



# Toolbox for Java<sup>TM</sup> : Basics

*IBM @server iSeries 400 and AS/400e*

**Susan Funk**

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# *AS/400 Toolbox for Java*

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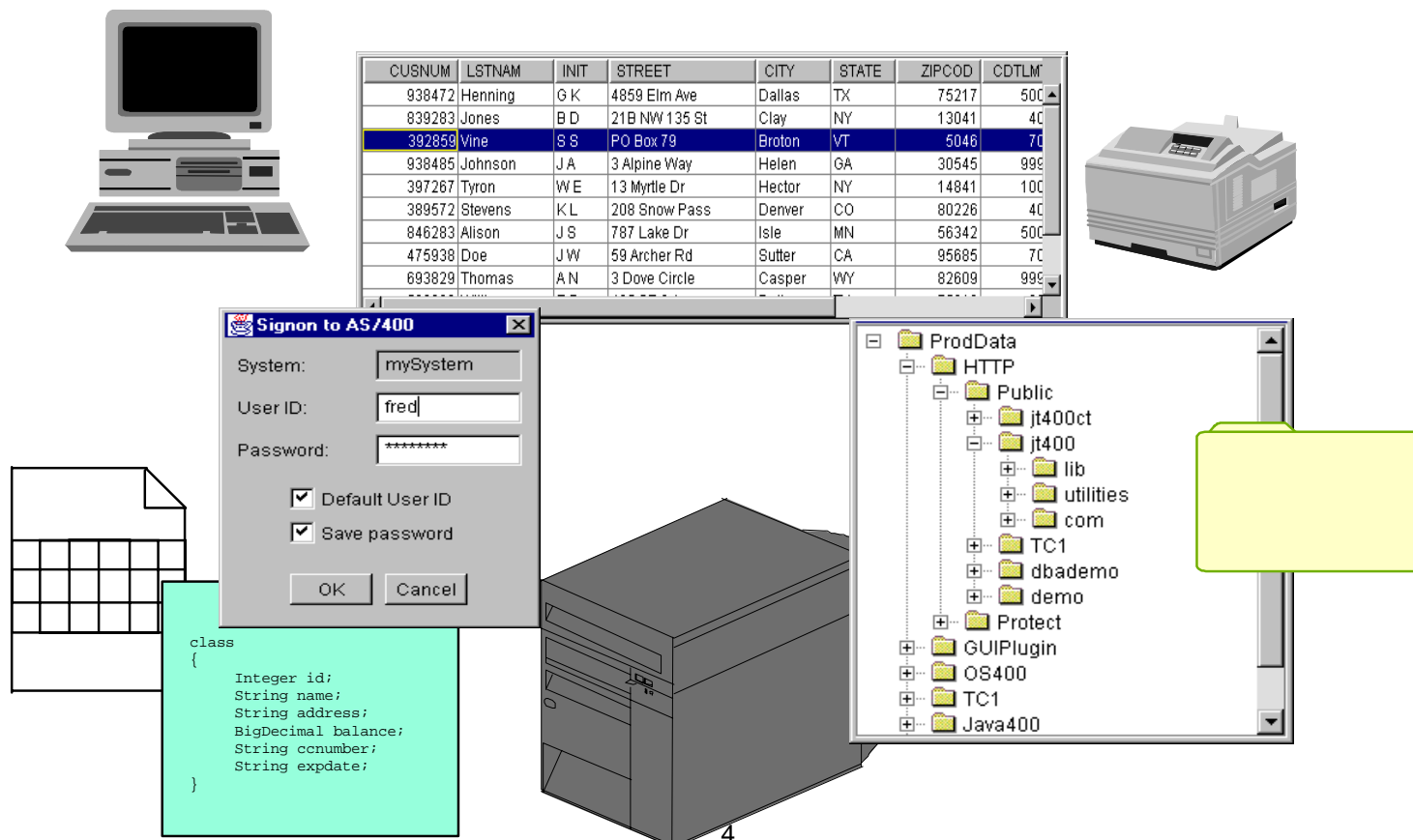
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# AS/400 Toolbox for Java

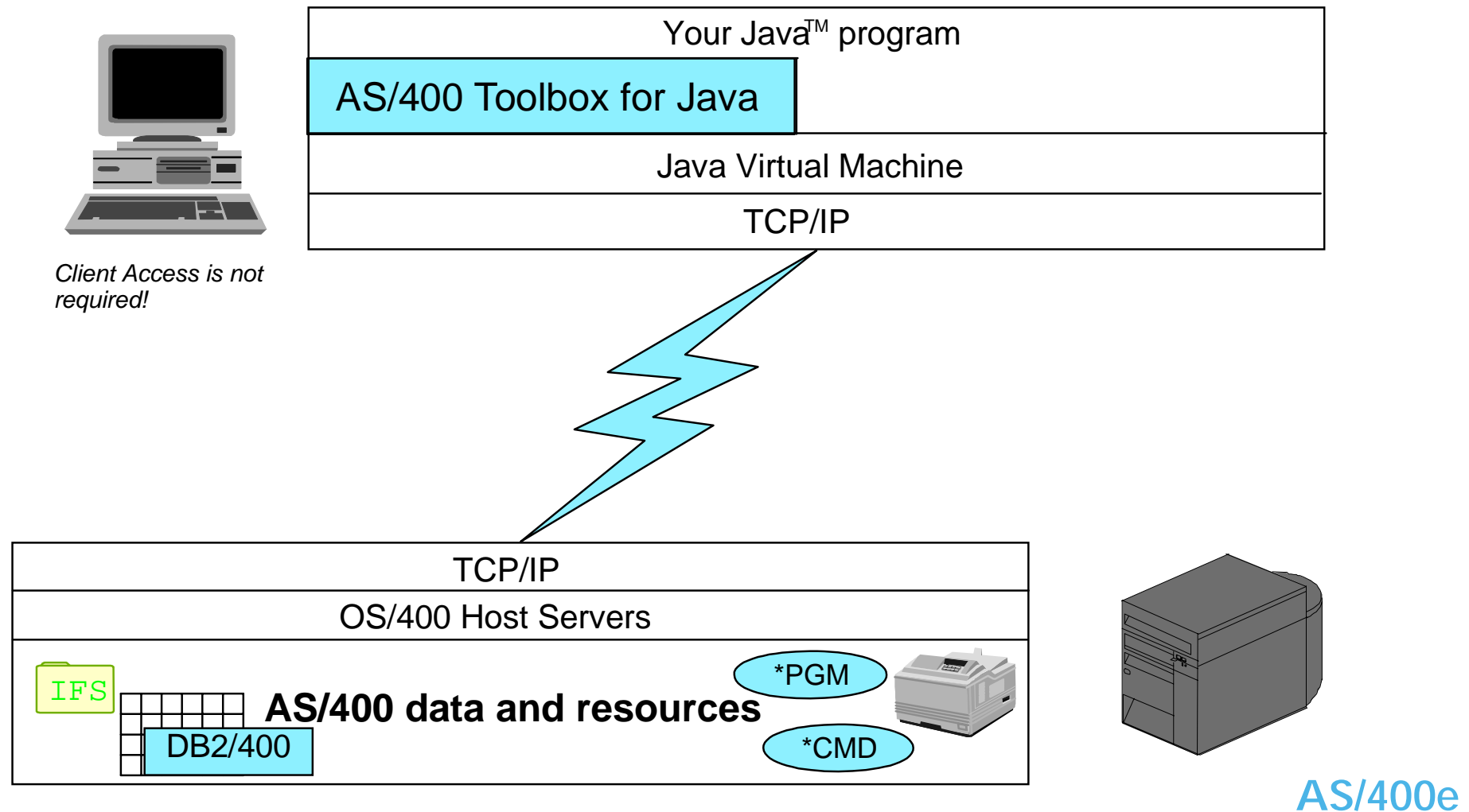
## What is the Toolbox?

A set of Java classes and utilities which provide access to AS/400 data and resources



