

Agenda Key: 35CB
Session Number: 403552

Introducing... The IBM Toolbox for Java™

Jeff Lee



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Java related sessions



Basic Java

Mon 9:30 - 22MD A Java Introduction to Object-Oriented Programming (OOP)

Mon 3:30 - 26MJ Debugging the New Java ***New Session***

Tues 8:00 - 31CD Java 101: Basic Syntax and Structure

Tues 11:00 - 33LA LAB: Introduction to Java ***LAB***

Web 9:30 - 42CD The Future of Java on IBM i

Java Toolbox

Tues 2:00 - 35CB Introducing the IBM Toolbox for Java

Wed 8:00 - 41LA LAB: IBM Toolbox for Java ***LAB***

Thur 9:30 - 52CC IBM Toolbox for Java: Advanced

Advanced Java related topics

Mon 11:00 - 23MH Introduction to XML Processing with Java

Tues 3:30 - 36MG Java Application Performance Analysis and Tuning on IBM i

Wed 2:00 - 45CD Using the JVM Tools Interface (JVMTI)

Thur 12:30 - 54CB Multi-Threaded Programming Using Java

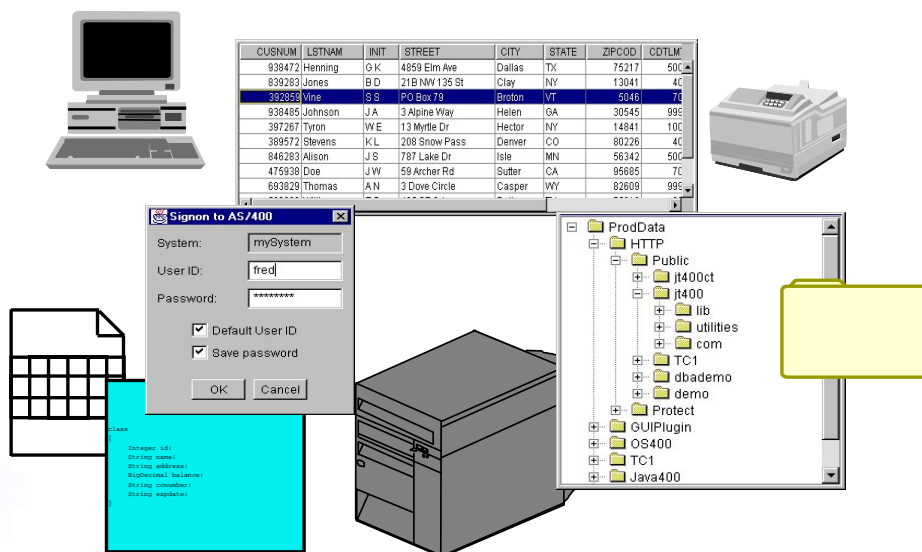
Thur 2:00 - 55MH Java Stored Procedures and Java User-Defined Functions



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



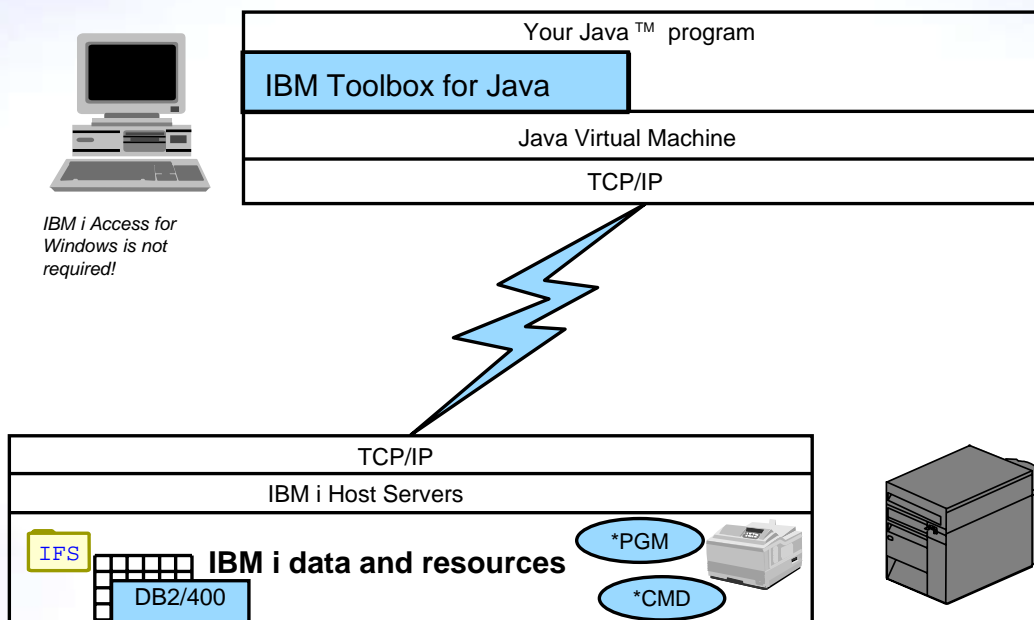
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IBM Toolbox for Java

The big picture - Client/Server



IBM i Access for Windows is not required!

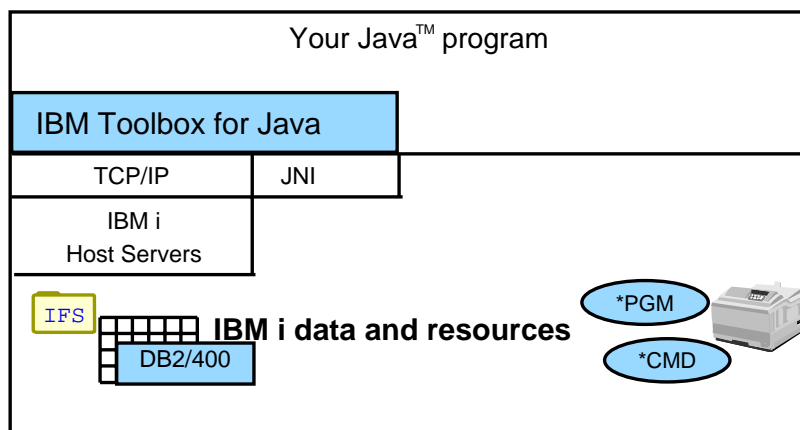
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IBM Toolbox for Java

