Legal Notice

For information about NetIQ trademarks, see https://www.netiq.com/company/legal/.

Copyright (C) 2018 NetIQ Corporation. All rights reserved.
# Contents

<table>
<thead>
<tr>
<th>Topic</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>About this Book and the Library</strong></td>
<td>11</td>
</tr>
<tr>
<td><strong>About NetIQ Corporation</strong></td>
<td>13</td>
</tr>
<tr>
<td><strong>1 Understanding the Identity Manager Driver for JDBC</strong></td>
<td>15</td>
</tr>
<tr>
<td>Components for Data Synchronization</td>
<td>15</td>
</tr>
<tr>
<td>JDBC</td>
<td>15</td>
</tr>
<tr>
<td>Third-Party JDBC Driver</td>
<td>16</td>
</tr>
<tr>
<td>Identity Vault</td>
<td>16</td>
</tr>
<tr>
<td>Schema</td>
<td>16</td>
</tr>
<tr>
<td>Logical Database Class</td>
<td>17</td>
</tr>
<tr>
<td>XDS</td>
<td>17</td>
</tr>
<tr>
<td>Database Concepts</td>
<td>17</td>
</tr>
<tr>
<td>Structured Query Language</td>
<td>18</td>
</tr>
<tr>
<td>Data Manipulation Language</td>
<td>18</td>
</tr>
<tr>
<td>Data Definition Language</td>
<td>18</td>
</tr>
<tr>
<td>View</td>
<td>18</td>
</tr>
<tr>
<td>Identity Columns/Sequences</td>
<td>19</td>
</tr>
<tr>
<td>Transaction</td>
<td>19</td>
</tr>
<tr>
<td>Stored Procedures or Functions</td>
<td>20</td>
</tr>
<tr>
<td>Trigger</td>
<td>20</td>
</tr>
<tr>
<td>Instead-Of-Trigger</td>
<td>21</td>
</tr>
<tr>
<td>How the Driver Works</td>
<td>22</td>
</tr>
<tr>
<td>Generic JDBC Driver</td>
<td>22</td>
</tr>
<tr>
<td>Supported Operations</td>
<td>23</td>
</tr>
<tr>
<td>Supported Databases</td>
<td>23</td>
</tr>
<tr>
<td>Supported Third Party JDBC Drivers</td>
<td>23</td>
</tr>
<tr>
<td>Support for Password Synchronization</td>
<td>23</td>
</tr>
<tr>
<td>Supported Data Synchronization Models</td>
<td>23</td>
</tr>
<tr>
<td>Triggerless vs. Triggered Publication</td>
<td>25</td>
</tr>
<tr>
<td>Planning to Install the Driver</td>
<td>26</td>
</tr>
<tr>
<td>Installation Requirements</td>
<td>26</td>
</tr>
<tr>
<td>Options for Installing the Driver Shim</td>
<td>26</td>
</tr>
<tr>
<td><strong>2 Installing the Driver Files</strong></td>
<td>29</td>
</tr>
<tr>
<td>Installing the Driver Files</td>
<td>29</td>
</tr>
<tr>
<td>Installing JDBC Driver Jar Files</td>
<td>29</td>
</tr>
<tr>
<td><strong>3 The Association Utility</strong></td>
<td>31</td>
</tr>
<tr>
<td>Independent Operations</td>
<td>31</td>
</tr>
<tr>
<td>Before You Begin</td>
<td>32</td>
</tr>
<tr>
<td>Using the Association Utility</td>
<td>32</td>
</tr>
<tr>
<td>Parameters for Searching and Replacing</td>
<td>33</td>
</tr>
<tr>
<td><strong>4 Installing and Configuring Database Objects</strong></td>
<td>35</td>
</tr>
<tr>
<td>SQL Script Conventions</td>
<td>35</td>
</tr>
<tr>
<td>Installing IBM DB2 Universal Database (UDB)</td>
<td>37</td>
</tr>
<tr>
<td>Installing Informix Dynamic Server (IDS)</td>
<td>37</td>
</tr>
</tbody>
</table>
# Contents

Working with MapDB 3.0.5 ................................................................. 98
Understanding Identity Manager 4.7 Engine Support for Driver Versions .... 98
Manually Removing the MapDB Cache Files .................................... 98
Considerations for Upgrading the Driver With Different Identity Manager and MapDB Versions .... 98
Upgrading the Driver ....................................................................... 99

8 Managing the Driver .................................................................. 103

9 Schema Mapping ...................................................................... 105

High-Level View .......................................................................... 105
Logical Database Classes ............................................................... 105
Indirect Synchronization ................................................................. 105

- Mapping eDirectory Classes to Logical Database Classes .............. 106
- Parent Tables ........................................................................... 108
- Parent Table Columns ............................................................... 108
- Child Tables ............................................................................ 109
- Referential Attributes ................................................................ 110
- Single-Value Referential Attributes .......................................... 110
- Multivalue Referential Attributes .............................................. 111

Direct Synchronization ................................................................ 112

- View Column Meta-Identifiers .................................................. 113
- Primary Key Columns ............................................................... 115
- Schema Mapping ..................................................................... 115
- Synchronizing Primary Key Columns ........................................ 116
- Synchronizing Multiple Classes ............................................... 116
- Mapping Multivalue Attributes to Single-Value Database Fields .... 116

10 Mapping XDS Events to SQL Statements .................................... 119

- Mapping XDS Events for Indirect Synchronization ...................... 119
- Mapping XDS Events for Direct Synchronization ....................... 119

11 The Event Log Table ................................................................ 121

- Event Log Columns .................................................................. 121
  record_id ............................................................................. 121
  table_key ............................................................................ 121
  status ................................................................................. 122
  event_type ........................................................................... 122
  event_time ........................................................................... 123
  perpetrator ......................................................................... 123
  table_name ......................................................................... 123
  column_name ...................................................................... 123
  old_value ............................................................................ 123
  new_value ........................................................................... 124

- Event Types ............................................................................ 124

12 Embedded SQL Statements in XDS Events ................................. 133

- Common Uses of Embedded SQL ............................................. 134
- Embedded SQL Basics ............................................................. 134
13 Supported Databases

Database Interoperability ................................................. 157
Supported Databases .................................................. 157
Database Characteristics ............................................... 158
  Database Features ..................................................... 158
  Current Time Stamp Statements ................................. 159
  Syntaxes for Calling Stored Procedures and Functions .... 160
  Left Outer Join Operators ........................................ 160
  Undelimited Identifier Case Sensitivity ....................... 161
  Supported Transaction Isolation Levels ....................... 161
  Commit Keywords .................................................. 162
  IBM DB2 Universal Database (UDB) ............................. 162
  Informix Dynamic Server (IDS) .................................. 163
  Microsoft SQL Server .............................................. 164
  MySQL/MariaDB ..................................................... 165
  Oracle ............................................................. 166
  PostgreSQL .......................................................... 167
  Sybase Adaptive Server Enterprise (ASE) ..................... 167

14 Third-Party JDBC Drivers ............................................ 169

Third-Party JDBC Driver Interoperability ......................... 169
Third-Party JDBC Driver Types ....................................... 169
  Driver Types ....................................................... 169
  Which Type To Use? ................................................ 170
Supported Third-Party JDBC Drivers (Recommended) ............. 170
  Third-Party JDBC Driver Features ............................. 171
  JDBC URL Syntaxes ............................................... 171
  JDBC Driver Class Names ........................................ 171
  Supported Third-Party Jar File Placement ..................... 172
  IBM DB2 Universal Database Type 4 JDBC Driver ............ 172
  Informix JDBC Driver .............................................. 174
  Microsoft JDBC Driver for SQL Server ....................... 175
  jTDS JDBC Driver .................................................. 176
  MySQL Connector/J JDBC Driver ............................... 178
  Oracle Thin Client JDBC Driver ................................. 179
<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>ECMAScript</td>
<td>239</td>
</tr>
<tr>
<td>Global Configuration</td>
<td>239</td>
</tr>
<tr>
<td>Global Configuration Values</td>
<td>239</td>
</tr>
<tr>
<td>Global Configuration Values</td>
<td>240</td>
</tr>
<tr>
<td>Managed System Information</td>
<td>240</td>
</tr>
<tr>
<td>Entitlements</td>
<td>242</td>
</tr>
<tr>
<td>Account Tracking</td>
<td>243</td>
</tr>
<tr>
<td>Password Synchronization</td>
<td>244</td>
</tr>
<tr>
<td>JDBC Fanout Common</td>
<td>244</td>
</tr>
</tbody>
</table>
About this Book and the Library

The *Identity Manager Driver for Java Database Connectivity (JDBC) Implementation Guide* provides a generic solution for synchronizing data between an Identity Vault and relational databases. This guide provides an overview of the driver's technology as well as configuration instructions.