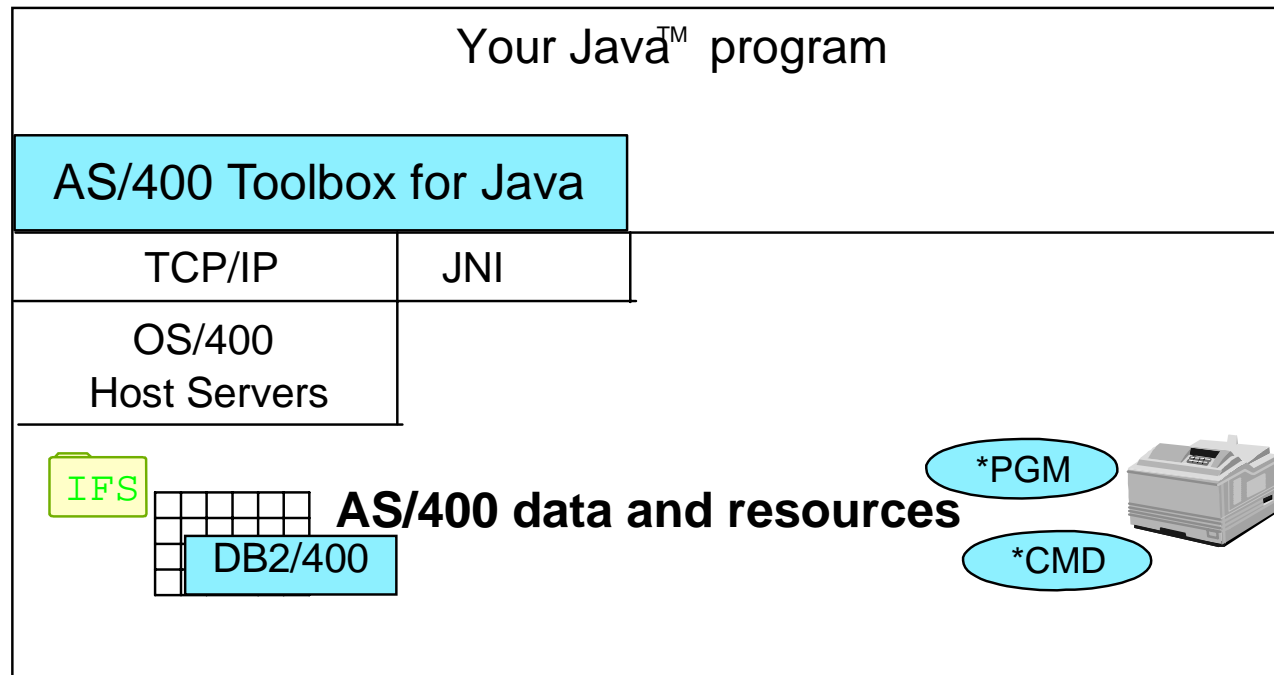
# AS/400 Toolbox for Java

## The big picture - Client/Server



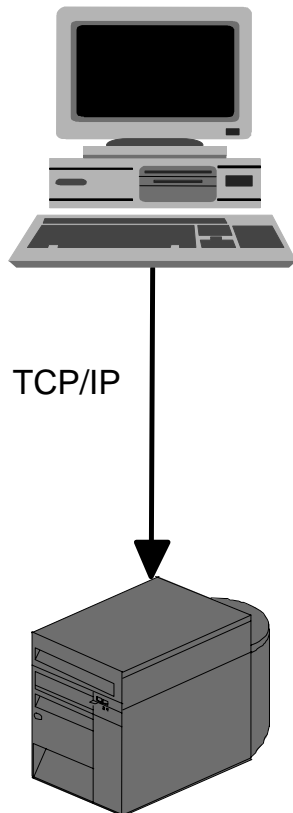
# AS/400 Toolbox for Java

## The big picture - Toolbox and data on same AS/400

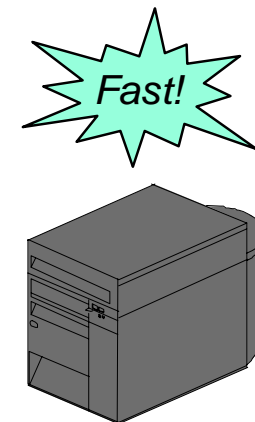
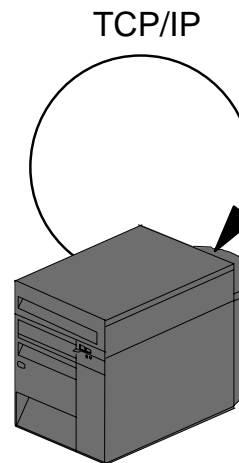


## "Native optimizations"

Java program  
runs on the client



Java program and the data are  
on the same AS/400

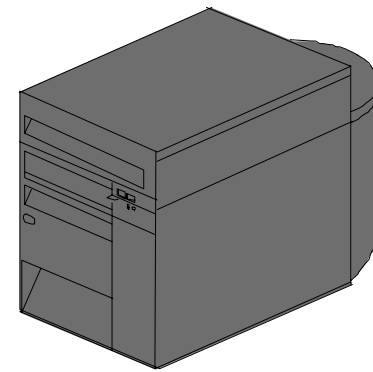


Direct system  
API calls

AS/400e

## Using the Toolbox in server applications

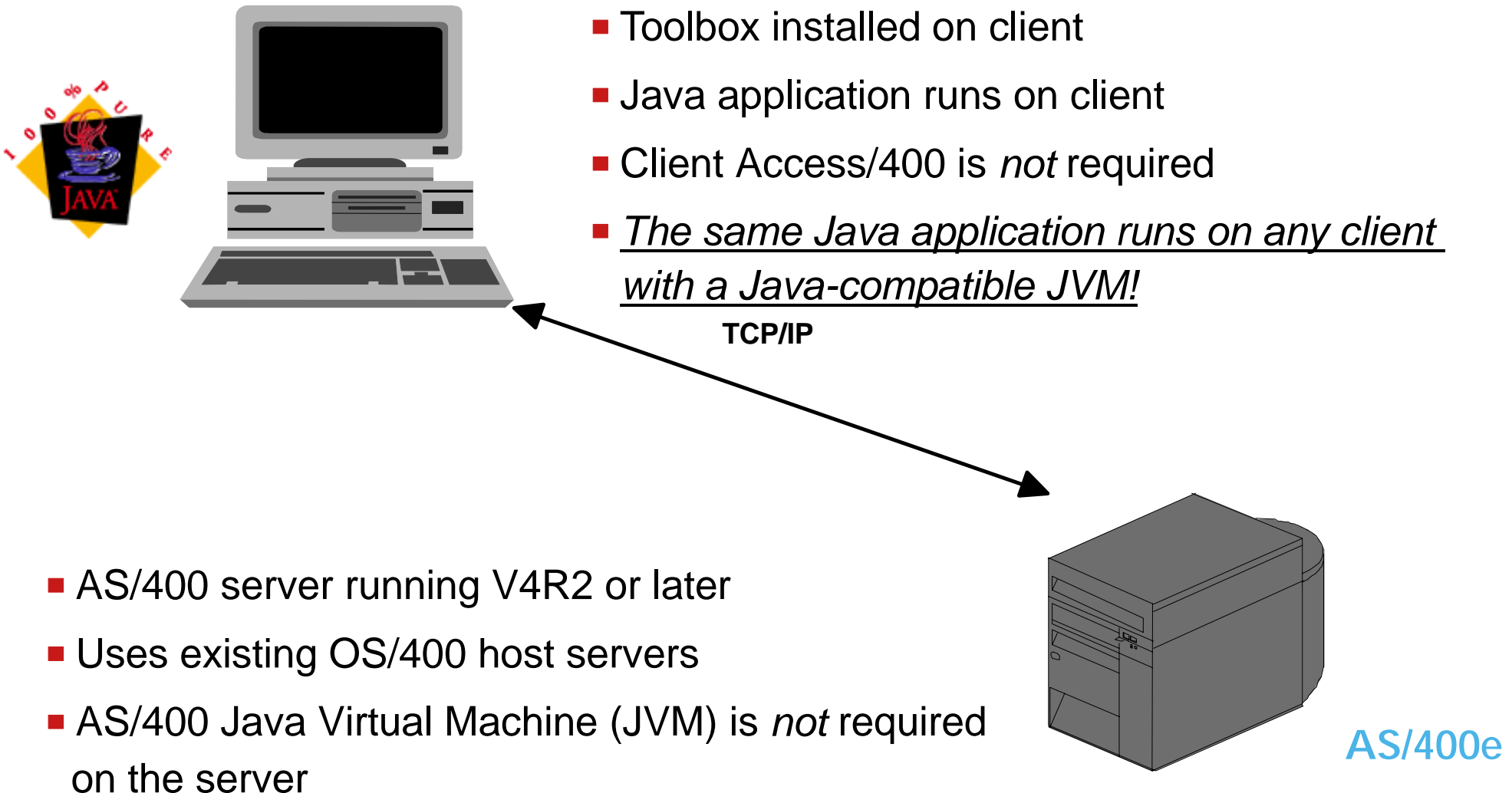
- Toolbox installed on AS/400
- Java application runs on AS/400
- Use Toolbox instead of JNI
- "Local" sockets used to communicate between Toolbox and servers
- Direct API calls used in some cases to avoid the servers
- AS/400 with Java Virtual Machine (JVM) is required (V4R2 or later)