The big picture - Toolbox and data on same IBM i



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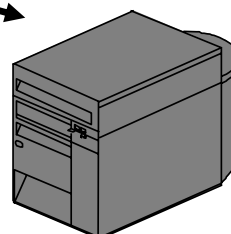
IBM Toolbox for Java

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

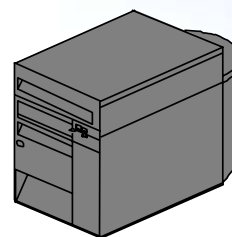
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IBM Toolbox for Java

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 servers
- Direct API calls used in some cases to avoid the servers
- IBM i with Java Virtual Machine (JVM) is required

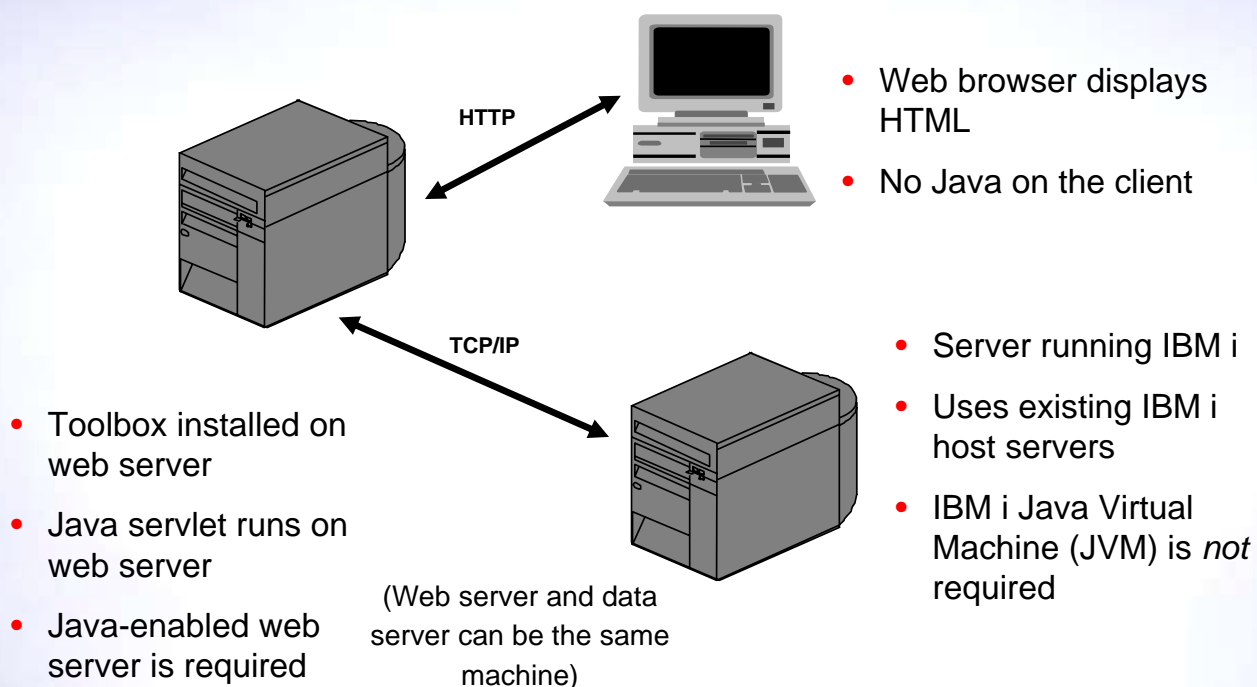
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IBM Toolbox for Java

Using the Toolbox in Internet-based servlets



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IBM Toolbox for Java

Supported platforms:

- **IBM i, Linux, Windows, AIX**, Solaris, Netscape Communicator, 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

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IBM Toolbox for Java

Packaging

Licensed program 5722-JC1 (V5R3/V5R4) or 5761-JC1 (V6R1) (no additional charge)

Downloadable from Toolbox or JTOpen websites (no additional 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, x4j400.jar - Graphical Toolbox
- tes.jar - System Debugger



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

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JTOpen (Open Source)

All of the primary Toolbox packages are open source!

sourceforge.net/projects/jt400

- Part of IBM's open source development community
- Use source 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 versions 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
 - New functions and fixes available here fi



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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 IBM i objects (Jobs, Users, System Values, etc.)
- Built-in automatic data conversion
- HTML / Servlet wrappers
- Wireless APIs
- XML-based GUI Builder
- Components are Java Beans

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IBM Toolbox for Java

IBM i Products 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...

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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

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Infrastructure

"The AS400 object"

Represents a connection to the IBM i

Provides a sign-on GUI

- Password caching available
- Change password GUI when appropriate

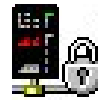
Controls conversations with server jobs

- 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);
```

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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)

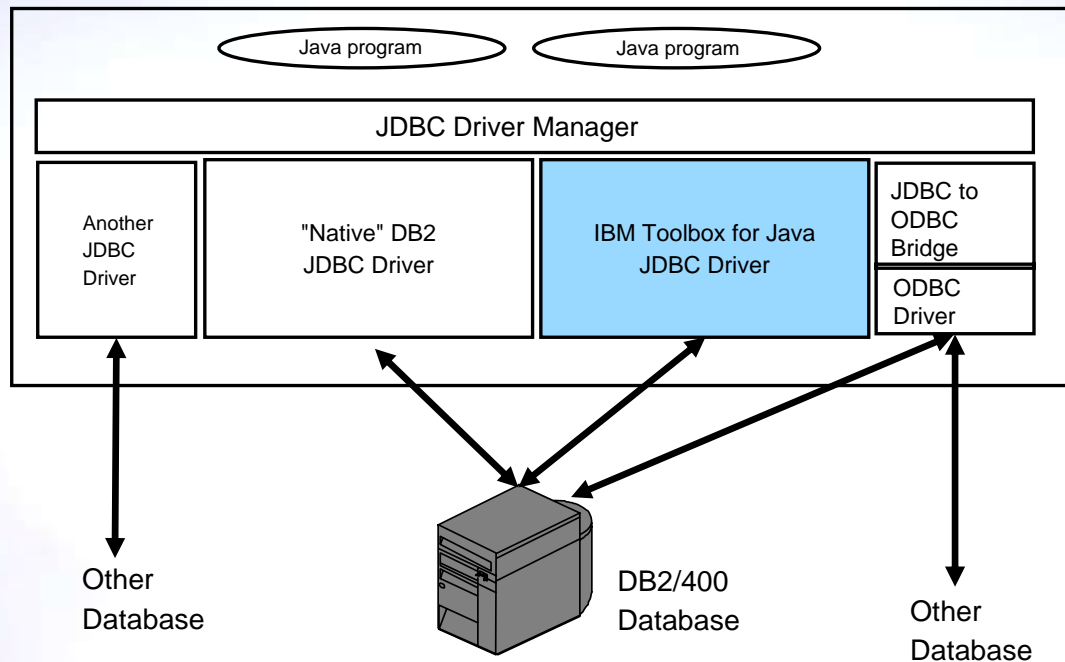
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JDBC

The Java standard for SQL database access



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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 JTOpen

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));
```