**Intended Audience**

This book provides information for individuals responsible for understanding administration concepts and implementing a secure, distributed administration model.

**Other Information in the Library**

For more information about the library for Identity Manager, see the following websites:

- [Identity Manager documentation website](#)
- [Identity Manager drivers documentation website](#)
About NetIQ Corporation

We are a global, enterprise software company, with a focus on the three persistent challenges in your environment: Change, complexity and risk—and how we can help you control them.

Our Viewpoint

Adapting to change and managing complexity and risk are nothing new
In fact, of all the challenges you face, these are perhaps the most prominent variables that deny you the control you need to securely measure, monitor, and manage your physical, virtual, and cloud computing environments.

Enabling critical business services, better and faster
We believe that providing as much control as possible to IT organizations is the only way to enable timelier and cost effective delivery of services. Persistent pressures like change and complexity will only continue to increase as organizations continue to change and the technologies needed to manage them become inherently more complex.

Our Philosophy

Selling intelligent solutions, not just software
In order to provide reliable control, we first make sure we understand the real-world scenarios in which IT organizations like yours operate—day in and day out. That's the only way we can develop practical, intelligent IT solutions that successfully yield proven, measurable results. And that's so much more rewarding than simply selling software.

Driving your success is our passion
We place your success at the heart of how we do business. From product inception to deployment, we understand that you need IT solutions that work well and integrate seamlessly with your existing investments; you need ongoing support and training post-deployment; and you need someone that is truly easy to work with—for a change. Ultimately, when you succeed, we all succeed.

Our Solutions

- Identity & Access Governance
- Access Management
- Security Management
- Systems & Application Management
- Workload Management
- Service Management
Contacting Sales Support

For questions about products, pricing, and capabilities, contact your local partner. If you cannot contact your partner, contact our Sales Support team.

Worldwide:  www.netiq.com/about_netiq/officelocations.asp
United States and Canada:  1-888-323-6768
Email:  info@netiq.com
Web Site:  www.netiq.com

Contacting Technical Support

For specific product issues, contact our Technical Support team.

Worldwide:  www.netiq.com/support/contactinfo.asp
North and South America:  1-713-418-5555
Europe, Middle East, and Africa:  +353 (0) 91-782 677
Email:  support@netiq.com
Web Site:  www.netiq.com/support

Contacting Documentation Support

Our goal is to provide documentation that meets your needs. The documentation for this product is available on the NetIQ Web site in HTML and PDF formats on a page that does not require you to log in. If you have suggestions for documentation improvements, click Add Comment at the bottom of any page in the HTML version of the documentation posted at www.netiq.com/documentation. You can also email Documentation-Feedback@netiq.com. We value your input and look forward to hearing from you.

Contacting the Online User Community

NetIQ Communities, the NetIQ online community, is a collaborative network connecting you to your peers and NetIQ experts. By providing more immediate information, useful links to helpful resources, and access to NetIQ experts, NetIQ Communities helps ensure you are mastering the knowledge you need to realize the full potential of IT investments upon which you rely. For more information, visit community.netiq.com.

Other Information in the Library

For more information about the library for Identity Manager, see the Identity Manager documentation website.
Understanding the Identity Manager Driver for JDBC

The Identity Manager Driver for Java DataBase Connectivity (JDBC) provides a generic solution for synchronizing data between Identity Manager and JDBC-accessible relational databases. The principal value of this driver resides in its generic nature. Unlike most drivers that interface with a single application, this driver can interface with most relational databases and database-hosted applications.

You can connect to a single database using a single JDBC driver. To configure a single JDBC driver to connect to multiple databases of the same type (for example, Oracle, MySQL, or PostgreSQL) use the driver with the Fan-Out agent. For more information, see NetIQ Identity Manager Driver for JDBC Fanout Implementation Guide.

- “Components for Data Synchronization” on page 15
- “Database Concepts” on page 17
- “How the Driver Works” on page 22
- “Supported Operations” on page 23
- “Planning to Install the Driver” on page 26

Components for Data Synchronization

This section provides information about the components required to integrate a connected system (database) with Identity Manager.

- “JDBC” on page 15
- “Third-Party JDBC Driver” on page 16
- “Identity Vault” on page 16
- “Schema” on page 16
- “Logical Database Class” on page 17
- “XDS” on page 17

JDBC

Java DataBase Connectivity (JDBC) is a cross-platform database interface standard that Sun Microsystems developed.

Most enterprise database vendors provide a unique implementation of the JDBC interface. Four versions of the JDBC interface are available:

- JDBC 1 (Java 1.0)
- JDBC 2 (Java 1.2 or 1.3)
- JDBC 3 (Java 1.4 or 1.5)
- JDBC 4 (Java 1.6 or 1.7)
The JDBC driver primarily uses the JDBC 1 interface. It uses a small subset of JDBC 2, JDBC 3, or JDBC 4 methods when supported by third-party JDBC drivers.

**Third-Party JDBC Driver**

A third-party JDBC driver is one of the numerous JDBC interface implementations that the Identity Manager JDBC driver uses to communicate with a particular database.

For example, `ojdbc6.jar` is one of the Oracle JDBC drivers. Different third-party JDBC drivers implement different portions of the JDBC interface specification and implement the interface in a relatively consistent manner.

The following illustration indicates the relationship between the Identity Manager JDBC driver and third-party JDBC drivers.

*Figure 1-1 Identity Manager JDBC Driver vs. Third-Party JDBC Drivers*

**Identity Vault**

An Identity Vault is the data store that Identity Manager uses.

The Identity Vault is a persistent database powered by eDirectory and used by Identity Manager to hold data for synchronization with a connected system. The vault can be viewed narrowly as a private data store for Identity Manager or more broadly as a metadirectory that holds enterprise-wide data. Data in the vault is available to any protocol supported by eDirectory, including the NetWare Core Protocol (NCP), which is the traditional protocol used by iManager, and LDAP.

**Schema**

- “Directory Schema” on page 17
- “Application Schema” on page 17
- “Database Schema” on page 17
- “Synchronization Schema” on page 17
Directory Schema

The directory schema is the set of object classes and attributes in the directory.
A database schema is a way to logically group objects such as tables, views, and stored procedures.
For example, the eDirectory User class and Given Name attribute are part of the eDirectory schema.

Application Schema

The application schema is the set of classes and attributes in an application.
Because databases have no concept of classes or attributes, the JDBC driver maps eDirectory classes to tables or views, and maps eDirectory attributes to columns.

Database Schema

Database schema is essentially synonymous with ownership. A database schema consists of database objects (for example, tables, views, triggers, stored procedures, and functions) that a database user owns.

With the JDBC driver, schema is useful to scope the database (reduce the number of database objects visible to the driver at runtime).

Ownership is often expressed by using a qualified dot notation (for example, indirect.usr, where indirect is the name of the database user that owns the table usr). All of the database objects owned by indirect constitute the indirect database schema.