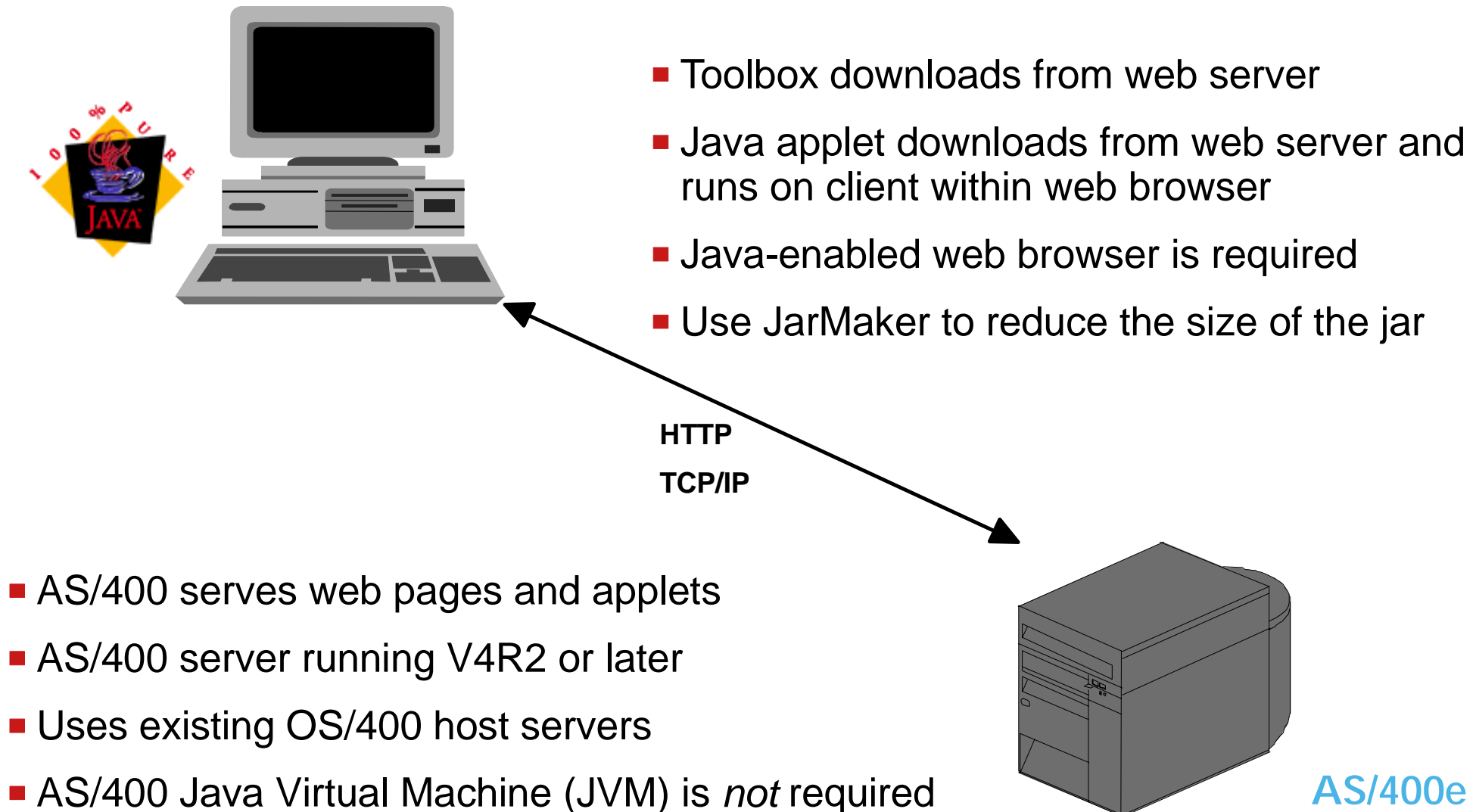
# AS/400 Toolbox for Java

## Using the Toolbox in client/server applications



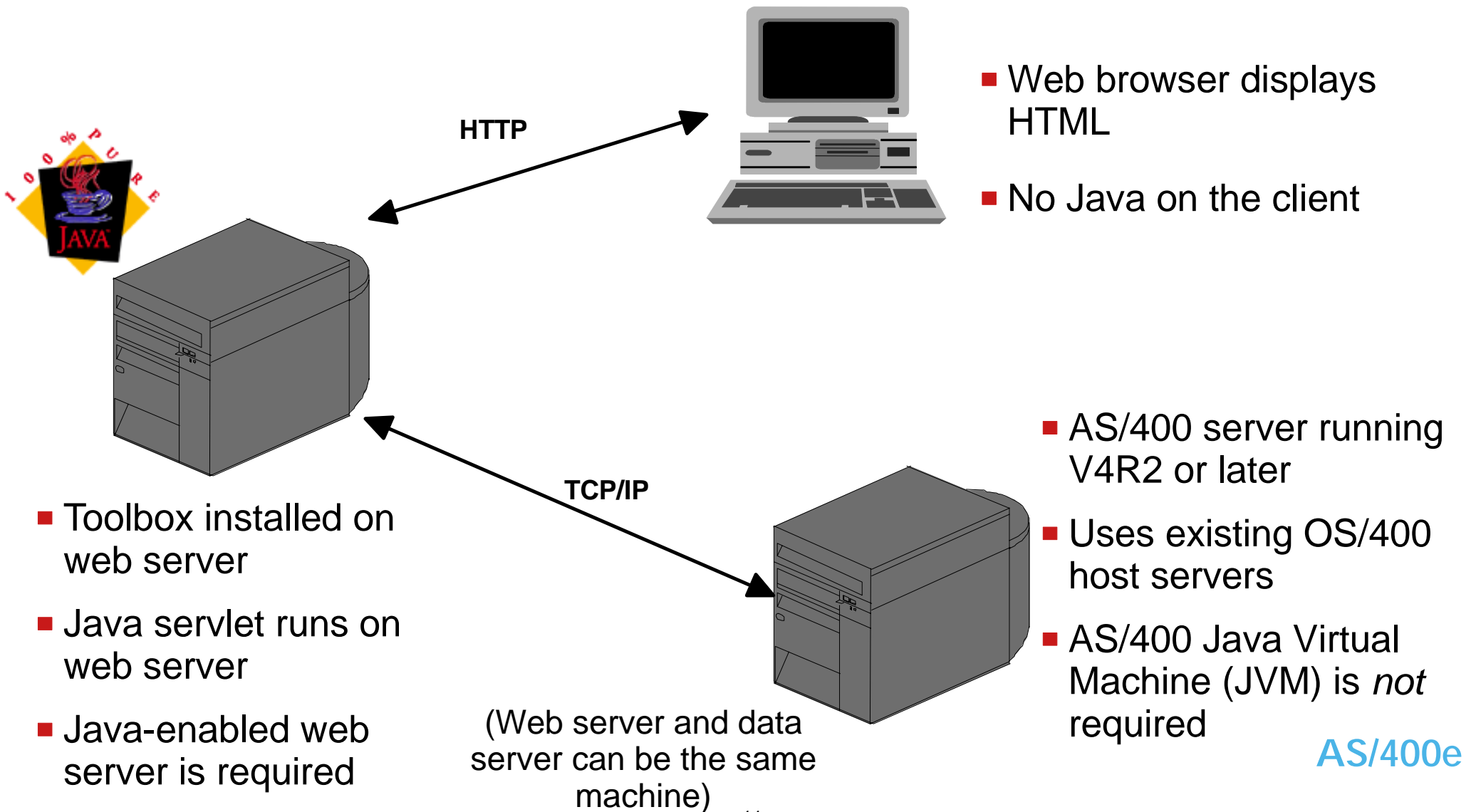
# AS/400 Toolbox for Java

## Using the Toolbox in Internet-based applets



# AS/400 Toolbox for Java

## Using the Toolbox in Internet-based servlets



# AS/400 Toolbox for Java

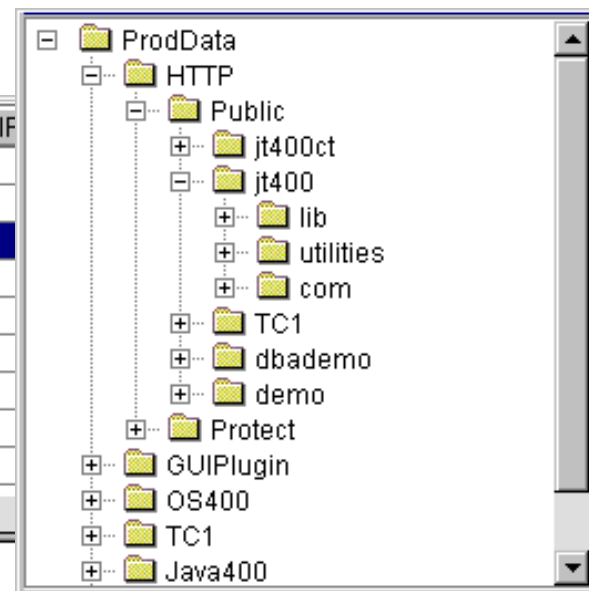
## Graphical user interface components

A set of Java GUI components which present AS/400 data and resources

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

Requires Swing 1.0.3 through Toolbox mod 2 (V4R4). Toolbox mod 3 (V4R5) requires Swing 1.1 via either the 1.1.x add-on or Java 2.

CUSNUM	LSTNAM	INIT	STREET	CITY	STATE	ZIP
938472	Henning	G K	4859 Elm Ave	Dallas	TX	
839283	Jones	B D	21B NW 135 St	Clay	NY	
392859	Vine	S S	PO Box 79	Broton	VT	
938485	Johnson	J A	3 Alpine Way	Helen	GA	
397267	Tyron	W E	13 Myrtle Dr	Hector	NY	
389572	Stevens	K L	208 Snow Pass	Denver	CO	
846283	Alison	J S	787 Lake Dr	Isle	MN	
475938	Doe	J W	59 Archer Rd	Sutter	CA	
693829	Thomas	A N	3 Dove Circle	Casper	WY	

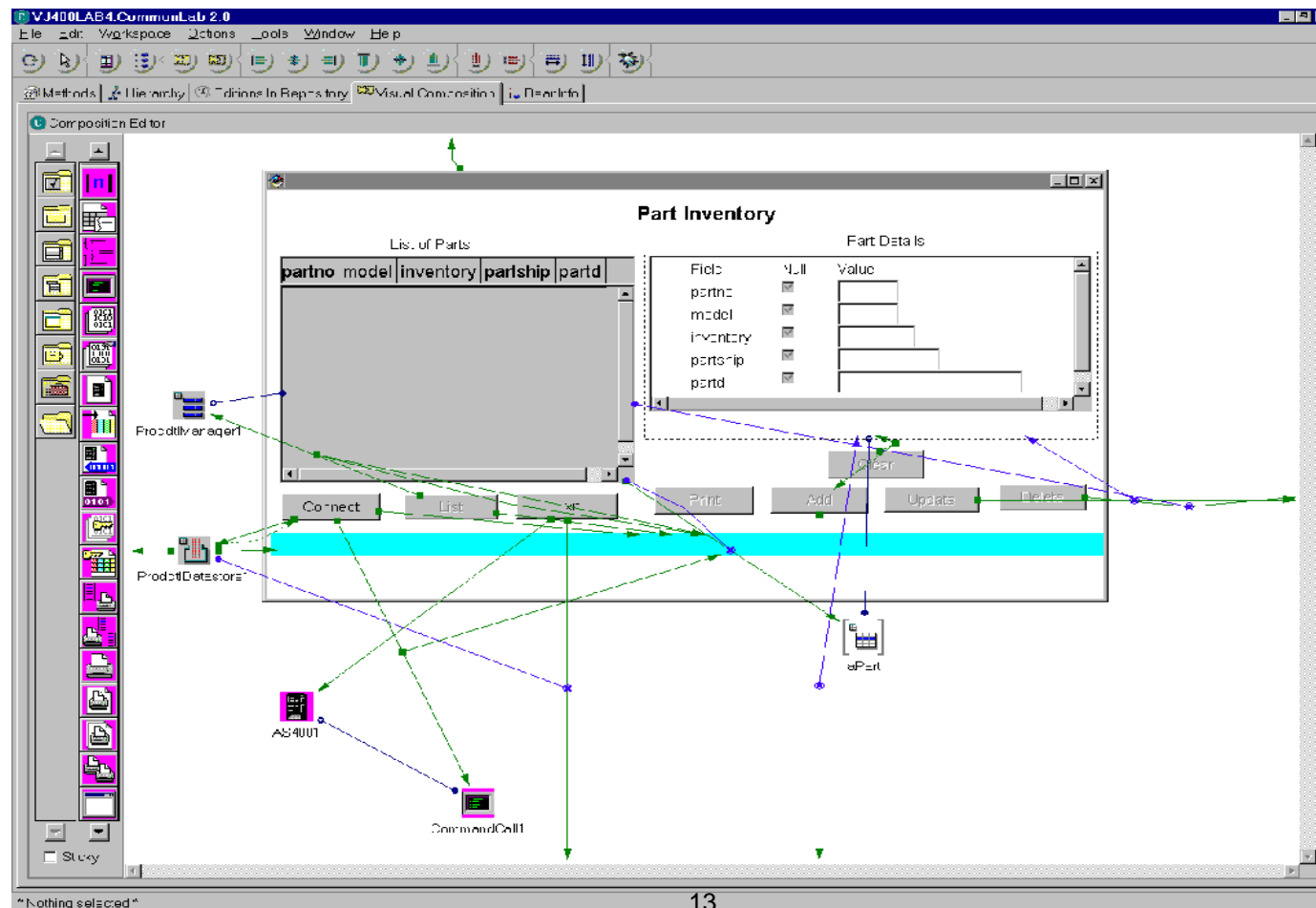


AS/400e

# AS/400 Toolbox for Java

## Visual development environments

Most Toolbox public classes are Java Beans. With visual development tools like VAJava, no coding necessary!