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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();
```

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Integrated file system

File input, output, and more

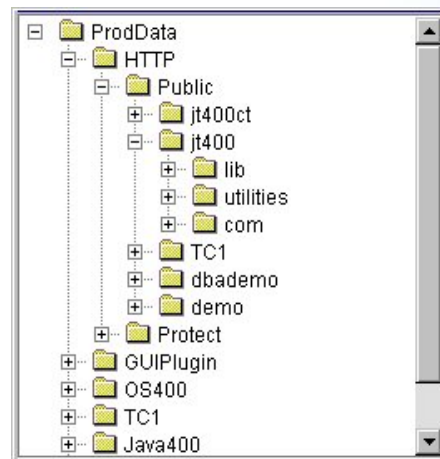
Implements standard Java input/output (*java.io*) classes:

- 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");
```



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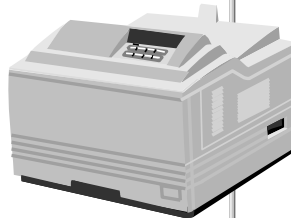
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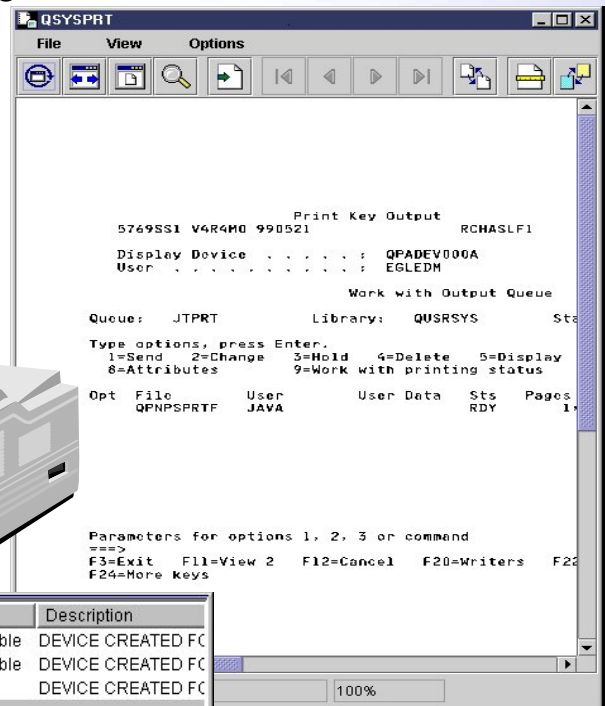
Network print

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



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



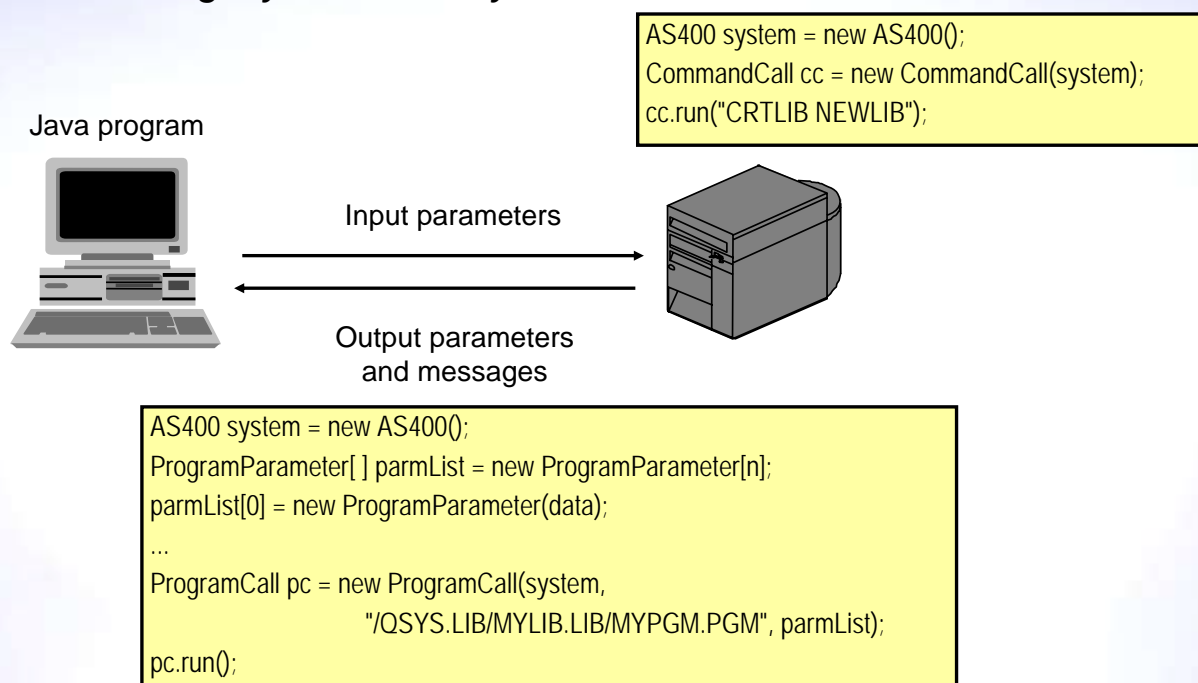
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Command call and program call