Synchronization Schema

The synchronization schema is the database schema visible to the driver at runtime.

Logical Database Class

The logical database class is the set of tables or view used to represent an eDirectory class in a database.

XDS

XDS format is the defined NetIQ subset of possible XML formats that Identity Manager can use.
XDS is the initial format for data coming from the Identity Vault. By modifying default rules and changing the style sheets, you can configure the JDBC driver to work with any XML format.

Database Concepts

- “Structured Query Language” on page 18
- “Data Manipulation Language” on page 18
- “Data Definition Language” on page 18
- “View” on page 18
- “Identity Columns/Sequences” on page 19
Structured Query Language

Structured Query Language (SQL) is the language used to query and manipulate data in relational databases.

Data Manipulation Language

Data Manipulation Language (DML) statements are highly standardized SQL statements that manipulate database data.

DML statements are essentially the same, regardless of the database that you use. The JDBC driver is DML-based. It maps Identity Manager events expressed as XDS XML to standardized DML statements.

The following example shows several DML statements:

```sql
SELECT * FROM usr;
INSERT INTO usr(lname) VALUES('Doe');
UPDATE usr SET fname = 'John' WHERE idu = 1;
```

Data Definition Language

Data Definition Language (DDL) statements manipulate database objects such as tables, indexes, and user accounts.

DDL statements are proprietary and differ substantially between databases. Even though the JDBC driver is DML-based, you can embed DDL statements in XDS events. For additional information, refer to Chapter 12, "Embedded SQL Statements in XDS Events," on page 133.

The following examples show several DDL statements:

```sql
CREATE TABLE usr
(
    idu   INTEGER,
    fname VARCHAR2(64),
    lname VARCHAR2(64)
);

CREATE USER idm IDENTIFIED BY novell;
```

NOTE: Examples used throughout this guide are for the Oracle database.

View

A view is a logical table.

When queried by using a `SELECT` statement, the view is created by executing the SQL query supplied when the view was defined. Views are a useful abstraction mechanism for representing multiple tables of arbitrary structure as a single table or logical database class.
CREATE VIEW view_usr
{
   pk_idu,
   fname,
   lname
}
AS
SELECT idu, fname, lname from usr;

Identity Columns/Sequences

Identity columns and sequences are used to generate unique primary key values. Identity Manager can associate with these values, among other things.

An identity column is a self-incrementing column used to uniquely identify a row in a table. Identity column values are automatically filled in when a row is inserted into a table.

A sequence object is a counter that can be used to uniquely identify a row in a table. Unlike an identity column, a sequence object is not bound to a single table. However, if it is used by a single table, a sequence object can be used to achieve an equivalent result.

The following is an example of a sequence object:

CREATE SEQUENCE seq_idu
   START WITH 1
   INCREMENT BY 1
   NOMINVALUE
   NOMAXVALUE
   ORDER;

Transaction

A transaction is an atomic database operation that consists of one or more statements.

When a transaction is complete, all statements in the transaction are committed. When a transaction is interrupted or one of the statements in the transaction has an error, the transaction is said to roll back. When a transaction is rolled back, the database is left in the same state it was before the transaction began.

Transactions are either manual (user-defined) or automatic. Manual transactions can consist of one or more statements and must be explicitly committed. Automatic transactions consist of a single statement and are implicitly committed after each statement is executed.

- “Manual (User-Defined) Transactions” on page 19
- “Automatic Transactions” on page 20

Manual (User-Defined) Transactions

Manual transactions usually contain more than one statement. DDL statements typically cannot be grouped with DML statements in a manual transaction.

The following example illustrates a manual transaction:

SET AUTOCOMMIT OFF
INSERT INTO usr(lname) VALUES('Doe');
UPDATE usr SET fname = 'John' WHERE idu = 1;
COMMIT; -- explicit commit
Automatic Transactions

Automatic transactions consist of only one statement. They are often referred to as auto-committed statements because changes are implicitly committed after each statement. An auto-committed statement is autonomous of any other statement.

The following example illustrates an automatic transaction:

```
SET AUTOCOMMIT ON
INSERT INTO emp(lname) VALUES('Doe');
-- implicit commit
```

Stored Procedures or Functions

A stored procedure or function is programmatic logic stored in a database. Stored procedures or functions can be invoked from almost any context.

The Subscriber channel can use stored procedures or functions to retrieve primary key values from rows inserted into tables, to create associations. Stored procedures or functions can also be invoked from within embedded SQL statements or triggers.

The distinction between stored procedures and functions varies by database. Typically, both can return output, but they differ in how they do it. Stored procedures usually return values through parameters. Functions usually return values through a scalar return value or result set.

The following example illustrates a stored procedure definition that returns the next value of a sequence object:

```
CREATE SEQUENCE seq_idu
    START WITH 1
    INCREMENT BY 1
    NOMINVALUE
    NOMAXVALUE
ORDER;

CREATE PROCEDURE sp_idu(    io_idu IN OUT INTEGER)
IS
BEGIN
    IF (io_idu IS NULL) THEN
        SELECT seq_idu.nextval INTO io_idu FROM DUAL;
    END IF;
END sp_idu;
```

Trigger

A database trigger is programmatic logic associated with a table, which executes under certain conditions. A trigger is said to fire when its execution criteria are met.

Triggers are often useful for creating side effects in a database. In the context of the JDBC driver, triggers are useful to capture event publications. The following is an example of a database trigger on the `usr` table.
CREATE TABLE usr
{
    idu   INTEGER,
    fname VARCHAR2(64),
    lname VARCHAR2(64)
};

-- t = trigger; i = insert
CREATE TRIGGER t_usr_i
    AFTER INSERT ON usr
    FOR EACH ROW
BEGIN
    UPDATE usr SET fname = 'John';
END;

When a statement is executed against a table with triggers, a trigger fires if the statement satisfies the conditions specified in the trigger. For example, using the above table, suppose the following insert statement is executed:

INSERT INTO usr(lname) VALUES('Doe')

Trigger t_emp_i fires after the insert statement is executed, and the following update statement is also executed:

UPDATE usr SET fname = 'John'

A trigger can typically be fired before or after the statement that triggered it. Statements that are executed as part of a database trigger are typically included in the same transaction as the triggering statement. In the above example, both the INSERT and UPDATE statements are committed or rolled back together.

**Instead-Of-Trigger**

An instead-of-trigger is programmatic logic associated with a view, which executes under certain conditions.

Instead-of-triggers are useful for making views writable or subscribeable. They are often used to define what it means to INSERT, UPDATE, and DELETE from a view. The following is an example of an instead-of-trigger on the usr table.

CREATE TABLE usr
{
    idu   INTEGER,
    fname VARCHAR2(64),
    lname VARCHAR2(64)
};
CREATE VIEW view_usr
(
    pk_idu,
    fname,
    lname
)
AS
SELECT idu, fname, lname from usr;

-- t = trigger; i = insert
CREATE TRIGGER t_view_usr_i
    INSTEAD OF INSERT ON usr
BEGIN
    INSERT INTO usr(idu, fname, lname)
    VALUES(:NEW.pk_idu, :NEW.fname, :NEW.lname);
END;

When a statement is executed against a view with instead-of-triggers, an instead-of-trigger executes if the statement satisfies the conditions specified in the trigger. Unlike triggers, instead-of-triggers always execute before the triggering statement. Also, unlike regular triggers, instead-of-triggers are executed instead of, not in addition to, the triggering statement.

For example, using the above view, suppose the following insert statement is executed instead of the original insert statement:

INSERT INTO view_usr(pk_idu, fname, lname)
    VALUES(1, 'John', 'Doe')

Rather than executing the original statement, instead-of-trigger t_view_usr_i fires and executes the following statement:

INSERT INTO usr(idu, fname, lname)
    VALUES(:NEW.pk_idu, :NEW.fname, :NEW.lname);

In this example, the statements happen to be equivalent.