AS/400e

# *AS/400 Toolbox for Java*

## ***The details***

### **Certified 100% Pure Java**



- Supported platforms: AS/400, Linux, Windows, AIX, Solaris, OS/2, Netscape Communicator, Microsoft Internet Explorer

### **Requires Java 1.1.7 or greater, and now supports Java 2**

### **Divided into packages:**

- com.ibm.as400.access - APIs for accessing AS/400 data and resources
- com.ibm.as400.vaccess - GUI components
- com.ibm.as400.data - Program call markup language
- com.ibm.as400.ui.\* - Graphical Toolbox
- com.ibm.as400.util.\* - HTML and Servlet components
- utilities - utility classes such as AS400ToolboxInstaller and JarMaker

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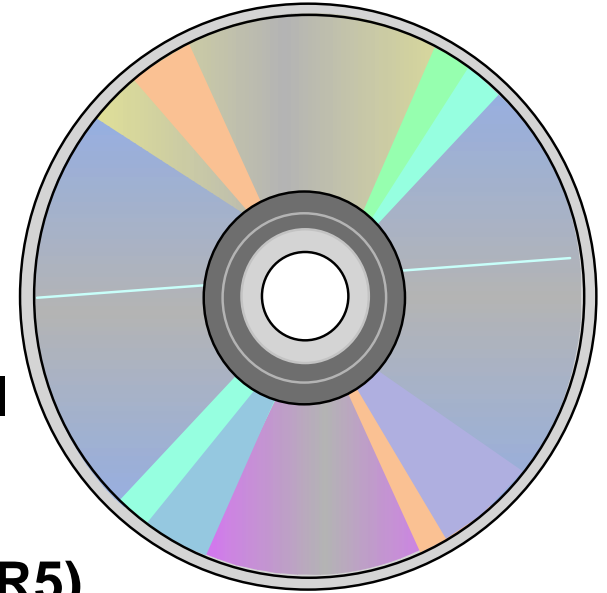
# *AS/400 Toolbox for Java*

## ***Packaging***

**Licensed program 5769JC1 (no additional charge)**

**Downloadable from Toolbox website (no additional charge)**

**Comes with OS/400 (modification 3 comes with V4R5)**



### **Jar and zip files:**

- jt400.jar, jt400.zip - Base function + GUI components
- jt400Access.zip - Base function only, intended for use on AS/400 JVM
- jt400Proxy.jar - Proxy support, subset of jt400.jar
- jt400Servlet.jar - HTML and Servlet components
- data400.jar - Program call markup language
- uitools.jar, jui400.jar, util400.jar, x4j400.jar - Graphical Toolbox

**Use AS400ToolboxJarMaker to reduce the size of jt400.jar**

**AS/400e**

## ***Access Classes: Low-level Java APIs to Access Data***

- User Authentication and Identification
- Command Call
- Data Area
- Data Description
- Data Conversion
- Data Queues
- IFS
- JDBC
- Jobs
- Messages
- Print
- Permissions
- Program Call
- Record-level Database Access
- System Status
- System Values
- Users and Groups
- User Space



New In Mod3:  
FTP  
Java Application Call  
Service Program Call



## ***"The AS400 object"***

**Represents a connection to the AS/400**

**Provides a sign-on GUI**

- Password caching available
- Change password GUI when appropriate

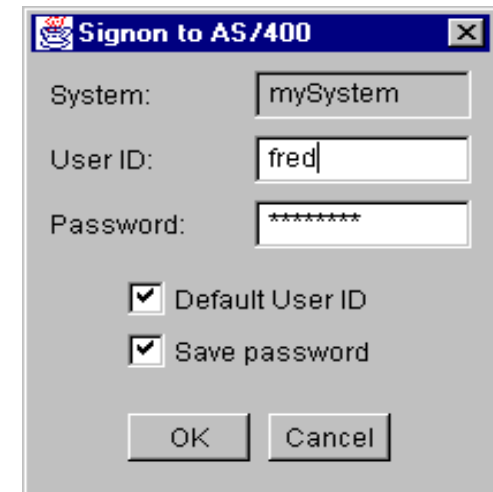
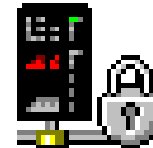
**Controls conversations with server jobs**

- 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***

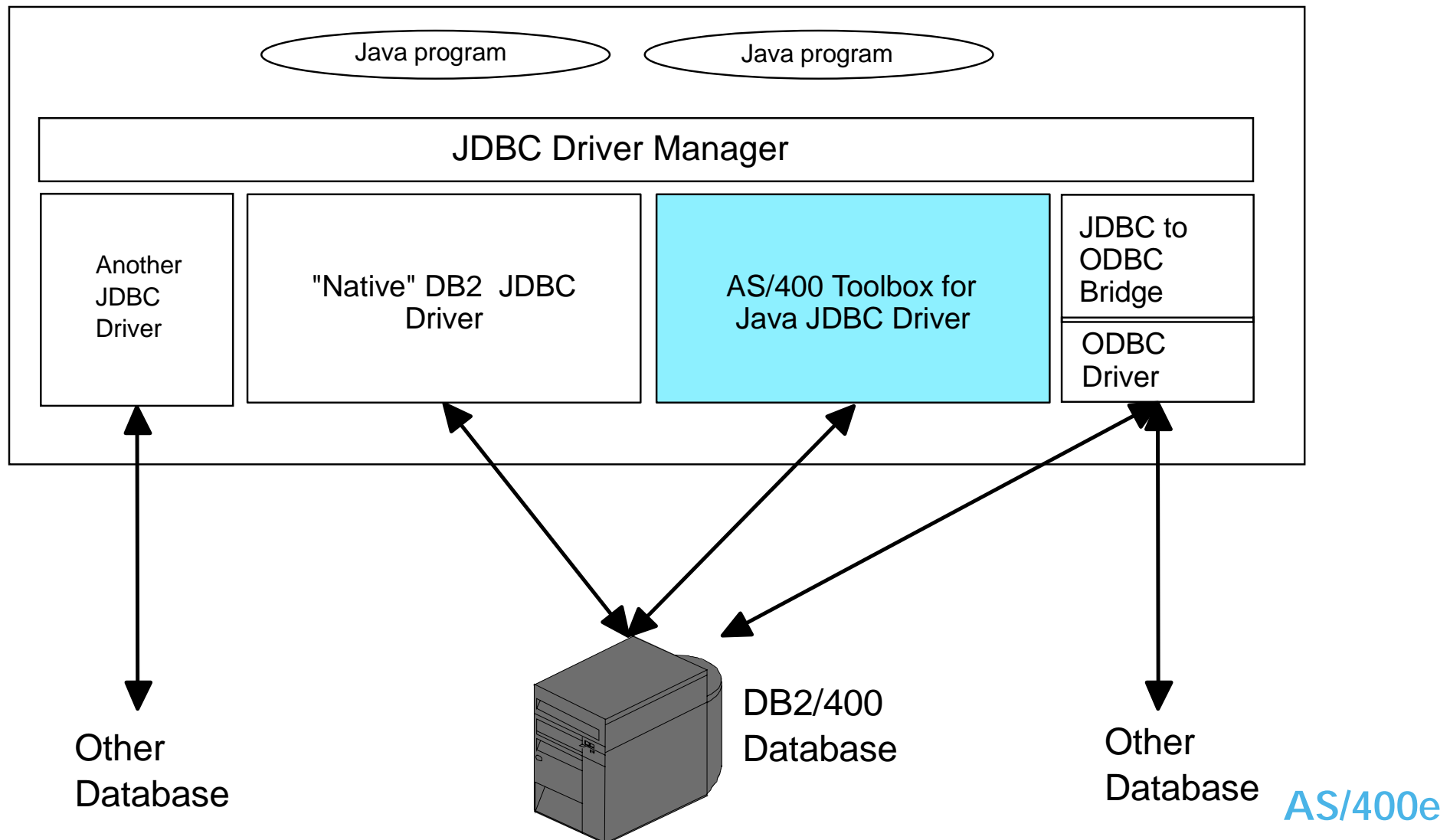


```
AS400 sys = new AS400();  
AS400 sys2 = new AS400("mySystem");  
AS400 sys3 = new AS400("mySystem",  
    "myUID", "myPWD);
```

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

# JDBC

## *The Java standard for SQL database access*



## AS/400 JDBC driver choices

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

- 100% Pure Java
- 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 AS/400

### 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 AS/400*

**Both support JDBC 2.0**

```
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));
```

## Graphical user interface components

CUSNUM	LSTNAM	INIT	STREET	CITY	STATE	ZIPCOD	CDTLMT
938472	Henning	G K	4859 Elm Ave	Dallas	TX	75217	500
839283	Jones	B D	21B NW 135 St	Clay	NY	13041	40
392859	Vine	S S	PO Box 79	Broton	VT	5046	70
938485	Johnson	J A	3 Alpine Way	Helen	GA	30545	999
397267	Tyron	W E	13 Myrtle Dr	Hector	NY	14841	100
389572	Stevens	K L	208 Snow Pass	Denver	CO	80226	40
846283	Alison	J S	787 Lake Dr	Isle	MN		
475938	Doe	J W	59 Archer Rd	Sutter	CA		
693829	Thomas	A N	3 Dove Circle	Casper	WY		

Record number: 1

CUSNUM

LSTNAM

INIT

STREET

CITY

STATE

ZIPCOD

CDTLMT

CHGCOD

BALDUE

CDTDUE

SQLQueryBuilderPane example

Catalog:

Schema	Table	Type	Description
QIWS	QAZDCOLM	TABLE	CATALOG - SYSCOLUMNS, C
QIWS	QAZDGCOL	TABLE	CATALOG - SYSCOLUMNS, C
QIWS	QAZDGTB1	TABLE	CATALOG - SYSTABLES, ALL
QIWS	QAZDGTB4	TABLE	CATALOG - SYSTABLES, ALL
QIWS	QAZDGTB5	TABLE	CATALOG - SYSTABLES, ALL
QIWS	QAZDGTB7	TABLE	CATALOG - SYSTABLES, ALL
QIWS	QAZDTBL1	TABLE	CATALOG - SYSTABLES, ALL
QIWS	QAZDTBL2	TABLE	CATALOG - SYSTABLES, PH
QIWS	QAZDTBL3	TABLE	CATALOG - SYSTABLES, PH
QIWS	QAZDTBL4	TABLE	CATALOG - SYSTABLES, PH
QIWS	QAZDTBL5	TABLE	CATALOG - SYSTABLES, PH

Tables

QIWS.QCUSTCDT

# *Record-level database access*

## ***Fast access to AS/400 database files***

### **Provides access to database files:**

- Access records sequentially, by record number, or by key
- Support for locking
- Support for transactions

### **Options for describing the record format:**

- Programmer can write the code
- Toolbox can retrieve the record format at development-time and generate Java source code
- Toolbox can retrieve the record format at run-time

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

# Record-level database access

## Graphical user interface components

Record number: 1

CUSNUM

LSTNAM

INIT

STREET

CITY

STATE

ZIPCOD

CDTLMT

CHGCOD

BALDUE

CDTDUE

CUSNUM	LSTNAM	INIT	STREET	CITY	STATE	ZIPCOD	CDTLMT
938472	Henning	G K	4859 Elm Ave	Dallas	TX	75217	5000
839283	Jones	B D	21B NW 135 St	Clay	NY	13041	4000
392859	Vine	S S	PO Box 79	Broton	VT	5046	7000
938485	Johnson	J A	3 Alpine Way	Helen	GA	30545	9999
397267	Tyron	W E	13 Myrtle Dr	Hector	NY	14841	1000
389572	Stevens	K L	208 Snow Pass	Denver	CO	80226	4000
846283	Alison	J S	787 Lake Dr	Isle	MN	56342	5000
475938	Doe	J W	59 Archer Rd	Sutter	CA	95685	7000
693829	Thomas	A N	3 Dove Circle	Casper	WY	82609	9999

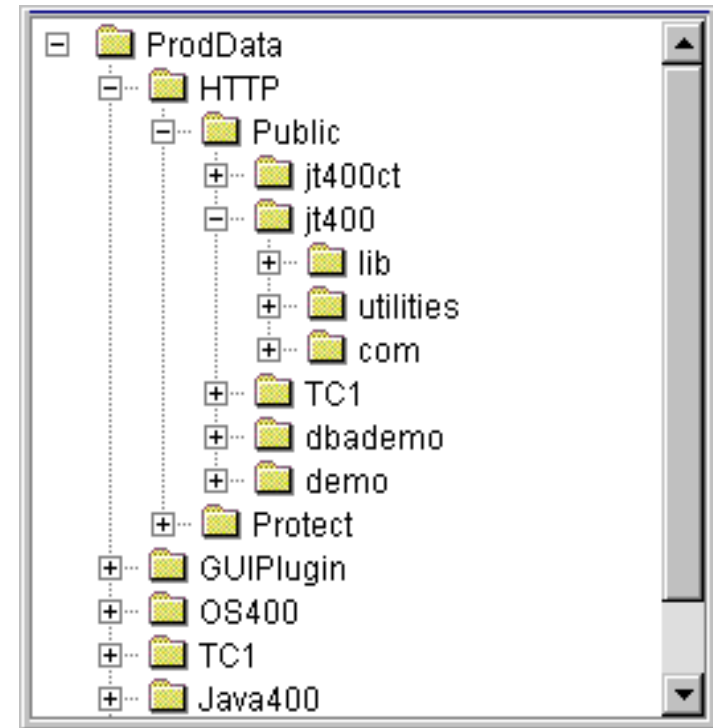
# *Integrated file system*

## *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");
```

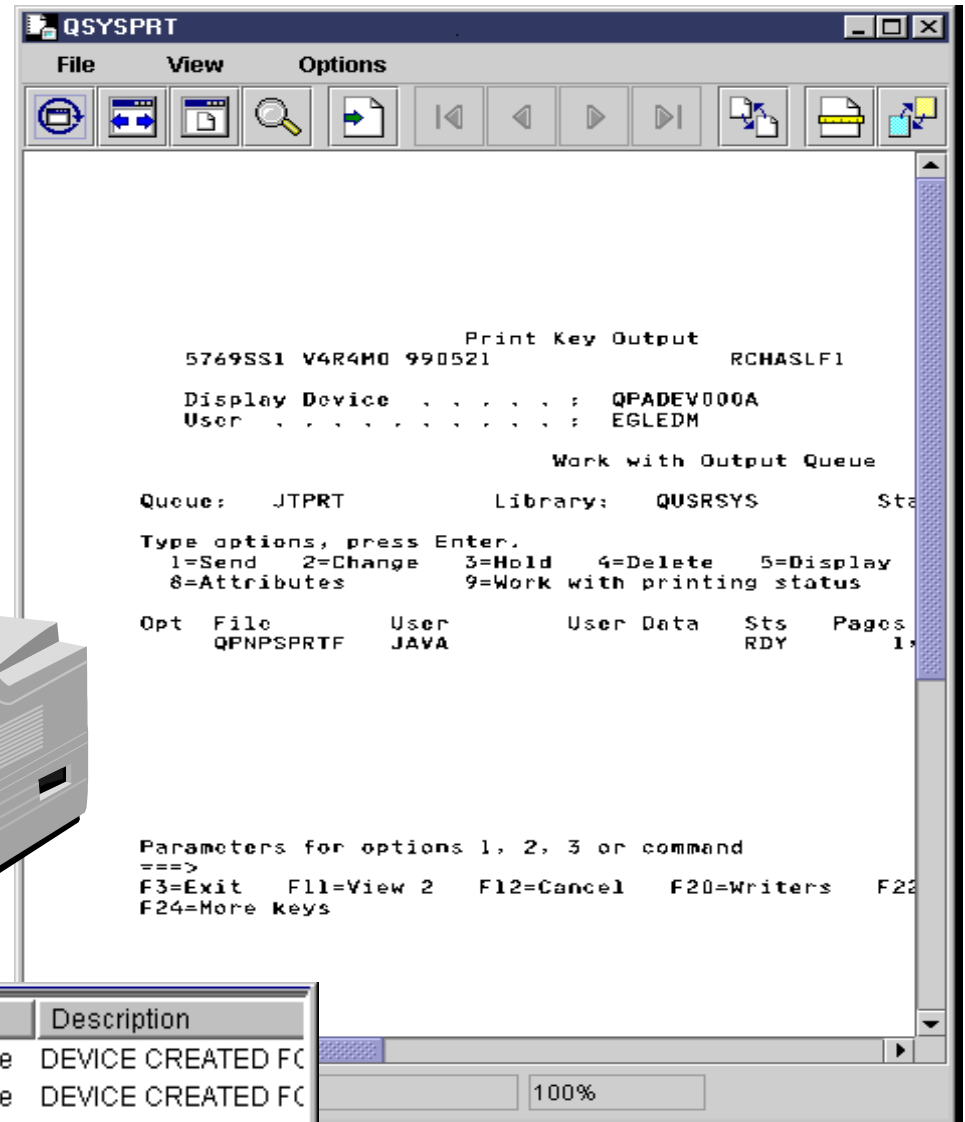
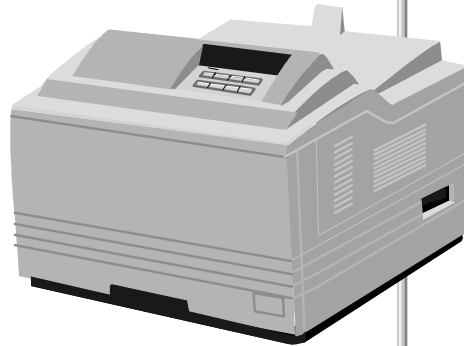


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# Network print

## 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



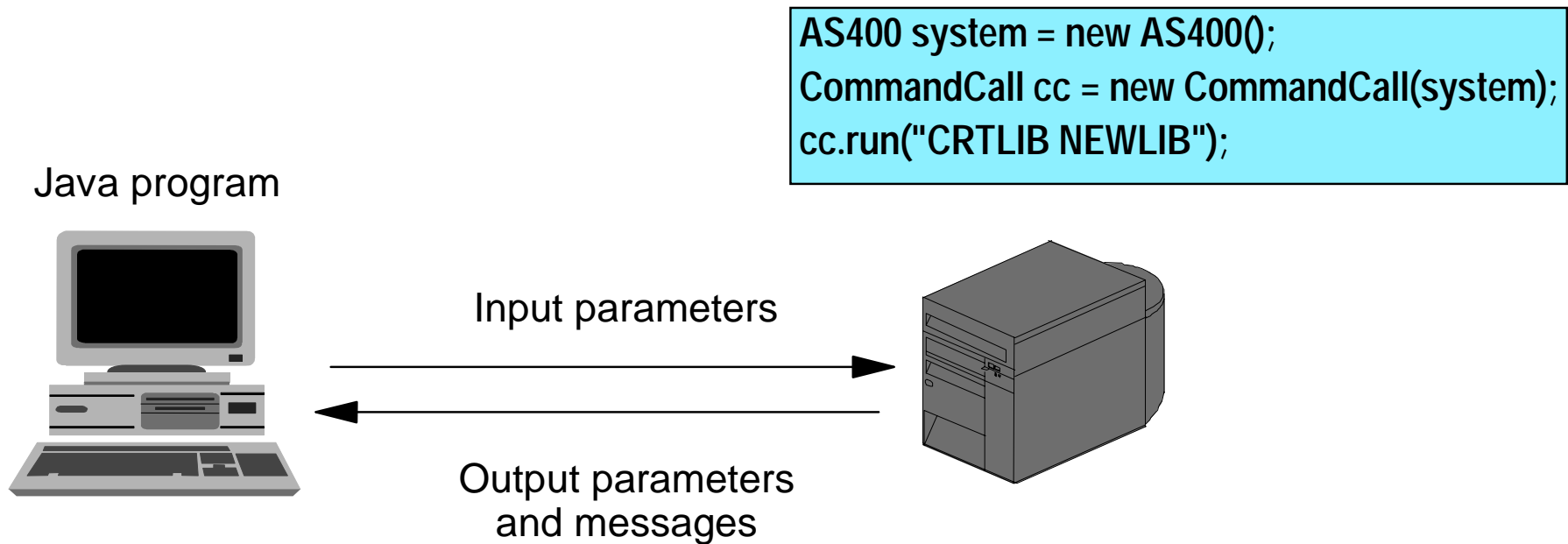
Printer	Status	Description
JAVABLDA	Powered off or not yet available	DEVICE CREATED FC
JAVABLDB	Powered off or not yet available	DEVICE CREATED FC
OS2VPRT	Stopped	DEVICE CREATED FC

AS/400e



# Command call and program call

## Make use of legacy code and system APIs