Make use of legacy code and system APIs



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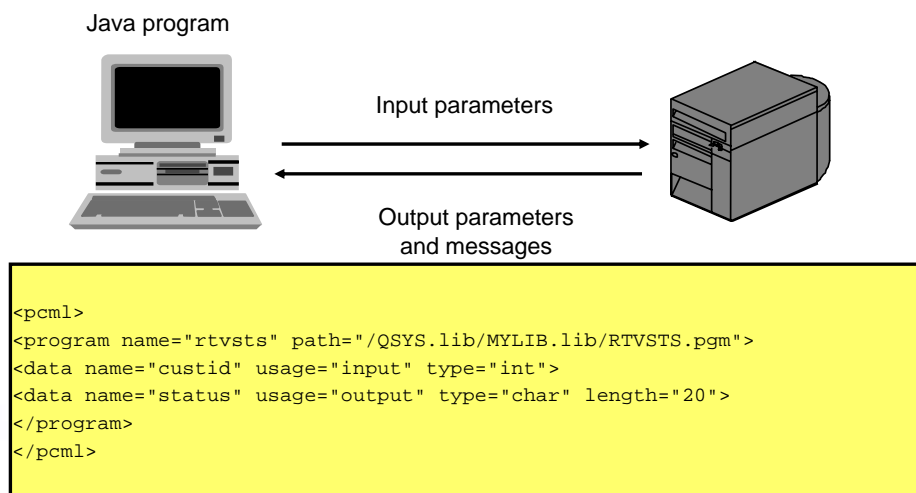
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Program Call Markup Language (PCML)

Describe program calls using XML

Automates program call parameter and structure definition

Simplifies data description and conversion



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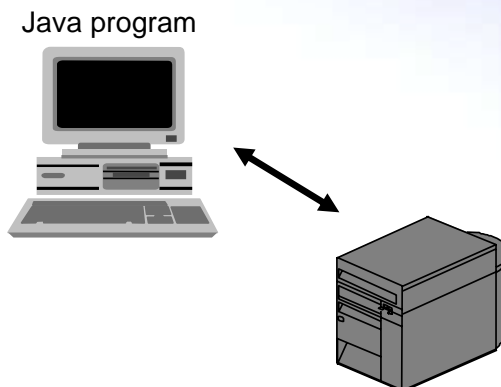
Interprogram Communication

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);
```

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RFML (Record Format Markup Language)

Very similar to PCML (Program Call Markup Language)

While PCML is designed only for Program Parameters, RFML is useful for parsing/composing:

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

Specify record formats using XML; get/set field values

Segregate the data layout from the program logic

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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);
```

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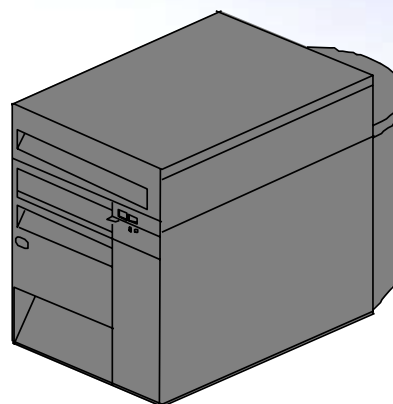
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Server Objects

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());
```

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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!

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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

```
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");
```

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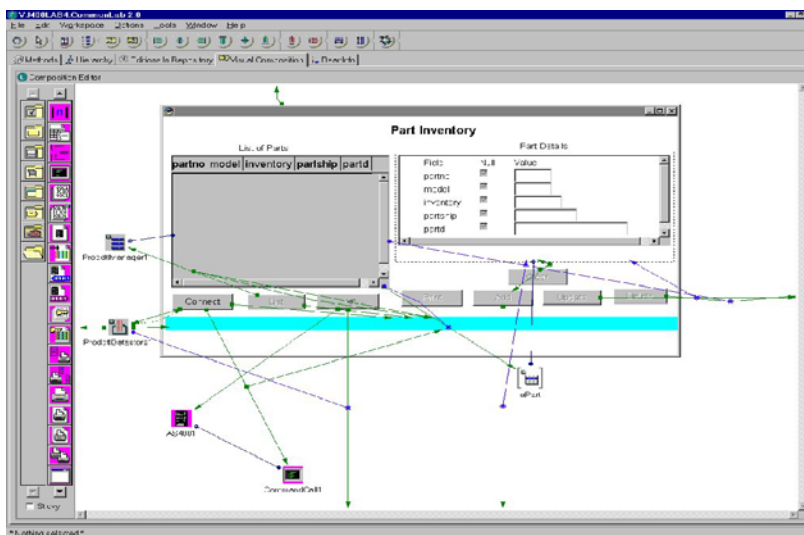
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IBM Toolbox for Java

Visual development environments

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



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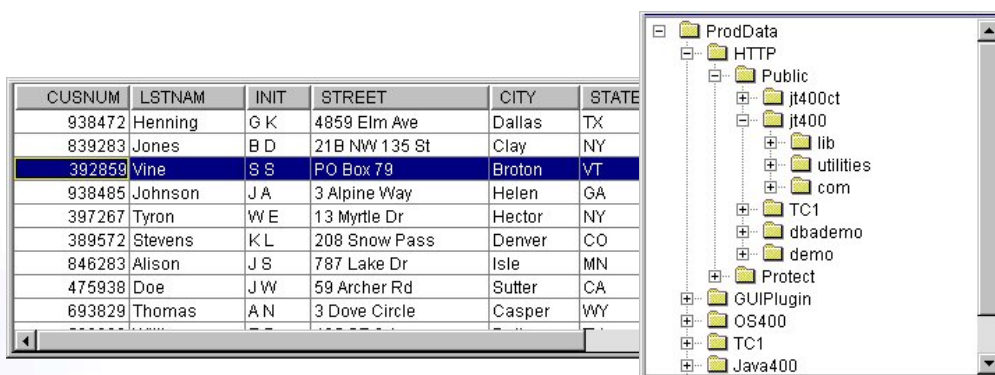
IBM Toolbox for Java

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.



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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]);
```