How the Driver Works

• “Generic JDBC Driver” on page 22

Generic JDBC Driver

The Identity Manager JDBC driver uses the JDBC interface to synchronize data and identities between an Identity Vault and relational databases.

The driver consists of the following jar files:

• JDBCShim.jar
• JDBCUtil.jar
• JDBCConfig.jar

In addition to these files, you need a third-party JDBC driver to communicate with every database.
Supported Operations

- “Supported Databases” on page 23
- “Supported Third Party JDBC Drivers” on page 23
- “Support for Password Synchronization” on page 23
- “Supported Data Synchronization Models” on page 23
- “Triggerless vs. Triggered Publication” on page 25

Supported Databases

For information on supported databases, see “Supported Databases” on page 157.

Supported Third Party JDBC Drivers

For information on supported third-party JDBC drivers, see “Third-Party JDBC Driver Interoperability” on page 169.

Support for Password Synchronization

The JDBC driver supports password set and check on the Subscriber channel. The driver does not support bidirectional password synchronization.

Supported Data Synchronization Models

The JDBC driver supports two data synchronization models: direct and indirect. Both terms are best understood with respect to the final destination of the data being synchronized.

<table>
<thead>
<tr>
<th>Model</th>
<th>Association</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indirect</td>
<td>Usually associated with tables</td>
<td>Target database tables probably don’t match the structure required by the driver. Therefore, it’s usually necessary to create intermediate staging tables that do match the structure that the driver requires.</td>
</tr>
<tr>
<td>Direct</td>
<td>Usually associated with views</td>
<td>Views provide the abstraction mechanism that best facilitates integration with the target database tables.</td>
</tr>
</tbody>
</table>

The following sections describe how direct and indirect synchronization work on both the Subscriber and Publisher channels.

- “Indirect Synchronization” on page 23
- “Direct Synchronization” on page 24

Indirect Synchronization

Indirect synchronization uses intermediate staging tables to synchronize data between the Identity Vault and a database. You can have one or more customer tables and intermediate staging tables.
**Subscriber Channel**

The Subscriber channel updates the intermediate staging tables in the synchronization schema. This action triggers an update to customer tables elsewhere in the database.

**Publisher Channel**

Synchronization triggers update the intermediate staging tables when target database tables are updated. Publication triggers then insert one or more rows into the event log table. The Publisher channel then reads the inserted rows and updates the Identity Vault.

Depending on the contents of the rows read from the event log table, the Publisher channel might need to retrieve additional information from the intermediate tables before updating the Identity Vault. After updating the Identity Vault, the Publisher channel then deletes or marks the rows as processed.

**Direct Synchronization**

Direct synchronization typically uses views to synchronize data between Identity Manager and a database. You can use tables if they conform to the structure that the JDBC driver requires. You can have one or more customer views or tables.

**Subscriber Channel**

Updates existing customer tables through a view in the synchronization schema.
Direct synchronization without a view is possible only if the target database tables match the structure that the JDBC driver requires. For additional information, see “Indirect Synchronization” on page 105.

Publisher Channel

When a target database table is updated, publication triggers insert rows into the event log table. The Publisher channel then reads the inserted rows and updates the Identity Vault.

Depending on the contents of the rows read from the event log table, the Publisher channel might need to retrieve additional information from the view before updating the Identity Vault. After updating the Identity Vault, the Publisher channel then deletes or marks the rows as processed.

Triggerless vs. Triggered Publication

Triggers are not required to log events for the Publisher channel. In situations where triggers cannot be used to capture granular events, the Publisher channel can derive database changes by inspecting database data.

Triggerless publication is particularly useful when support contracts forbid the use of triggers on database application tables or for rapid prototyping.

However, triggerless publication is less efficient than triggered publication. With triggered publication, what changed is already known. With triggerless publication, change calculation must occur before events can be processed.

Triggerless publication, unlike triggered publication, does not preserve event order. It only guarantees that, by the end of a polling cycle, objects in the database and the Identity Vault are in sync.

Triggerless publication, unlike triggered publication, does not provide historical data such as old values. It provides information on the current state of an object, not the previous state.
Triggerless publication does have the advantage of being much simpler because it reduces database-side dependencies. Writing database triggers can be complicated and requires extensive knowledge of database-specific SQL syntaxes.

The following figure illustrates direct triggerless publication:

*Figure 1-2 Direct Triggerless Publication*

The following figure illustrates indirect triggerless publication:

*Figure 1-3 Indirect Triggerless Publication*

If you move the driver without moving the state files, the driver must build up new state files by resynchronizing. For information on this situation, see “State Directory” on page 59.

**Planning to Install the Driver**

This section provides information for planning the installation and configuration process for the driver.

**Installation Requirements**

For information about installing the driver, see “Installing the Driver Files” on page 29.

**Options for Installing the Driver Shim**

You can install the driver shim on the Identity Manager server. Alternatively, you can use the Remote Loader service to run the driver on a server other than the Identity Manager server. In this case, the driver and the Remote Loader service run on the same server. The Remote Loader loads drivers and communicates with the Identity Manager engine on behalf of drivers installed on remote servers. For
information about the operating systems supported for Identity Manager engine and Remote Loader, see the NetIQ Identity Manager Technical Information website (https://www.netiq.com/products/identity-manager/advanced/technical-information/).
Installing the Driver Files

By default, the JDBC driver files are installed on the Identity Manager server at the same time as the Identity Manager engine. The installation program extends the Identity Vault’s schema and installs the driver shim and a driver configuration file. It does not create the driver object in the Identity Vault (see Chapter 5, “Creating a New Driver Object,” on page 43) or upgrade an existing driver’s configuration (see Chapter 7, “Upgrading an Existing Driver,” on page 97).

The JDBC driver can either be located on the same server as the JDBC database or any other server. The following sections explain what to do if the JDBC driver files are not on the JDBC database server and how to install the third-party JDBC jar files that the driver uses to communicate with the database:

For information about uninstalling the driver, see Appendix A, “Uninstalling the Driver,” on page 195.

- "Installing the Driver Files” on page 29
- “Installing JDBC Driver Jar Files” on page 29

Installing the Driver Files

You can install the JDBC driver files in the following ways:

- On a local machine: Install the JDBC driver files on the Identity Manager server and connect to the database by using the Provider URL (Connection Properties).
- On a remote machine: Install the JDBC driver files on the Remote Loader.

For information on installing the Identity Manager server or the Remote Loader, see Considerations for Installing Identity Manager Engine Components and Remote Loader in the NetIQ Identity Manager Setup Guide for Linux or Planning to Install the Engine, Drivers, and Plug-ins in the NetIQ Identity Manager Setup Guide for Windows.

Installing JDBC Driver Jar Files

To communicate with the JDBC database, the JDBC driver requires that you copy the appropriate JDBC driver jar files to the driver location.

1. Locate the appropriate JDBC driver jar files.
   
   Information about the jar files you need and where to download them from is found in “Supported Third-Party JDBC Drivers (Recommended)” on page 170.

2. Place the files in the appropriate location.

   The following tables identify the paths where you need to place JDBC driver jar files on a Identity Manager server or on a Remote Loader server that is running the JDBC driver.
### Table 2-1  Locations for JAR Files: Identity Manager Server

<table>
<thead>
<tr>
<th>Platform</th>
<th>Directory Path</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solaris, Linux, or AIX</td>
<td>/opt/novell/eDirectory/lib/dirxml/classes</td>
</tr>
<tr>
<td>Windows</td>
<td>novell\NDS\lib</td>
</tr>
</tbody>
</table>

### Table 2-2  Locations for JAR Files: Remote Loader

<table>
<thead>
<tr>
<th>Platform</th>
<th>Directory Path</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solaris, Linux, or AIX</td>
<td>/opt/novell/eDirectory/lib/dirxml/classes</td>
</tr>
<tr>
<td>Windows</td>
<td>novell\RemoteLoader\lib</td>
</tr>
</tbody>
</table>
### The Association Utility

The Association utility normalizes associations of objects associated under the 1.0 or later versions of the JDBC driver. It also provides several other features that simplify driver administration.

