Java Database Connectivity with IBM i

SAP on IBM i Porting Team
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JDBC Interface - Java Database Connectivity

- Interface for the relational Database access from Java. The Interface covers the Java packages `java.sql` and `javax.sql`.
- JDBC is the basis for object-relational database entrances such as EJB, JPA, JDO, ...
- The so-called JDBC API version determines the power of the interface and is directly coupled to the JVM/JDK version:
  - JDK 1.4 → JDBC 3.0 → SAP Basis Release 6.40 and 7.0x
  - JDK 5.0 → JDBC 3.0 → SAP Basis Release 7.10 and 7.11
  - JDK 6.0 → JDBC 4.0 → SAP Basis Release >= 7.20
- Implementation of this interface, the JDBC Driver, is typically coming from database manufactures but it could also come from third party distributors.
- The idea behind: Besides establishing the connection, which is configurable, programming is relatively “driver independent against the JDBC interface”.
  → Open SQL for Java
JDBC on IBM i

- IBM offers three JDBC drivers for the access to IBM i: „IBM Toolbox for Java / JTOpen“, „IBM Native JDBC Driver“, „IBM JCC“
- Third party distributors offer additional drivers, for example „HiT JDBC/400“
- Toolbox and Native Driver are built and maintained by IBM Rochester. The drivers are optimised for IBM i. SAP on IBM i supports Toolbox and Native JDBC Driver.
  - **Toolbox / JTOpen** is a type 4 driver, this means that the client side is composed 100% out of Java (and it uses TCP/IP for the connection to the database server)
  - **Native Driver** is a so-called type 2 driver, this means it uses native operating system parts for performance optimization on the client side.
    - Only applicable, when the client also uses IBM i as the operating system
    - Restrictions with Configtool ([SAP Note 657117](https://support.sap.com.sap/note/657117))
  - That happens usually with 2-tier SAP installations
    - Restriction on such scenarios without validation of DRDA
(De-)Motivation:
- According to experience from the last 10 years: Java performance is not dominated by database access.
- Not released for SAP JVM
- Already mentioned limitation to 2-tier IBM i scenarios

Consequence: Gradual elimination of support
- There has never been support for such SAP releases that run with SAP JVM 5 and higher. That means products based on SAP basis release 7.1 and higher.
- Discontinuation of the Native Driver for old releases with migration to SAP JVM 1.4.
- No support for EHPI installations with target 7.0x, since EHPI is itself using SAP JVM.

We recommend that you change your driver soon!
Driver Portrait: Toolbox / JTOpen
IBM Toolbox for Java

• It is delivered as a license program and already patched.
  • Until V6R1: 57xxJC1 ("IBM Toolbox for Java")
  • From IBM 7.1: 57xxSS1, Option 3 ("Extended Base Directory Support")
• The JDBC 3.0 version:
  /QIBM/ProdData/HTTP/Public/jt400/lib/jt400.jar
• The JDBC 4.0 version:
  /QIBM/ProdData/HTTP/Public/jt400/lib/java6/jt400.jar

→ Caution: Identical Naming!

• The current IBM patch strategy: The driver is identical for all the IBM i releases that are in maintenance at the release time for the patch.
• The driver is able to connect downward-compatible to all IBM i releases supported by IBM currently.
JTOpen is the code identical open source version of the IBM Toolbox

Download from http://jt400.sourceforge.net/

Full IBM support
Driver Portrait: Toolbox / JTOpen

JTOpen

- JDBC 3.0 version: 
  `jtopen_x_y.zip` (Default)
- JDBC 4.0 version: 
  `jtopen_x_y_jdbc40_jdk6.zip`
For SAP basis release >= 7.0 is valid: SAP installations including dialog instances use by standard the driver under 
/QFileSvr.400/<SAPGLOBALHOST>/sapmnt/<SID>/SYS/jdbc/tbx/jt400.jar
SAPinst stores there a physical instance of the driver.
In SAP basis release 6.40 Windows dialog instances use local copies.

→ Also when the Toolbox is used, the PTF process is not enough!

Tip: Replacing of the driver by a symbolic link on the PTF location on <SAPGLOBALHOST>:

ADDLNK OBJ('<driver_path>/jt400.jar')
NEWLNK('<SAPGLOBALHOST_path>/jt400.jar')
Driver Portrait: Toolbox / JTOpen
Determination of the Driver Version

- You determine the driver version in the following way from a shell:
  