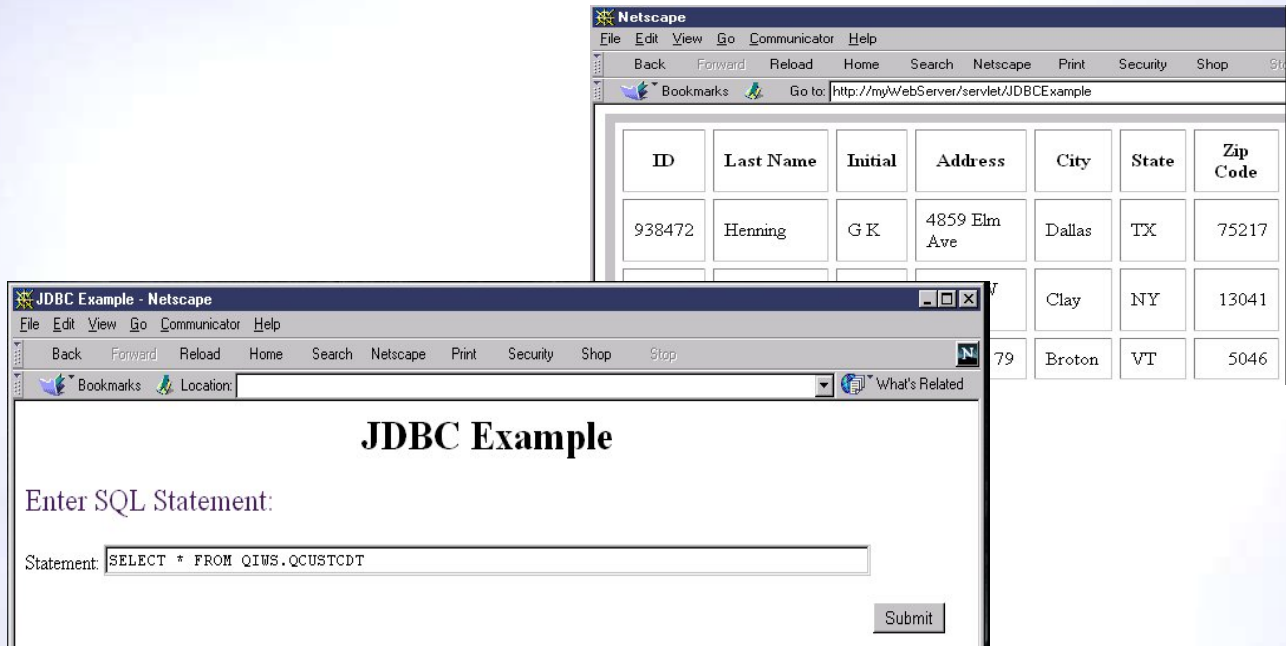
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HTML and Servlet classes

Web components create tables and forms



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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);
}
```

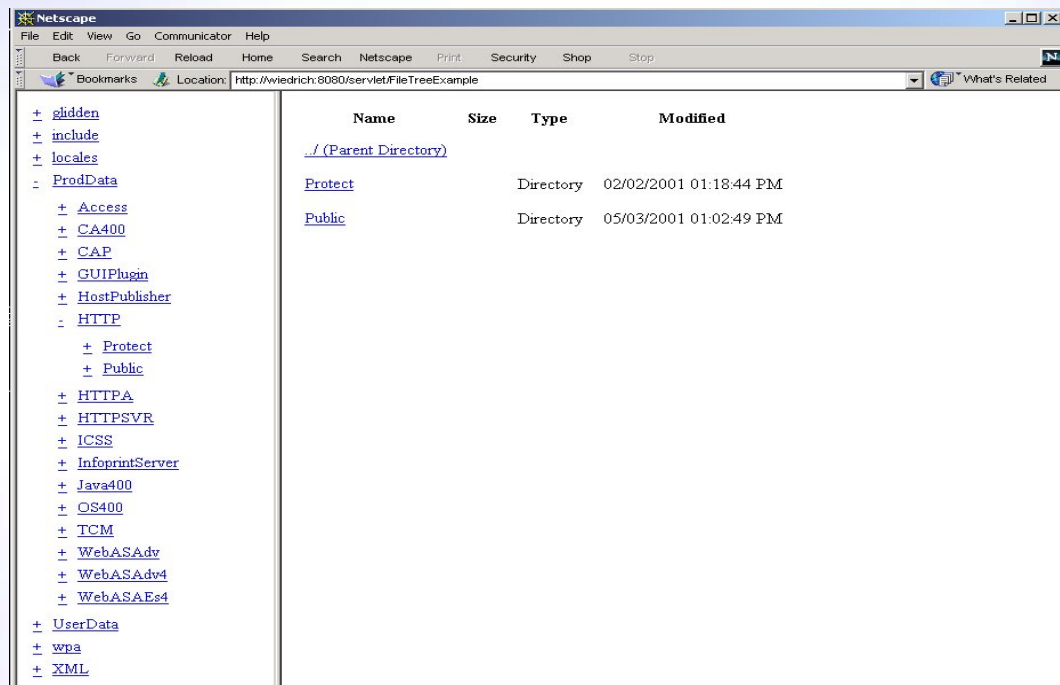
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HTML and Servlet classes

Web components create tree hierarchy



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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 (PDAs).

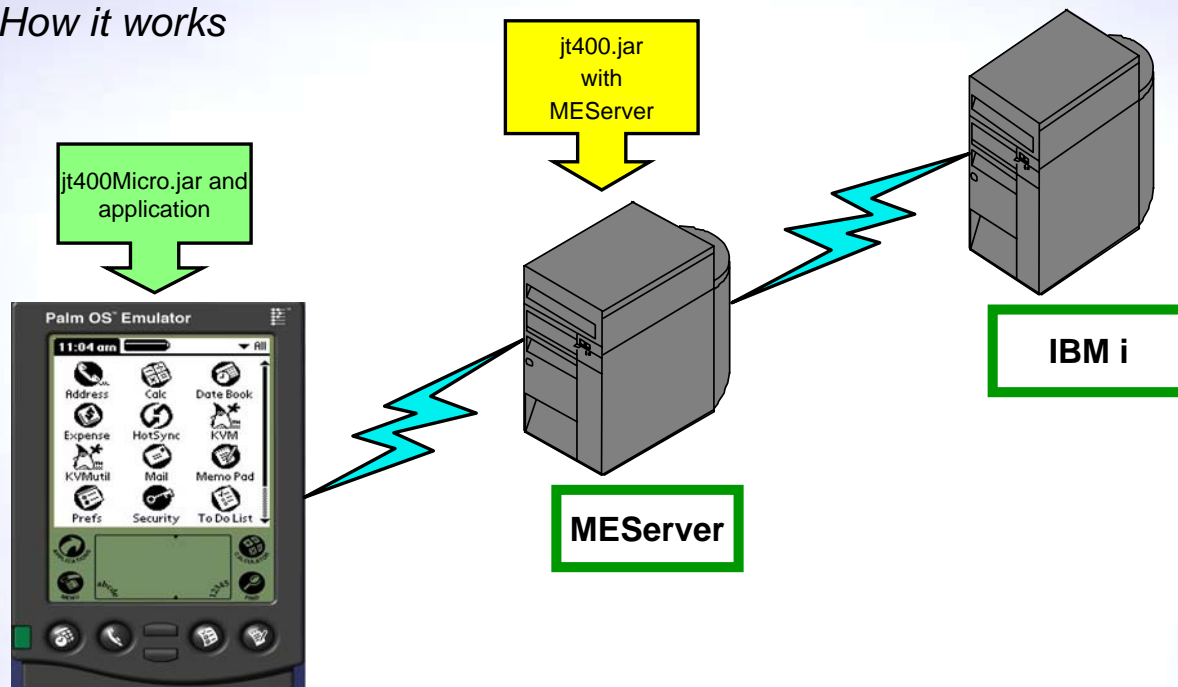
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Toolbox Micro Edition

How it works



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Toolbox Micro Edition

Supported Components

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



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Graphical Toolbox

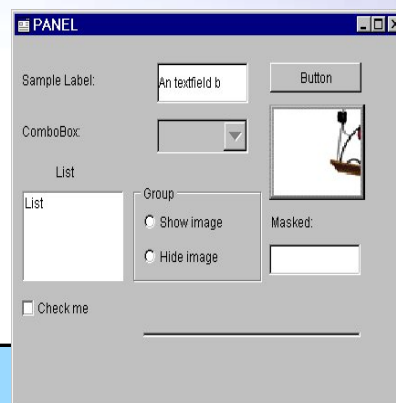
Describe GUI panels using XML

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>
```