This version of the utility is compatible with the 1.0 and later versions of the JDBC driver, and supersedes all previous versions.

- “Independent Operations” on page 31
- “Before You Begin” on page 32
- “Using the Association Utility” on page 32
- “Parameters for Searching and Replacing” on page 33

### Independent Operations

The Association utility supports seven independent operations:

#### Table 3-1  Independent Operations

<table>
<thead>
<tr>
<th>Operation</th>
<th>Description</th>
<th>Read-Write Functionality</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Lists objects associated with a driver (default).</td>
<td>Read-only</td>
</tr>
<tr>
<td>2</td>
<td>Lists objects that have multiple associations to a driver.</td>
<td>Read-only</td>
</tr>
<tr>
<td>3</td>
<td>Lists objects that have invalid associations to a driver.</td>
<td>Read-only</td>
</tr>
</tbody>
</table>

An association is invalid if:

- It is malformed.
  
  For example, the association is missing the schema RDN, missing the table RDN, or the schema keyword is misspelled.

- It contains database identifiers that do not map to identifiers in the target database.
  
  For example, an association includes a mapping to a table that does not exist.

- It maps to no row or multiple rows.
  
  An association is broken if it doesn’t map to a row. Also, associations aren’t unique if they map to more than one row.

| 4         | Lists objects that need to be normalized.        | Read-only                |

A normalized association is valid, correctly ordered, and uses the correct case. Normal case is uppercase for case-insensitive databases and mixed case for case-sensitive databases.

| 5         | Normalizes object associations listed during operation 4. | Write                   |
Before You Begin

Modifying associations can cause problems. If associations are corrupted, Identity Manager ceases to function. Therefore, use write operations only when necessary. To avoid unintentionally corrupting an association, the Association utility creates an undo ldiff file for all write operations.

Review the following cautions before using the utility:

- The Association utility, like the driver, assumes that database identifiers are undelimited (unquoted and contain no special characters).
- Update all object associations related to a driver at the same time.
  
  Updating associations at the same time is extremely important.
  
  To see all of the objects associated with a particular driver, run the Association utility on the Identity Manager server associated with a particular driver instance.
  
  The LDAP search base must contain all of the objects associated with a particular driver.
  
  To ensure complete containment, we recommend that you use your tree’s root container as the search base.
- Make sure that the JDBC URL of the target database supplied to this utility is the same as the URL that the driver uses. Pointing this utility at a case-insensitive database when the database is actually case-sensitive might result in associations being normalized to the wrong case.
- Because the Association utility runs locally, it uses an unsecured connection. Therefore, the Identity Vault LDAP server must be temporarily configured to accept clear text passwords. Depending upon the third-party JDBC driver you are using, the database connection established by this utility might not be secure.
  
  We recommend changing the driver’s authentication password on the database after you run this utility.

Using the Association Utility

Run the Association utility once for each instance of the driver installed on an Identity Manager server. In the install-dir\DirXMLUtilities\jdbc\util directory, a batch file association.bat or shell script association.sh (depending upon your platform) starts the utility.

A properties file containing association utility parameters is provided for each supported database. These files are in the install-dir\DirXMLUtilities\jdbc\util directory.

<table>
<thead>
<tr>
<th>Operation</th>
<th>Description</th>
<th>Read-Write Functionality</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>Lists object associations to be modified.</td>
<td>Read-only</td>
</tr>
<tr>
<td></td>
<td>Allows for global replacement of schema, table, and column names based on search criteria.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>This operation requires two parameters (oldRDN and newRDN). See “Parameters for Searching and Replacing” on page 33.</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Modifies object associations listed during operation 6.</td>
<td>Write</td>
</tr>
<tr>
<td></td>
<td>This operation requires two parameters (oldRDN and newRDN). See “Parameters for Searching and Replacing” on page 33.</td>
<td></td>
</tr>
</tbody>
</table>
This utility does not work with Informix ANSI-compliant databases.

1 Stop the driver.

2 Use `association.bat` or `association.sh` to run the Association utility to identify and remove extraneous associations (operations 2 and 3).

   No object associated by this product should have multiple associations. Manually remove extraneous associations on a per object basis. Operation 3 might help you identify which of the multiple associations is actually valid. After you know this, you can probably discard the extraneous associations.

3 Run the Association utility to identify and fix invalid associations (operation 3 and possibly operations 6 and 7).

   As a general rule, if the problem is isolated, manually edit each invalid association. If the problem is repetitive and affects a large number of associations, consider using operations 6 and 7. This utility can replace bad identifiers on a global basis, but cannot insert or remove them where they do not already exist. See "Parameters for Searching and Replacing" on page 33 for information about search parameters.

4 Run the Association utility to normalize associations (operations 4 and 5).

### Parameters for Searching and Replacing

The Association utility requires two parameters (oldRDN and newRDN) for operations 6 and 7 in order to search and replace.

The first value (for example, schema) in the parameter is the search criterion. The second value (for example, old) is the replacement value. Under certain scenarios, you can use the wildcard character `*` to generalize the search criterion or replacement value.

Three types of search and replace operations are possible:

<table>
<thead>
<tr>
<th>Option</th>
<th>Description</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Replace the schema name</td>
<td>Replace schema old with schema new. Wildcards are supported on the right side only.</td>
<td>oldRDN: schema=old newRDN: schema=new</td>
</tr>
<tr>
<td>Option</td>
<td>Description</td>
<td>Example</td>
</tr>
<tr>
<td>-------------------------------</td>
<td>-----------------------------------------------------------------------------</td>
<td>--------------------------</td>
</tr>
<tr>
<td>Replace the table name</td>
<td>Replace table <code>old</code> with table <code>new</code>. Wildcards are not supported.</td>
<td>oldRDN: <code>table=old</code></td>
</tr>
<tr>
<td></td>
<td></td>
<td>newRDN: <code>table=new</code></td>
</tr>
<tr>
<td>Replace the column name</td>
<td>Replace column <code>old</code> with column <code>new</code>. Wildcards are required on the right side, but they aren’t supported on the left side.</td>
<td>oldRDN: <code>old=*</code></td>
</tr>
<tr>
<td></td>
<td></td>
<td>newRDN: <code>new=*</code></td>
</tr>
</tbody>
</table>
4 Installing and Configuring Database Objects

You need to install and configure database objects (for example, tables, triggers, and indexes) for synchronization with the sample driver configuration. If you do not configure the database objects, the sample configuration file will not work.

- “SQL Script Conventions” on page 35
- “Installing IBM DB2 Universal Database (UDB)” on page 37
- “Installing Informix Dynamic Server (IDS)” on page 37
- “Installing Microsoft SQL Server” on page 38
- “Installing MySQL” on page 38
- “Installing Oracle” on page 39
- “Installing PostgreSQL 8” on page 39
- “Installing PostgreSQL 9” on page 40
- “Installing Sybase Adaptive Server Enterprise (ASE)” on page 40
- “Testing the Database Object Installation” on page 41

SQL Script Conventions

The following table lists default locations for SQL scripts:

<table>
<thead>
<tr>
<th>Platform</th>
<th>Default Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Windows</td>
<td><code>c:\Novell\IdentityManager\NDS\DirXMLUtilities\jdbc\sql\</code></td>
</tr>
<tr>
<td>UNIX/Linux</td>
<td><code>/opt/novell/eDirectory/lib/dirxml/rules/jdbc/sql/</code></td>
</tr>
</tbody>
</table>

For example, when the scripts are installed on a SUSE Linux Enterprise Server with eDirectory, the DB2 scripts are found in `/opt/novell/eDirectory/lib/dirxml/rules/jdbc/db2_udb/install` directory.