```
AS400 system = new AS400();  
ProgramParameter[] parmList = new ProgramParameter[n];  
parmList[0] = new ProgramParameter(data);  
...  
ProgramCall pc = new ProgramCall(system,  
    "/QSYS.LIB/MYLIB.LIB/MYPGM.PGM", parmList);  
pc.run();
```

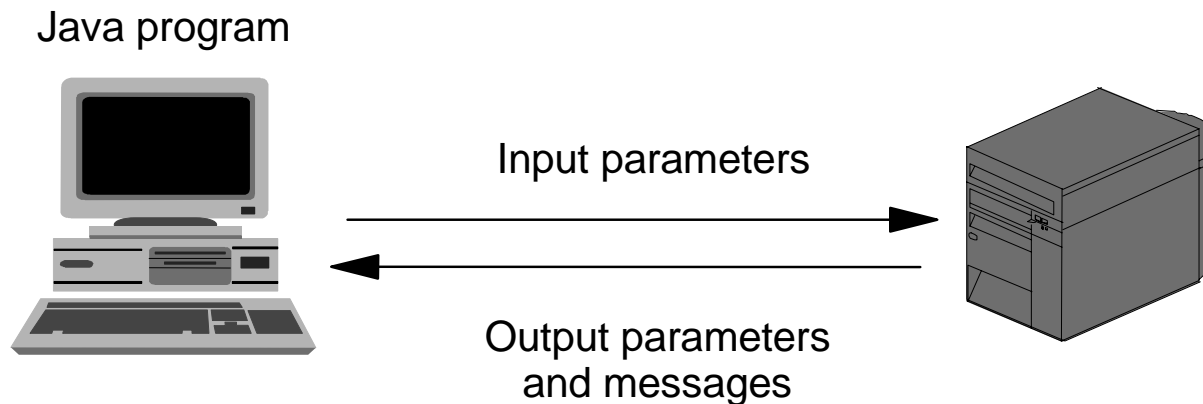
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# *Program Call Markup Language (PCML)*

***Describe program calls using XML***

**Automates program call parameter and structure definition**

**Simplifies data description and conversion**



```
<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>
```

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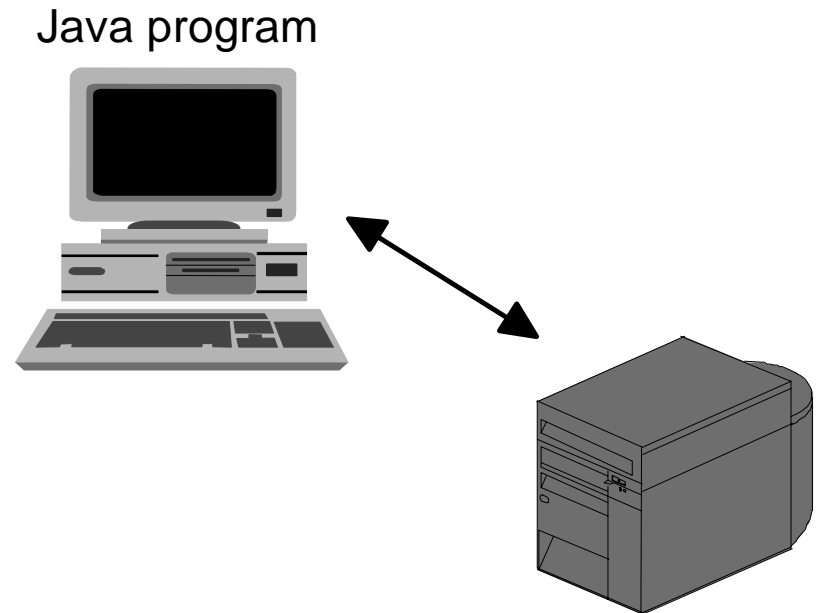
# Interprogram Communication

## *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 AS/400 program, on AS/400 or another client



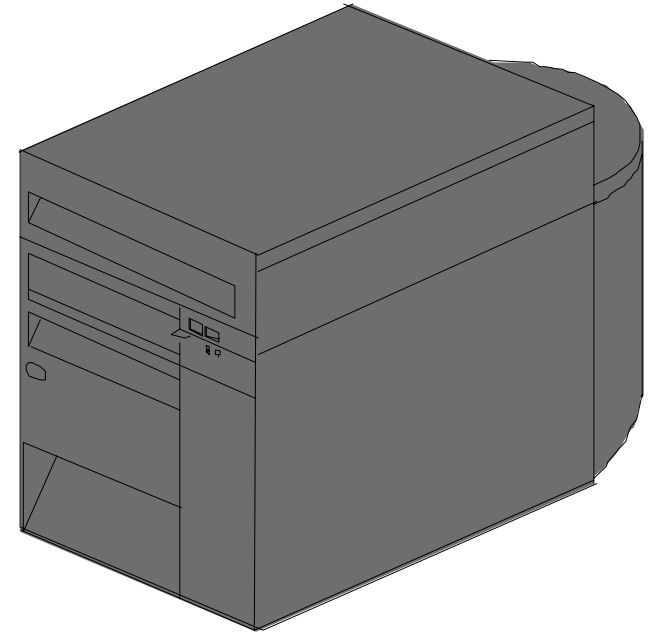
```
AS400 system = new AS400();  
UserSpace us = new UserSpace(system,  
    "/QSYS.LIB/MYLIB.LIB/MYDATA.USRSPC");  
byte[] data = new byte(1024);  
us.read(data, 0);
```

AS/400e

# AS/400 Objects

## ***Jobs, Users, System Values, ...***

- List AS/400 jobs
- List AS/400 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 AS/400 data***

<i>Java data type</i>		<i>AS/400 data type</i>
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

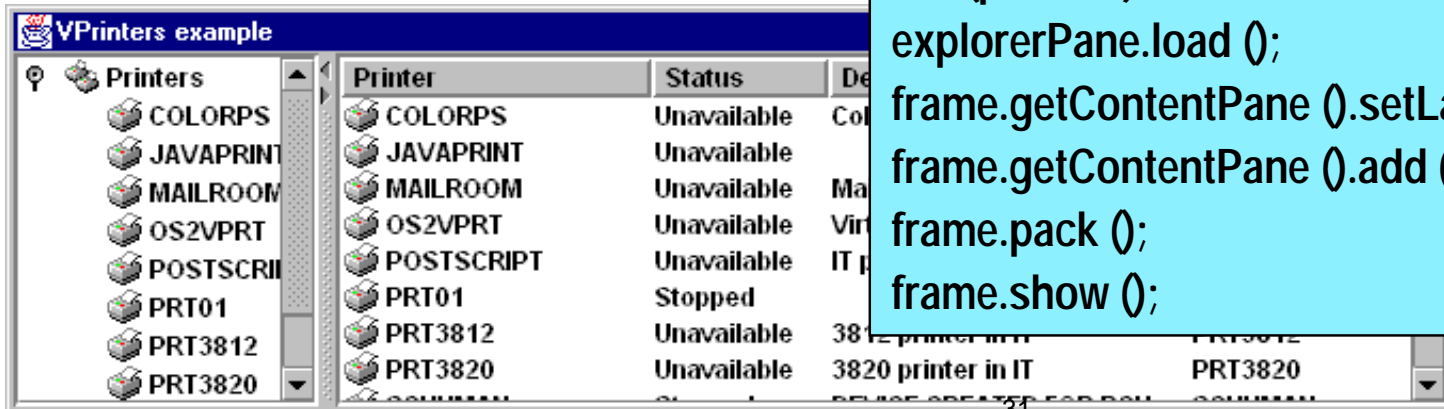
```
BinaryFieldDescription customerNumber = new BinaryFieldDescription(new AS400Bin4(),  
                                                                    "CUSTOMER_NUMBER");  
CharacterFieldDescription customerName = new CharacterFieldDescription  
    (new AS400Text(20, system), "CUSTOMER_NAME");  
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");
```

AS/400e

# GUI Classes

## Swing-based components to plug into your frame

- "vaccess" package
- Uses access classes to get data, then displays it in a Swing component
- List, details, explorer and tree views
- VIFSDirectory, VJob, VJobList, VMessageList, VMessageQueue, VPrinters, VUserList, and more