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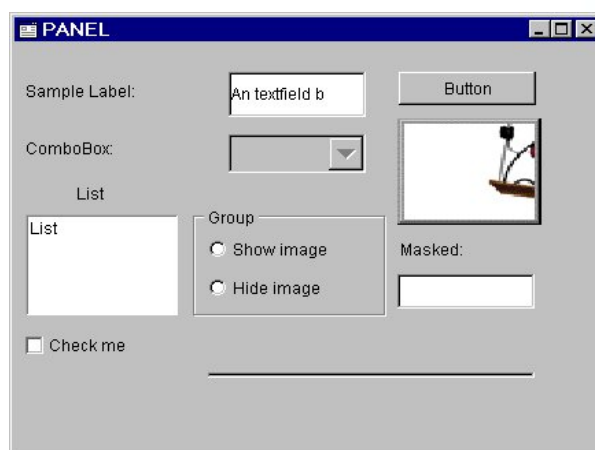
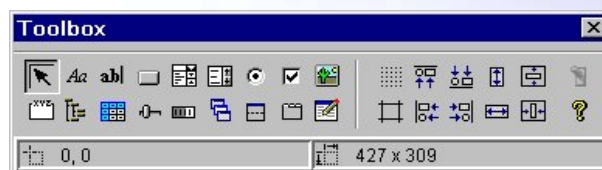
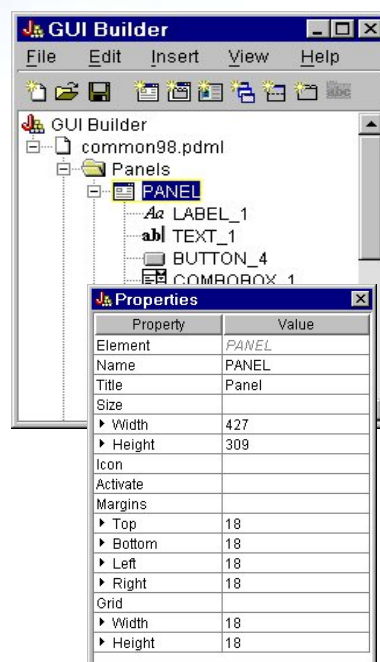
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Graphical Toolbox

GUI builder

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



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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

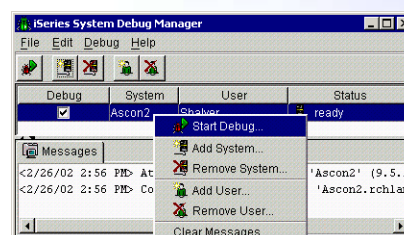
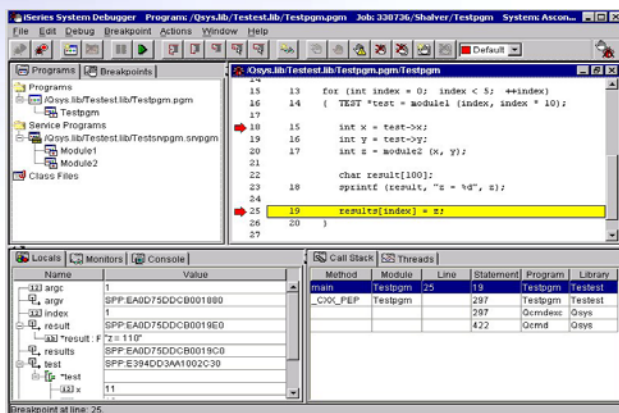


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System Debugger and Debug Manager



- 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`

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New in JTOpen and V6R1

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

Other new classes in V6R1

- JDBC enhancements including generated key support
- JDBC 4.0 support (JTOpen)
- JDBC performance improvements
- AS400JDBCManagedConnectionPoolDataSource
- FileAttributes
- HistoryLog
- ObjectReferences
- UDFS



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 Commands

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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.

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That's it!

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References

Where can I get more information?