All SQL scripts use the same conventions, regardless of the database.

The maximum size of a DB2 identifier is 18 characters. This least common denominator length defines the upper bound of database identifier length across all SQL scripts. Because of this restricted length, abbreviations are used. The following table summarizes identifier abbreviations and their meanings:
Instead of proc_, the more common abbreviation is sp_. This prefix is reserved for system-stored procedures on Microsoft SQL Server. Also, this prefix forces lookup of a procedure first in the master database before evaluating any qualifiers (for example, database or owner). To maximize procedure lookup efficiency, this prefix has been deliberately avoided.

The following table indicates identifier naming conventions for indexes, triggers, stored procedures, functions, and constraints:

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>proc_</td>
<td>stored procedure/function</td>
</tr>
<tr>
<td>idx_</td>
<td>index</td>
</tr>
<tr>
<td>trg_</td>
<td>trigger</td>
</tr>
<tr>
<td>_i</td>
<td>on insert trigger</td>
</tr>
<tr>
<td>_u</td>
<td>on update trigger</td>
</tr>
<tr>
<td>_d</td>
<td>on delete trigger</td>
</tr>
<tr>
<td>chk_</td>
<td>check constraint</td>
</tr>
<tr>
<td>pk_</td>
<td>view primary key constraint</td>
</tr>
<tr>
<td>fk_</td>
<td>view foreign key constraint</td>
</tr>
<tr>
<td>mv_</td>
<td>view multi-valued column</td>
</tr>
<tr>
<td>sv_</td>
<td>view single-valued column (implicit default)</td>
</tr>
</tbody>
</table>

Abbreviation Interpretation

Abbreviation Interpretation

Abbreviation Interpretation

Abbreviation Interpretation

Other conventions:

- All database identifiers are lowercase.
  
  This is the most commonly used case convention between databases.
- String field lengths are 64 characters.
  
  Fields of this length can hold most eDirectory attribute values. You might want to refine field lengths to enhance storage efficiency.
For performance reasons, primary key columns use native, scalar numeric types whenever possible (such as `BIGINT` as opposed to `NUMERIC`).

- The `record_id` column in event log tables has the maximum numeric range permitted by each database to avoid overflow.
- Identity columns and sequence objects do not cache values. Some databases throw away cached values when a rollback occurs. This action can cause large gaps in identity column or sequence values.

## Installing IBM DB2 Universal Database (UDB)

**IMPORTANT:** For IBM DB2, you must manually create operating system user accounts before running the provided SQL scripts.

Because the process to create user accounts differs between operating systems, Step 1 below is OS-specific. These instructions are for a Windows NT operating environment. If you rerun the SQL scripts, repeat only Step 2 through Step 4.

The directory context for DB2 is found in the `install-dir\DirXMLUtilities\jdbc\sql\db2_udb\install` directory on Windows or `install-dir/lib/dirxml/rules/jdbc/sql/db2_udb/install` directory on UNIX/Linux platforms.

1. **Create user accounts for users `idm`, indirect and direct.**
   - Use `novell` as the password in User Manager for Domains.
   - Remember to deselect User Must Change Password at Next Login for this account.
   - You might want to also select Password Never Expires.

   **NOTE:** The remaining instructions are OS-independent.

2. **Adjust the file path to `idm_db2.jar` in the `1_install.sql` installation script.** The file path to `idm_db2.jar` should reflect the location of this file on your client machine.

3. **Execute the `1_install.sql` script from the Command Line Processor (CLP).**
   - For example: `db2 -f 1_install.sql`

   **IMPORTANT:** The scripts won’t execute in the Command Center interface beyond version 7. The scripts use `\` as the line continuation character. Later versions of the Command Center don’t recognize this character.

4. **For versions 9 or later, execute the `2_install_9.sql` script.**
   - For example: `db2 -f 2_install_9.sql`

## Installing Informix Dynamic Server (IDS)

For Informix Dynamic Server, you must manually create an operating system user account before running the provided SQL scripts.

Because the process of creating user accounts differs between operating systems, Step 1 below is OS-specific. These instructions are for a Windows operating environment. If you rerun the SQL scripts, you should repeat only Steps 2 through 4.
The directory context for Informix SQL scripts is found in the `install-dir\DirXMLUtilities\jdbc\sql\informix_ids\install` on Windows or `install-dir/lib/dirxml/rules/jdbc/sql/informix_ids/install` directory on UNIX/Linux platforms.

1. In Windows, create a user account for user `idm`.
   - Use `novell` as the password in User Manager for Domains.
   - Remember to deselect User Must Change Password at Next Login for this account.
   - You might want to also select Password Never Expires.

   **NOTE:** The remaining instructions are OS-independent.

2. Start a client such as SQL Editor or DBAccess.

3. Log in to your server as the `informix` user or another user with DBA (database administrator) privileges.
   - By default, the password for the `informix` user is `informix`. If you execute scripts as a user other than `informix`, change all references to `informix` in the scripts prior to execution.

4. Open and execute `1_install_9.sql` from either the `ansi` (transactional, ANSI-compliant), `log` (transactional, non-ANSI-compliant), or `no_log` (non-transactional, non-ANSI-compliant) subdirectory, depending upon which type of database you want to create.

5. For version 11 or later, open and execute `2_install_10.sql` from either the `ansi` (transactional, ANSI-compliant), `log` (transactional, non-ANSI-compliant), or `no_log` (non-transactional, non-ANSI-compliant) subdirectory, depending upon which type of database you want to create.

### Installing Microsoft SQL Server

The directory context for Microsoft SQL Server scripts is found in the `install-dir\DirXMLUtilities\jdbc\sql\mssql\install` directory on Windows or `install-dir/lib/dirxml/rules/jdbc/sql/mssql/install` directory on UNIX/Linux platforms.

1. Start a client. For example, Microsoft SQL Server Management Studio.

2. Log in to your database server as the `sa` user.
   - By default, the `sa` user has no password.

3. Execute the installation script.
   - For version 2008 R2, execute `1_install_2005.sql`.

### Installing MySQL

The directory context for MySQL SQL scripts is found in the `\products\IDM\windows\setup\drivers\jdbc\tools\sql\` directory on Windows. On Linux platforms, the files are deployed at `/opt/novell/eDirectory/lib/dirxml/rules/jdbc/sql` when `novell-DXMLjdbc-4.1.0-0.noarch.rpm` is installed.

1. From a MySQL client, such as `mysql`, log in as root user or another user with administrative privileges.
   - For example, from the command line, execute
mysql -u root -p

By default, the root user has no password.

2 Execute the installation script `1_install_innodb.sql` or `1_install_myisam.sql`, depending upon which table type you wish to use. For version 5.5.15 use the scripts in subdirectory 5.

For example: `mysql> \c c:\1_install_innodb.sql`

Don’t use a semicolon to terminate this statement.

**Installing Oracle**

The directory context for Oracle SQL scripts is found in the `install-dir\DirXMLUtilities\jdbc\sql\oracle\install` directory on Windows or `install-dir/lib/dirxml/rules/jdbc/sql/oracle/install` directory on UNIX/Linux platforms.

1 From an Oracle client, such as SQL Plus, log in as the SYSTEM user.

   By default, the password for SYSTEM is MANAGER. If you execute scripts as a user other than SYSTEM with password MANAGER, change all references to SYSTEM in the scripts prior to execution.

2 Execute the installation script `1_install.sql`.

   For example: `SQL> @c:\1_install.sql`

**Installing PostgreSQL 8**

The directory context for PostgreSQL scripts is found in the `install-dir\DirXMLUtilities\jdbc\sql\postgres\install` directory on Windows or `install-dir/lib/dirxml/rules/jdbc/sql/postgres/install` directory on UNIX/Linux platforms. The directory context for executing PostgreSQL commands is `postgres-install-dir/pgsql/bin`.