  ```
  java -classpath /usr/sap/<sid>/sys/jdbc/tbx/jt400.jar
  utilities.AboutToolbox
  
  IBM Toolbox for Java:
  Open Source Software, JTOpen 7.3, codebase 5770-SS1 V7R1M0.03 2011/01/14 @B5
  Supports JDBC version 3.0
  Toolbox driver version 9.4
  
  For newer SAP JEE patch levels, the driver version is described also in the
  console log of the bootstrap
  (/usr/sap/<sid>/<inst>/work/jvm_bootstrap.out)
  (For more information, see SAP Note 1164640).

  SAP Note 654800, section 22 („Special notes about
  individual driver versions”) lists known driver problems.
Driver Portrait: Toolbox / JTOpen
Configuration Using URL

- Three configuration parts:
  - Driver file: /usr/sap/<sid>/sys/jdbc/tbx/jt400.jar
  - Driver class: com.ibm.as400.access.AS400JDBCDriver
  - URL: jdbc:as400://<Database_Host>;<Parameter (also iASP Info)>

- What happens?
  - JVM is asked to load the driver class. It therefore searches all files in the class path for it:
    
    ```java
    Class.forName("com.ibm.as400.access.AS400JDBCDriver");
    ```
  
  - While the connection is being established, the DriverManager class of the JVM searches for a driver class which fits to the URL and asks it to establish a connection to the given target:
    
    ```java
    java.sql.Connection con
    = java.sql.DriverManager.getConnection(<url>, <user>, <pwd>);
    ```
SAP JEE uses the already introduced URL method to establish a pool of physical database connections.

The configuration of the **driver class** and **entrance data** (URL, user, password) takes place centrally in the Secure Store, accessible via the ConfigTool.

List of the current parameters:

**SAP Note 654800**
Which driver file is to be loaded, is configured in various, different places depending on the SAP release.

In the Configurations Editor per instance:
- Bootstrap
- Server
- Dispatcher

In addition:
- SDM
- SAP Profil
- ConfigTool
- …
Help, I Must Change My JDBC Driver!
CONFIGJVM SCOPE(*JDBC)

- The exchanging of an existing Toolbox Driver by a new version, also a JDBC API version, is simple, since all configuration parameters stay the same.
- Changing from Native Driver to Toolbox (or reverse) is however complicated and error-prone.
- In order to avoid errors caused by the conversion, CONFIGJVM is expanded for this task for SAP releases 6.40 to 7.02. SAP Note 826449 describes the manual procedure and also the functions of this tool.
Help, I Must Change My JDBC Driver!
CONFIGJVM SCOPE(*JDBC), Example

• Prerequisites:
  • The SAP system complies to the prerequisites mentioned in SAP Note 1161275 to run CONFIGJVM SCOPE(*JDBC).
  • Current patch level for CONFIGJVM, ILE, and/or J2EEKRN are present.
  • The driver to be used in the future is found in /usr/sap/<sid>/jdbc/tbx.

• Preview:

  CONFIGJVM SCOPE(*JDBC) ACTION(*PREVIEW) DRIVER(*TBX)

  ➔ From the log file configJVM__<dd>_<mm>_<yy>__<hh>_<mm>.log in the directory /usr/sap/<sid>/<inst>/j2ee/configjvm/log, the necessary changes for the respective instance can be reconstructed.
Help, I Must Change My JDBC Driver!

CONFIGJVM SCOPE(*JDBC), Example

• Conversion:
  • Shut down SAP JEE
  • Call
    CONFIGJVM SCOPE(*JDBC) ACTION(*APPLY) DRIVER(*TBX)

→ Original configuration is exported pro instance to
  /usr/sap/<sid>/<inst>/j2ee/configjvm/store and can be restored again later using the following command:

    CONFIGJVM SCOPE(*JDBC) ACTION(*RESTORE)
    DATETIME('__<dd>_<mm>_<yy>_<hh>_<mm>')

• Perhaps the following configuration files must be manually adjusted, because they do not get saved in the database:
  /usr/sap/<sid>/<inst>/j2ee/cluster/instance.properties
  /usr/sap/<sid>/<inst>/j2ee/cluster/instance.properties.vmprops
Help, I Must Change My JDBC Driver!
What Can Go Wrong

- `java.sql.SQLException`: No suitable driver

Secure Store contains inconsistent data: The given driver class is found in the classpath, but does not correspond to the indicated URL.

- `java.lang.ClassNotFoundException`: com.ibm.as400.access.AS400JDBCDriver

`jt400.jar` could not be found in the classpath. Possible causes:
  - After switching from the Native Driver to Toolbox, someone forgot to adjust the classpath to `jt400.jar`
  - `jt400.jar` no longer exists under the indicated position in the classpath.
SAP JEE Connection Pool

- SAP JEE used the already introduced URL method to establish a pool of physical database connections. JEE applications may then logically request such a connection without the necessity to open a physical connection.

- To view the settings of the connection pools, do the following:
  - < 7.10: Visual Administrator
    → <Server Nodes>
    → JDBC Connector
  - >= 7.10: NetWeaver Administrator (http://<host>:5<inst>00/nwa)
    → Configuration Management
    → Infrastructure
    → Application Resources

- Changes happen via the *dbpool service* of the ConfigTool.
Driver Portrait: Toolbox / JTOpen
SAP JEE Connection Pool
Driver Portrait: Toolbox / JTOpen

SAP JEE Connection Pool
Driver Portrait: Toolbox / JTOpen
IBM i Connection Pooling

- Toolbox / JTOpen uses on the database side the so-called Host Server component.
- Associated jobs are called by standard QZDASOINIT and run in the subsystem QUSRWRK. As they are prestarted jobs, they can be configured as such, although that is not necessary. At least for applications, which use the pooling of the SAP JEE server.
- Changing the defaults: `CHGPJE SBSD(QUSRWRK) PGM(QZDASOINIT)`
SAP offers a set of analysis tools for database performance and database problems regarding Open SQL applications, similar to ABAP:

- SAP basis release < 7.10:
  
  http://<Host>:5<Instanz_Nr>00/OpenSQLMonitors/index.html

- From basis release 7.10:
  
  http://<Host>:5<Instanz_Nr>00/nwa
  → Problem Management → Database → Open SQL Monitors

**Tools:**

- Connection Monitor – *SQL statements in cache and cache hit ratio*
- Open SQL Statistics – *Performance statistics for SQL statements*
- SQL Trace – *Equivalent for ST05*
- Table Statistics Monitor – *Modifications by table*
- ...

**Monitoring:** Central out of the ABAP DBA Cockpit (for example Solution Manager)