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

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

sourceforge.net/projects/jt400

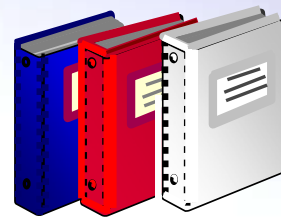
- JTOpen - open source, bug reporting, feature requests

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
 - publib.boulder.ibm.com/infocenter/systems/scope/i5os/topic/rzahh/page1.htm



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Questions

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Java related sessions

Basic Java

Mon 9:30 - 22MD A Java Introduction to Object-Oriented Programming (OOP)

Mon 3:30 - 26MJ Debugging the New Java ***New Session***

Tues 8:00 - 31CD Java 101: Basic Syntax and Structure

Tues 11:00 - 33LA LAB: Introduction to Java ***LAB***

Web 9:30 - 42CD The Future of Java on IBM i

Java Toolbox

Tues 2:00 - 35CB Introducing the IBM Toolbox for Java

Wed 8:00 - 41LA LAB: IBM Toolbox for Java ***LAB***

Thur 9:30 - 52CC IBM Toolbox for Java: Advanced

Advanced Java related topics

Mon 11:00 - 23MH Introduction to XML Processing with Java

Tues 3:30 - 36MG Java Application Performance Analysis and Tuning on IBM i

Wed 2:00 - 45CD Using the JVM Tools Interface (JVMTI)

Thur 12:30 - 54CB Multi-Threaded Programming Using Java

Thur 2:00 - 55MH Java Stored Procedures and Java User-Defined Functions



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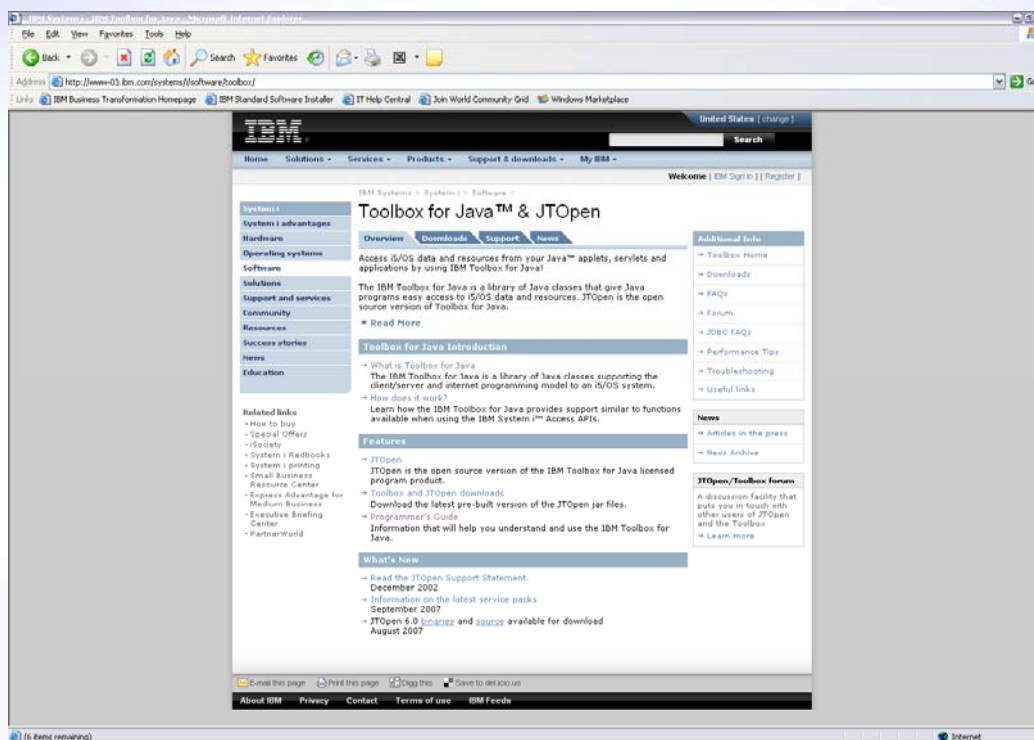
Backup Slides

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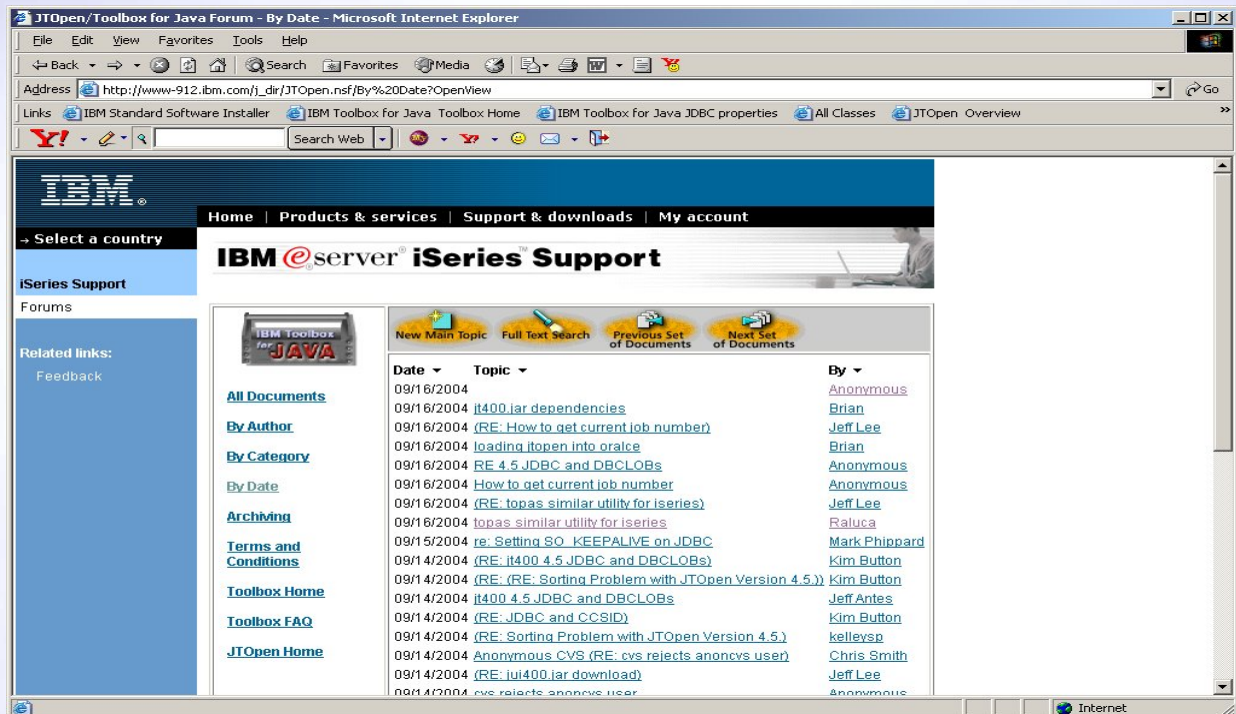