1 Create the idm database.

   For example, from the UNIX command line, execute the following command:

   ```
   ./createdb idm
   ```

2 From a PostgreSQL client such as psql, log in to the idm database as postgres user.

   For example, from the UNIX command line, execute the following command:

   ```
   ./psql -d idm postgres
   ```

   By default, the postgres user has no password.

3 From inside psql, execute the script `1_install_8.sql`. For example:

   ```
   idm=# \i 1_install_8.sql
   ```

4 Update the `pg_hba.conf` file.

   In PostgreSQL 8, you can update the file through pgAdminIII. After you start, go to Tools > Connect to connect to the server, select the idm database, then go to Tools > Server Configuration > pg_hba.conf. In the pgAdminIII pg_hba.conf editor, the IP-ADDRESS and IP-MASK columns in the file are combined into a single field named as IP-Address. Place the values of IP-ADDRESS and IP-MASK in this field separated by a single whitespace character.

   For example, add entries for the idm database user. Adjust the IP-ADDRESS and IP-MASK as necessary:
# TYPE DATABASE USER IP-ADDRESS IP-MASK METHOD
# allow
driver user idm to connect to database idm
host idm idm <ip-address> <net-mask> password

5 Restart the PostgreSQL server to effect changes made to the pg_hba.conf file.
6 (Conditional) If you are using pgAdminIII, in the pg_hba.conf editor select the disk icon (save file) in the toolbar. When prompted, press Yes.

## Installing PostgreSQL 9

The directory context for PostgreSQL scripts is found in the install-dir\DirXMLUtilities\jdbc\sql\postgres\install directory on Windows or install-dir/lib/dirxml/rules/jdbc/sql/postgres/install directory on UNIX/Linux platforms. The directory context for executing PostgreSQL commands is postgres-install-dir/pgsql/bin.

1 Create the idm database.
   For example, from the UNIX command line, execute the following command:
   
   ./createdb idm

2 Install the plpgsql procedural language to the idm database.
   For example, from the UNIX command line, execute the following command:
   
   ./createlang plpgsql idm

3 From a PostgreSQL client such as psql, log in to the idm database as postgres user.
   For example, from the UNIX command line, execute the following command:
   
   ./psql -d idm postgres
   By default, the postgres user has no password.

4 From inside psql, execute the script 1_install_8.sql. For example:
   
   idm=# \i 1_install_8.sql

5 Update the pg_hba.conf file.
   For example, add entries for the idm database user. Adjust the IP-ADDRESS and IP-MASK columns as necessary:
   
   # TYPE DATABASE USER IP-ADDRESS IP-MASK METHOD
   # allow
driver user idm to connect to database idm
   host idm idm <ip-address> <net-mask> password

6 Restart the PostgreSQL server to effect the changes made to the pg_hba.conf file.

## Installing Sybase Adaptive Server Enterprise (ASE)

The directory context for Sybase SQL scripts is found in the install-dir\DirXMLUtilities\jdbc\sql\sybase_ase\install directory on Windows or install-dir/lib/dirxml/rules/jdbc/sql/sybase_ase/install directory on UNIX/Linux platforms.

1 From a Sybase client, such as isql, log in as the sa user and execute the 1_install.sql installation script.
   For example, from the command line, execute:
   
   isql -U sa -P -i 1_install.sql
   By default, the sa account has no password.
Testing the Database Object Installation

Test scripts for each database are located in the following directories:

**Table 4-4  Location of Database Scripts**

<table>
<thead>
<tr>
<th>Database</th>
<th>UNIX/Linux:</th>
<th>Test SQL Scripts Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>IBM DB2 Universal Database</td>
<td></td>
<td><code>install-dir/lib/dirxml/rules/jdbc/sql/db2_udb/test</code></td>
</tr>
<tr>
<td></td>
<td>Windows:</td>
<td><code>install-dir\DirXMLUtilities\jdbc\sql\db2_udb\test</code></td>
</tr>
<tr>
<td>Informix Dynamic Server</td>
<td>UNIX/Linux:</td>
<td>The test scripts are located in the following directories:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- <code>install-dir/lib/dirxml/rules/jdbc/sql/informix_ids/test/log</code></td>
</tr>
<tr>
<td></td>
<td></td>
<td>- <code>install-dir/lib/dirxml/rules/jdbc/sql/informix_ids/test/no_log</code></td>
</tr>
<tr>
<td></td>
<td>Windows:</td>
<td>The test scripts are located in the following directories:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- <code>install-dir\DirXMLUtilities\jdbc\sql\informix_ids\log\test</code></td>
</tr>
<tr>
<td></td>
<td></td>
<td>- <code>install-dir\DirXMLUtilities\jdbc\sql\informix_ids\no_log\test</code></td>
</tr>
<tr>
<td></td>
<td>Informix:</td>
<td>Informix ANSI test scripts are located in the log subdirectory.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Windows: <code>install-dir\DirXMLUtilities\jdbc\sql\mssql\test</code></td>
</tr>
<tr>
<td>Microsoft SQL Server</td>
<td>UNIX/Linux:</td>
<td>The test scripts are located in the following directories:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- <code>install-dir/lib/dirxml/rules/jdbc/sql/mssql/3or4/test</code></td>
</tr>
<tr>
<td></td>
<td></td>
<td>- <code>install-dir/lib/dirxml/rules/jdbc/sql/mssql/5/test</code></td>
</tr>
<tr>
<td></td>
<td>Windows:</td>
<td><code>install-dir\DirXMLUtilities\jdbc\sql\mssql\test</code></td>
</tr>
<tr>
<td>MySQL</td>
<td>UNIX/Linux:</td>
<td>The test scripts are located in the following directories:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- <code>install-dir/lib/dirxml/rules/jdbc/sql/mysql/3or4/test</code></td>
</tr>
<tr>
<td></td>
<td></td>
<td>- <code>install-dir/lib/dirxml/rules/jdbc/sql/mysql/5/test</code></td>
</tr>
<tr>
<td></td>
<td>Windows:</td>
<td><code>install-dir\DirXMLUtilities\jdbc\sql\mysql\test</code></td>
</tr>
<tr>
<td>Oracle</td>
<td>UNIX/Linux:</td>
<td><code>install-dir/lib/dirxml/rules/jdbc/sql/oracle/test</code></td>
</tr>
<tr>
<td></td>
<td>Windows:</td>
<td><code>install-dir\DirXMLUtilities\jdbc\sql\oracle\test</code></td>
</tr>
</tbody>
</table>
You should try the test scripts before starting the sample driver.

If you encounter issues while testing, see the following sections:

- “Recognizing Publication Events” on page 192.
- “Executing Test Scripts” on page 192.

<table>
<thead>
<tr>
<th>Database</th>
<th>Test SQL Scripts Location</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>PostgreSQL</strong></td>
<td><strong>UNIX/Linux</strong>: <code>install-dir/lib/dirxml/rules/jdbc/sql/postgres/test</code></td>
</tr>
<tr>
<td></td>
<td><strong>Windows</strong>: <code>install-dir\DirXMLUtilities\jdbc\sql\postgres\test</code></td>
</tr>
<tr>
<td><strong>Sybase Adaptive Server</strong></td>
<td><strong>UNIX/Linux</strong>: <code>install-dir/lib/dirxml/rules/jdbc/sql/sybase_ase/test</code></td>
</tr>
<tr>
<td><strong>Enterprise</strong></td>
<td><strong>Windows</strong>: <code>install-dir\DirXMLUtilities\jdbc\sql\sybase_ase\test</code></td>
</tr>
</tbody>
</table>
Creating a New Driver Object

After the JDBC driver files are installed on the server where you want to run the driver object (see Chapter 2, “Installing the Driver Files,” on page 29), you can create a driver object in the Identity Vault. You do so by installing the driver packages and then modifying the driver configuration to suit your environment. The following sections provide instructions:

- “Creating the Driver Object in Designer” on page 43
- “Activating the Driver” on page 49
- “JDBC Driver Settings” on page 49

Creating the Driver Object in Designer

You create the JDBC driver by installing the driver packages and then modifying the configuration to suit your environment. After you create and configure the driver object, you need to deploy it to the Identity Vault and start it.