```
AS400 system = new AS400 ();
VPrinters printers = new VPrinters (system);
JFrame frame = new JFrame ("VPrinters example");
AS400ExplorerPane explorerPane = new AS400ExplorerPane
    (printers);
explorerPane.load ();
frame.getContentPane ().setLayout (new BorderLayout ());
frame.getContentPane ().add ("Center", explorerPane);
frame.pack ();
frame.show ();
```

## **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();

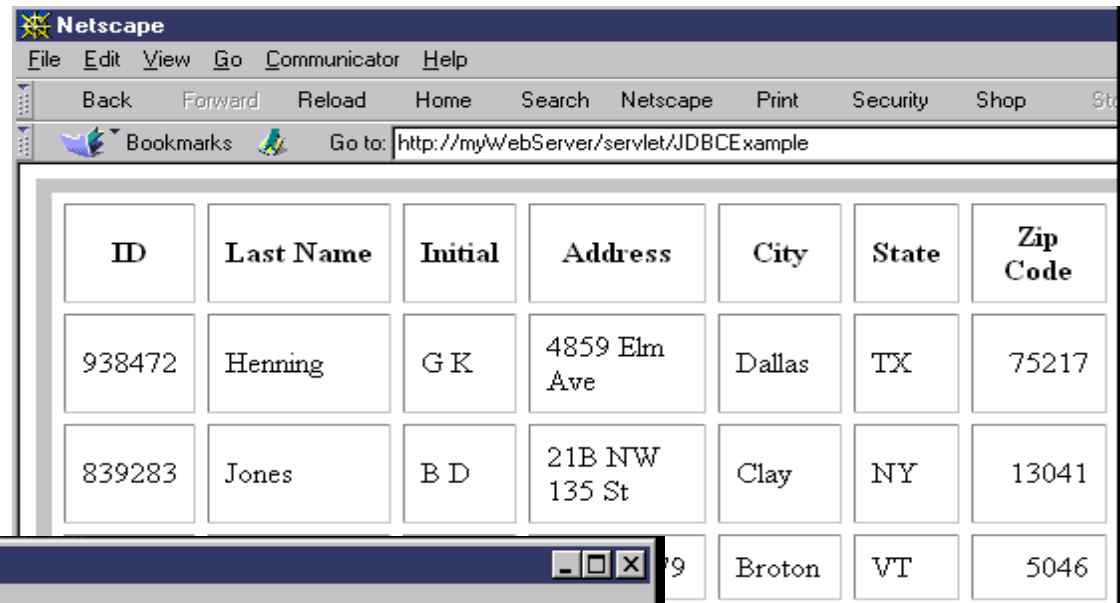
ResultSet resultSet = statement.getResultSet();
SQLResultSetRowData rowdata = new SQLResultSetRowData(resultSet);

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



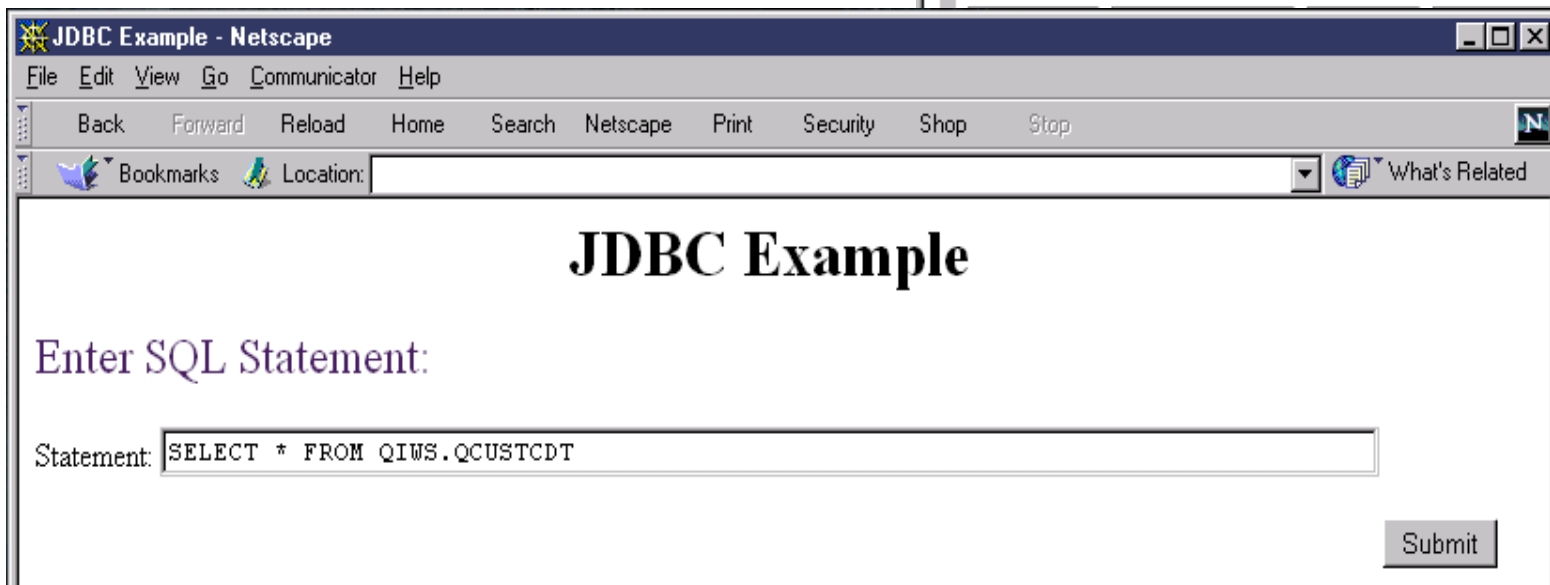
# HTML and Servlet classes

## Web components create tables and forms



A screenshot of a Netscape browser window. The title bar says "Netscape". The menu bar includes File, Edit, View, Go, Communicator, and Help. The toolbar has buttons for Back, Forward, Reload, Home, Search, Netscape, Print, Security, Shop, and Stop. The address bar shows "Go to: http://myWebServer/servlet/JDBCExample". The main content area displays a table with 7 columns: ID, Last Name, Initial, Address, City, State, and Zip Code. The table contains three rows of data.

ID	Last Name	Initial	Address	City	State	Zip Code
938472	Henning	G K	4859 Elm Ave	Dallas	TX	75217
839283	Jones	B D	21B NW 135 St	Clay	NY	13041



A screenshot of a Netscape browser window titled "JDBC Example - Netscape". The menu bar includes File, Edit, View, Go, Communicator, and Help. The toolbar has buttons for Back, Forward, Reload, Home, Search, Netscape, Print, Security, Shop, and Stop. The address bar shows "Location:". The main content area has the title "JDBC Example" and a label "Enter SQL Statement:". Below this is a text input field containing the SQL statement "SELECT \* FROM QIWS.QCUSTCDT". A "Submit" button is located at the bottom right of the form.

**JDBC Example**

Enter SQL Statement:

Statement:

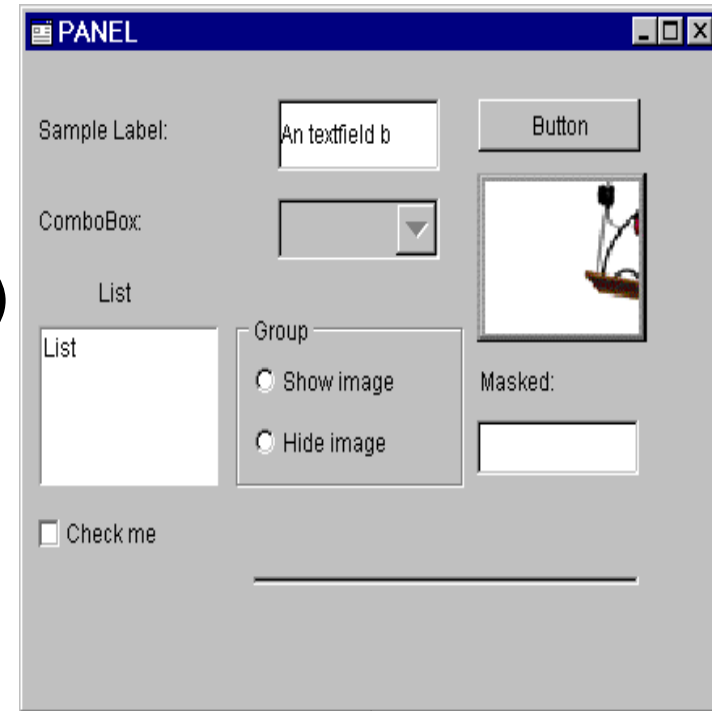
## *Describe GUI panels using XML*

### 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>
```

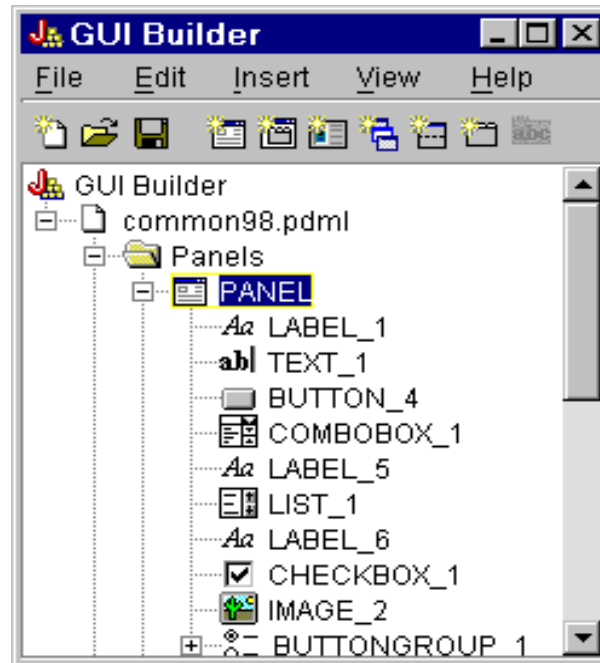
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# Graphical Toolbox

**GUI builder**

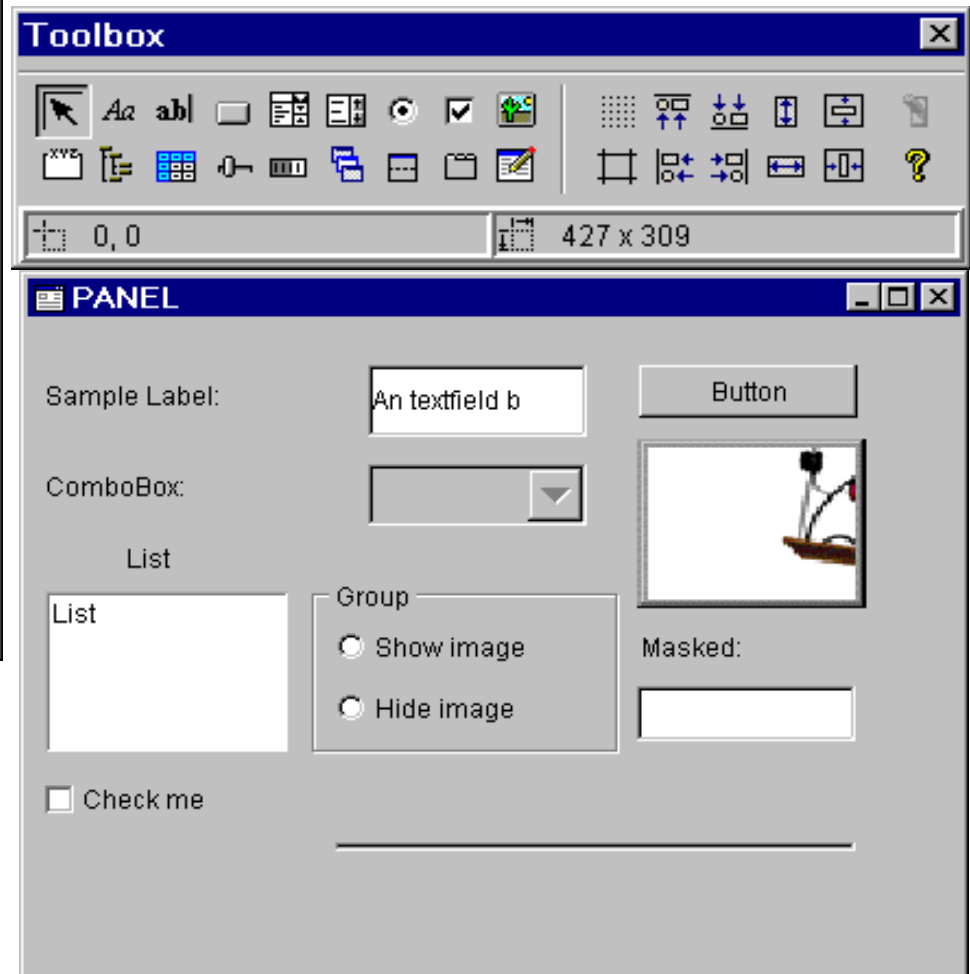
**WYSIWYG  
panel  
definition**

**Generates  
PDML code**



The screenshot shows the 'Properties' window for the selected 'PANEL'. It contains a table with the following data:

Property	Value
Element	PANEL
Name	PANEL
Title	Panel
Size	
Width	427
Height	309
Icon	
Activate	
Margins	
Top	18
Bottom	18
Left	18
Right	18
Grid	
Width	18
Height	18

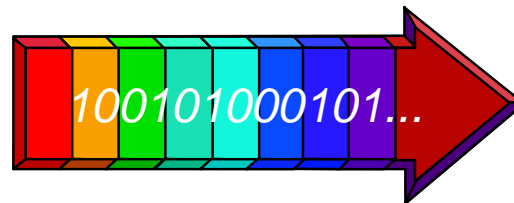
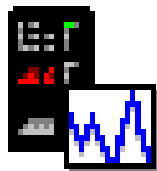
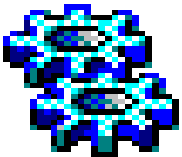
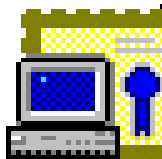


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# *Other components*

***The list keeps growing!***

- Digital certificates
- Installer
- JarMaker
- AS/400 Messages
- Message files
- System status
- HTML forms
- HTML tables
- Servlets
- System Properties



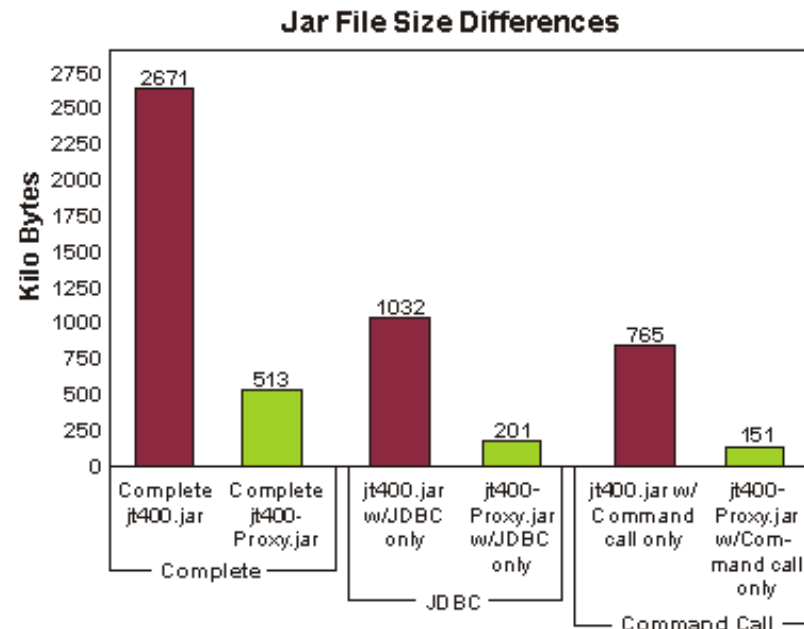
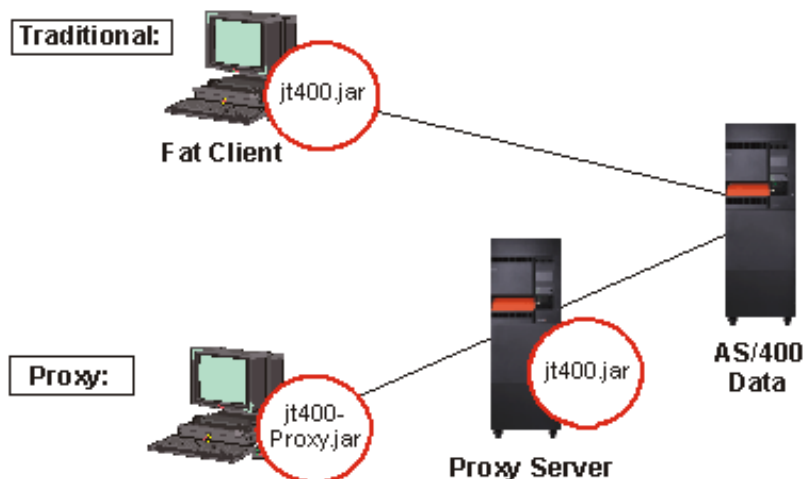
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# New in Modification 3

Now available at <http://www.ibm.com/as400/toolbox>

## Proxy Support

- Three-tier solution
- Set of lightweight classes runs on client
- Full set of Toolbox classes runs on middle-tier
- Full jt400Proxy.jar about 550KB (JDBC about 250 KB); full Toolbox jar about 2.5 MB



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# *New in Modification 3*

**Now available at <http://www.ibm.com/as400/toolbox>**

## **HTML and servlet classes**

- Set up HTML forms and tables from Java
- Quickly build servlets to access AS/400 data and resources

## **Other new classes**

- FTP (File transfer protocol)
- Service program call
- Remote Java application call



## **Plus**

- Java 2 officially supported
- GUIs now use Swing 1.1
- Linux Support
- Official JTOpen and Toolbox forum
  - Go to: <http://as400service.ibm.com/>
  - Select "Forums & Discussions", then "AS/400 Technology Forums"
  - then "JTOpen/Toolbox for Java Forum"

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# *JTOpen (Open Source)*

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**Much of the Toolbox code is open source - known as "JTOpen"**

***<http://www.ibm.com/developerworks/opensource>***

- Part of IBM's open source development community
- Use source as a debug tool
- Submit new function
- Modify source for your use
- Submit problem reports and bug fixes

## **Two versions of the Toolbox:**

- Licensed program
  - Only IBM developed code
  - Supported by IBM
- Open source version
  - Includes source from non-IBM contributors
  - Supported by open source community
  - New functions and fixes available first here!

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# Component list (part 1)

<b>Component</b>
AS400 object
AS400JPing/JPing ( <i>new in JTOpen</i> )
Authentication ( <i>com.ibm.as400.security.auth package</i> )
Command call
Connection pool ( <i>new in JTOpen</i> )
Data area
Data conversion
Data description
Data queue
Digital certificate
Environment variable ( <i>new in JTOpen</i> )
File Transfer Protocol (FTP)
Graphical Toolbox ( <i>com.ibm.as400.ui.* packages</i> )
GUI classes ( <i>com.ibm.as400.vaccess package</i> )
HTML classes ( <i>com.ibm.as400.util.html package</i> )

- **Components in *com.ibm.as400.access* package unless otherwise noted**
- ***JTOpen* refers to *JTOpen 2.0***



# Component list (part 2)

<b>Component</b>
Integrated file system (IFS)
JarMaker
Java application call
Java program information ( <i>new in JTOpen</i> )
JDBC
Job and job log
Message file
Message queue
NetServer ( <i>new in JTOpen</i> )
Permissions
Print
Product license ( <i>new in JTOpen</i> )

- **Components in com.ibm.as400.access package unless otherwise noted**
- **JTOpen refers to JTOpen 2.0**

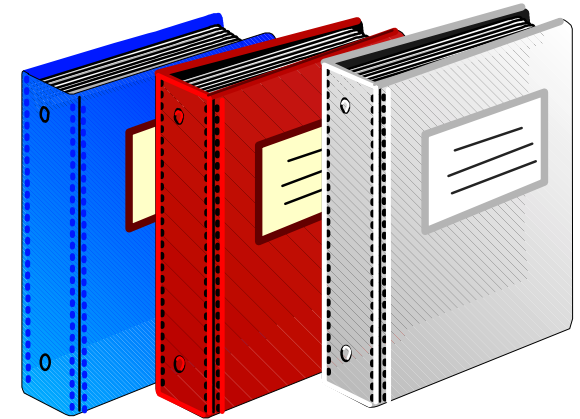
# Component list (part 3)

<b>Component</b>
Program call
Program Call Markup Language (PCML) ( <i>com.ibm.as400.data package</i> )
Proxy server
Record-level database access
Resource framework ( <i>com.ibm.as400.resource package</i> ) ( <i>new in JTOpen</i> )
Secure Sockets Layer (SSL)
Service program call
Servlet classes ( <i>com.ibm.as400.util.servlet package</i> )
Software resource ( <i>new in JTOpen</i> )
System pool
System status
System value
Toolbox installer
User and group
User space

- **Components in *com.ibm.as400.access* package unless otherwise noted**
- **JTOpen refers to JTOpen 2.0**

# References

## ***Where can I get more information?***



**<http://ibm.com/as400/toolbox>**

- News, downloads, FAQs, service packs, articles, COMMON labs

**<http://oss.software.ibm.com/developerworks/opensource/jt400/>**

- JTOpen - open source, bug reporting, feature requests

**<http://as400service.ibm.com/>**

- AS/400 Technical Forums - including AS/400 Toolbox for Java/JTOpen Forum

## ***AS/400 Toolbox for Java Programmers Guide***

- Shipped with the AS/400 Toolbox for Java
- Contains overview, full API documentation (javadoc), and code examples
- Available at AS/400 Information Center

## ***Building AS/400 Client/Server Applications with Java***

- Redbook SG24-2152-02

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