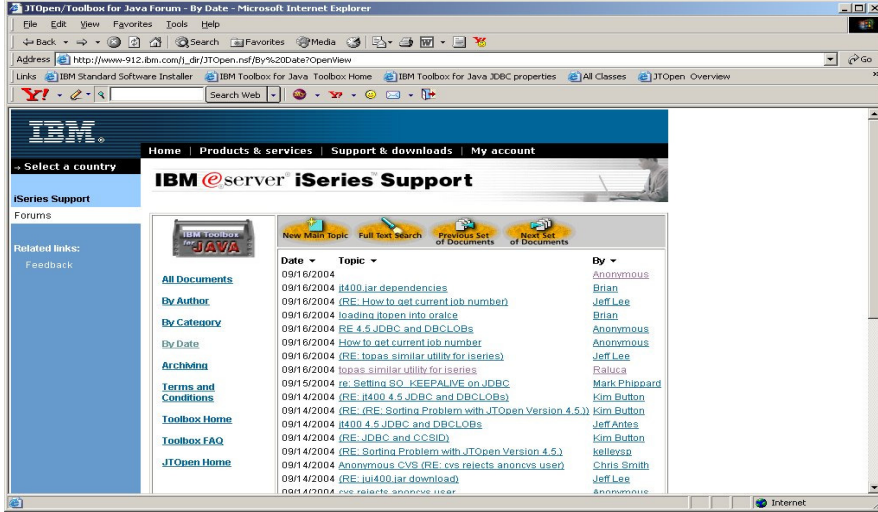
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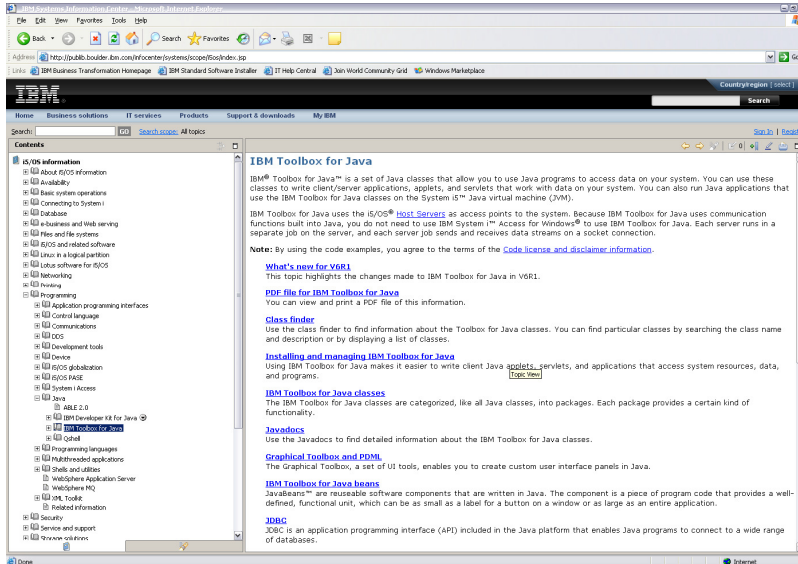
IBM Toolbox for Java home page



IBM Toolbox for Java/JTOpen Forum



Toolbox Programmer's Guide



Javadoc

Package	Description
com.ibm.as400.access	Provides classes that represent various iSeries AS400 data and resources.
com.ibm.as400.data	Provides classes to simplify calling iSeries or AS400 programs from Java.
com.ibm.as400.micro	Provides classes that allow access to various iSeries data and resources from a wireless or handheld device.
com.ibm.as400.resource	Provides classes that represent iSeries or AS400 resources using a generic list-based scheme.
com.ibm.as400.security.auth	Provides user profile swapping using iSeries or AS400 profile tokens and credential classes.
com.ibm.as400.ui.framework.java	The runtime API for the Graphical Toolbox.
com.ibm.as400.ui.util	Provides various utility applications and classes, in addition to what is included in the utilides package.
com.ibm.as400.util.communicationtrace	Provides an utility application and classes to assist in the formatting and display of iSeries communication traces.
com.ibm.as400.util.html	Provides classes that assist in setting up forms and tables for HTML pages.
com.ibm.as400.util.reportwriter.processor	
com.ibm.as400.util.servlet	Provides classes that assist in writing servlets that manipulate iSeries or AS400 data.
com.ibm.as400.view	Provides classes that graphically present iSeries or AS400 data to the user.
utilides	Provides various utility applications and classes.

JDBC Driver Types

- **Type 1 Driver - JDBC-ODBC bridge**
- **Type 2 Driver - Native-API Driver specification**
- **Type 3 Driver - Network-Protocol Driver**
- **Type 4 Driver - Native-Protocol Driver**
 - The Toolbox JDBC driver is this type.
- **References:**
 - <http://java.sun.com/products/jdbc/driverdesc.html>
 - http://en.wikipedia.org/wiki/JDBC_driver

What's different in IBM i 7.1

JDKs and JVMs

- The **LPP** for "IBM Developer Kit for Java" is **unchanged: 5761-JV1**
 - Same LPP number as in IBM i 6.1
- **"Classic" JDK is not available** in IBM i 7.1
 - Replaced by "IBM Technology for Java" (code name: "J9")
 - The **no-longer-supported JV1 Options** that had "Classic" JVMs:
 - JV1 Options **6, 7 and 10**
- **New Java Group PTF** number for IBM i 7.1
 - **SF99572** (versus SF99562 for IBM i 6.1)

For complete details, refer to the IBM i Information Center

- <http://publib.boulder.ibm.com/infocenter/iseres/v7r1m0/topic/rzaha/rzahawhatsnew.htm>

What's different in IBM i 7.1 - *continued*

"PASE for i" – Changes for improved security

"IBM Portable Application Solutions Environment for i"

- Provides an **AIX-like execution environment** on IBM i.
- The "new" IBM i JVMs **require** a PASE environment.

- PASE now **enforces stack execution disable** protection.
- Default behavior of PASE programs has changed.
 - **Instructions run from memory areas** (stack & heap) of a process are **blocked**.
 - JIT-generated code is created in memory areas.
 - If call `JNI_CreateJavaVM()` : **Must mark the program** as needing to **allow program execution** from memory areas.

For complete details, refer to the IBM i Information Center

- <http://publib.boulder.ibm.com/infocenter/iseres/v7r1m0/topic/rzalf/rzalfwhatsnew.htm>



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