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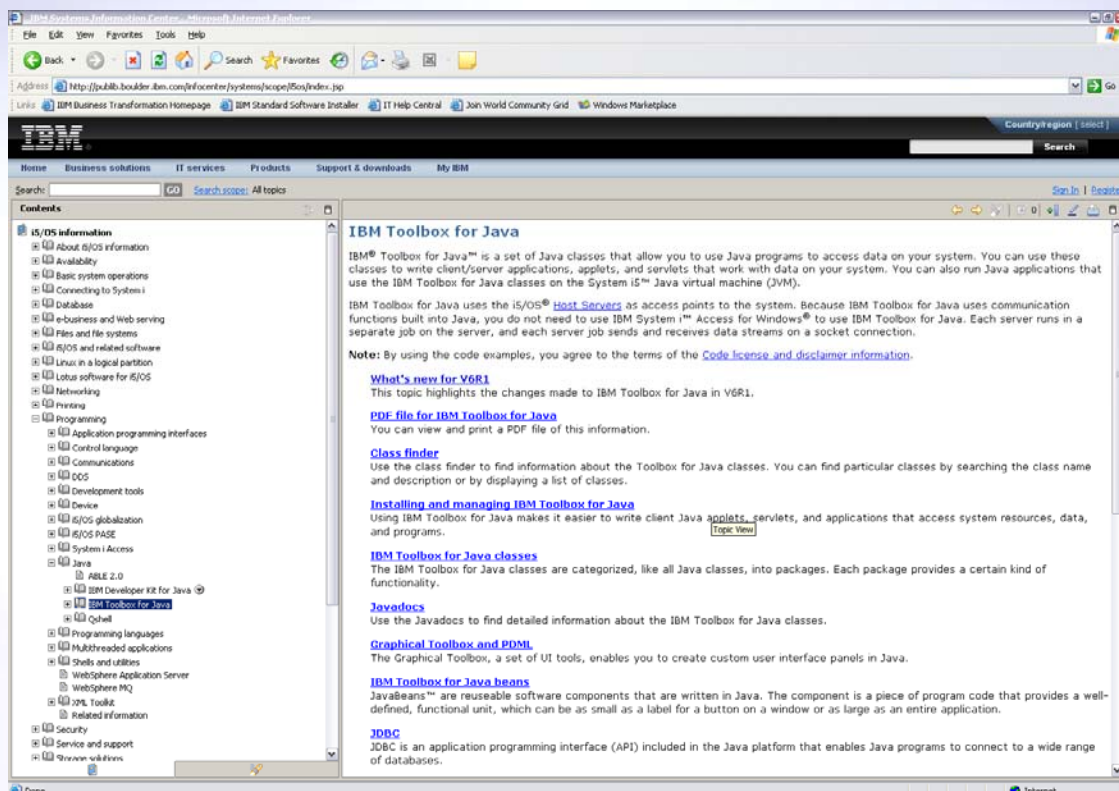


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Toolbox Programmer's Guide

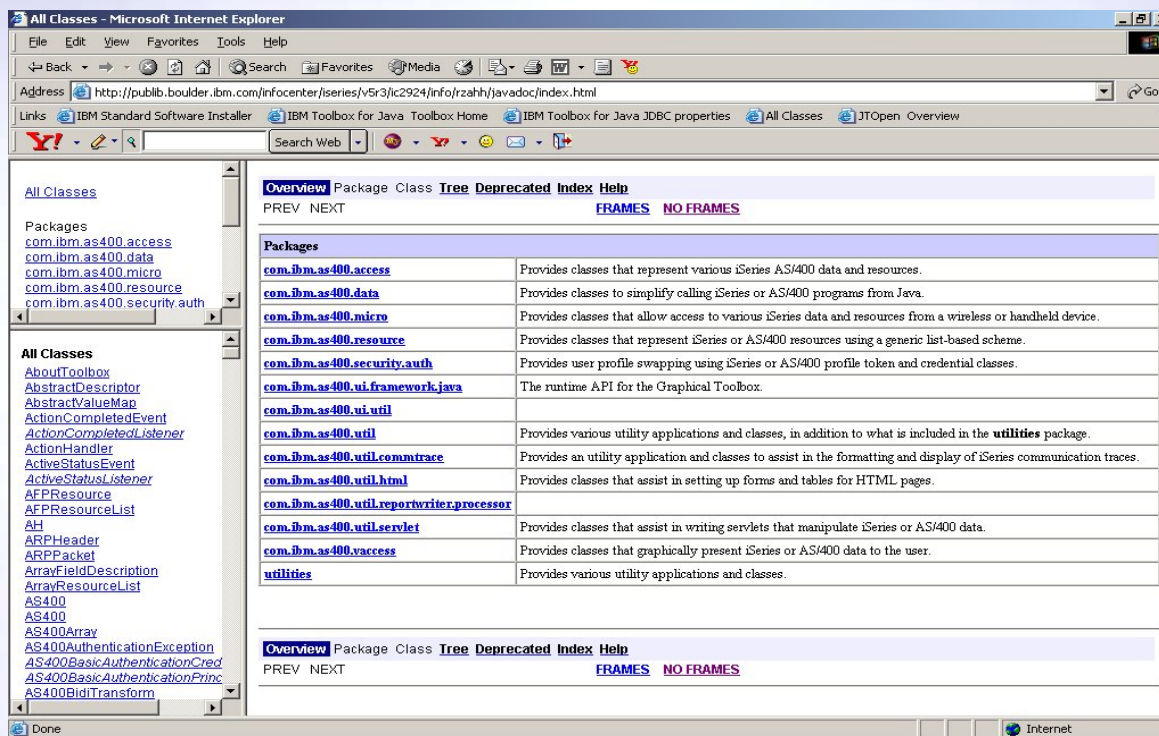


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Javadoc



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