- “Importing the Current Driver Packages” on page 43
- “Installing the Driver Packages” on page 44
- “Configuring the Driver Object” on page 47
- “Deploying the Driver Object” on page 48
- “Starting the Driver Object” on page 49

NOTE: You should not create driver objects by using the Identity Manager 4.0 and later configuration files through iManager. This method of creating driver objects is no longer supported. To create drivers, you need to use the new package management features provided in Designer.

Importing the Current Driver Packages

The driver packages contain the items required to create a driver object, such as policies, entitlements, filters, and Schema Mapping policies. These packages are only available in Designer. You can upgrade any package that is installed if there is a newer version of the package available. For more information on upgrading packages, see “Upgrading Installed Packages” in the NetIQ Designer for Identity Manager Administration Guide.

Before creating a driver object in Designer, you need to verify that you have all the required packages already imported in the Package Catalog of Designer. Designer prompts you for importing the required packages when it creates the driver object.

You can create packages based on the schema for your environment, keeping in mind the data synchronization model (direct/indirect) and its dependent packages.

To verify you have the most recent version of the driver packages in the Package Catalog:

1. Open Designer.
2. In the toolbar, click Help > Check for Package Updates.
3 Click **OK** to update the packages
   or
   Click **OK** if the packages are up-to-date.
4 In the Outline view, right-click the Package Catalog.
5 Click **Import Package**.

You can download the new packages from the Designer Auto-update site (http://cdn.novell.com/cached/designer/packages/idm/updatesite1_0_0/).

6 Select any JDBC driver packages.
   or
   Click **Select All** to import all of the packages displayed.
   By default, only the base packages are displayed. Deselect **Show Base Packages Only** to display all packages.
7 Click **OK** to import the selected packages, then click **OK** in the successfully imported packages message.
8 After the current packages are imported, continue with “Installing the Driver Packages” on page 44.

### Installing the Driver Packages

After you have imported the current driver packages into the Package Catalog, you can install the driver packages to create a new driver.

1 In Designer, open your project.
2 In the Modeler, right-click the driver set where you want to create the driver, then click **New > Driver**.
3 Select an appropriate JDBC Base Database Package, such as Oracle Base, then click **Next**.
4 Select the optional features to install for the JDBC driver, then click **Next**.
   All options are selected by default. The options are:
   - **Entitlements Support**: These packages contain the policies that provision the user accounts on the connected database. For more information, see the NetIQ Identity Manager Entitlements Guide.
   - **Data Collection**: These packages contain the policies that enable the driver to collect data for reports. If you are using Identity Reporting, ensure that this option is selected. For more information, see the Administrator Guide to NetIQ Identity Reporting.
Creating a New Driver Object

**Account Tracking:** These packages contain the policies that enable account tracking information for reports. If you are using Identity Reporting, ensure that this option is selected. For more information, see the *Administrator Guide to NetIQ Identity Reporting*.

**Synchronization Mode:** These packages contain the GCVs and sample policies. If you choose the direct/indirect synchronization mode, ensure that you don’t change this setting on the driver creation and configuration pages.

By default, the *Show only Applicable packages versions* option is selected.

**IMPORTANT:** The JDBC packages provide examples of the core functions of the JDBC driver. These examples help you customize the driver for your environment. You can add new policies and settings to the driver to meet your business requirements. The final implementation can be packaged and deployed in Identity Manager.

5  (Conditional) If there are package dependencies for the packages you selected to install for this driver, you must install them to install the selected package. Click *OK* to install the package dependency listed.

6  (Conditional) If more than one type of package dependency must be installed, you are presented with separate configuration pages for each package. Continue to click *OK* to install any additional package dependencies.

7  (Conditional) The Common Settings page is displayed only if the Common Settings package is installed as a dependency. On the Install Common Settings page, specify the common settings for User and Group containers:

   **User Container:** Select the Identity Vault container where the user accounts will be added in the Identity Vault. This value becomes the default for all drivers in the driver set.

   **Group Container:** Select the Identity Vault container where the groups will be added in the Identity Vault. This value becomes the default for all drivers in the driver set.

8  Click *Next*.

When all dependencies are installed, the components must be configured.

9  On the Driver Information page, specify a name for the driver that is unique within the driver set, then click *Next*.

10 On the Application Authentication page, fill in the following information for the connected database:

   **Version:** Specify the version of the connected database.

   **Synchronization Model:** Specify the mode of data synchronization based on the selected package.

   **Data Flow:** Specify whether the authoritative source of data is the database, Identity Manager, or bidirectional.

**IMPORTANT:** Ensure that you don’t change the setting for *Synchronization Model* and *Data Flow* options that you selected earlier in the Package Configuration Wizard.

**JDBC Implementation:** Specify the database connection details.

**Connection Information:** Specify the database information for the driver to use to connect to the database, such as the IP address, port, and type of the database.

If the database type is selected as SID, you need to enter the Oracle SID value. If the database type is selected as CDB, you need to enter the Oracle Service Name.

**Authentication ID:** Specify the authentication ID for the connected database.

**Password:** Specify the password for the driver to connect to the database.
For more information, see “JDBC Driver Settings” on page 49.

11 Click Next.

12 Fill in the following fields for Remote Loader information:

   **Connect To Remote Loader**: Select Yes or No to determine if the driver will use the Remote Loader. For more information, see “Configuring Identity Manager Drivers to Work with the Remote Loader” in the *NetIQ Identity Manager Driver Administration Guide*.

   If you select No, skip to Step 13. If you select Yes, use the following information to complete the configuration of the Remote Loader:

   **Host Name**: Specify the IP address or DNS name of the server where the Remote Loader is installed and running.

   **Port (Connection)**: Specify the port number for this driver object. Each driver object connects to the Remote Loader on a separate port. The default value is 8090.

   **Remote Loader Password**: Specify a password to control access to the Remote Loader. It must be the same password that is specified as the Remote Loader password on the Remote Loader.

   **Driver Password**: Specify a password for the driver object to authenticate to the Identity Manager server. It must be the same password that is specified as the Driver Object password on the Remote Loader.

13 Click Next.

14 (Conditional) This page is displayed only if you selected to install the Data Collection and Account Tracking groups of packages. On the JDBC Managed System Information page, fill in the following fields to define your connected database application:

   **Name**: Specify a descriptive name for the connected database application. The name is displayed in reports.

   **Description**: Specify a brief description for the connected database application. The description is displayed in reports.

   **Location**: Specify the physical location of the connected database application. The location is displayed in reports.

   **Vendor**: Specify the vendor of the connected database application. This information is displayed in reports.

   **Version**: Specify the version of the connected database application. The version is displayed in reports.

15 Click Next.

16 (Conditional) This page is displayed only if you selected to install the Managed System packages and the Account Tracking packages. On the Install JDBC Managed System Information page, fill in the following fields to define the classification of the connected database application:

   **Classification**: Select the classification of the connected database application. This information is displayed in the reports. Your options are:

   - Mission-Critical
   - Vital
   - Not-Critical
   - Other

   If you select Other, you must specify a custom classification for the JDBC system.

   **Environment**: Select the type of environment the connected database application provides. The options are:

   - Development
Creating a New Driver Object

- Test
- Staging
- Production
- Other

If you select Other, you must specify a custom classification for the database application.

17 Click Next.

18 (Conditional) This page is displayed only if you selected to install the Data Collection and Account Tracking groups of packages. Fill in the following fields to define the ownership of the connected database application:

**Business Owner:** Select a user object in the Identity Vault that is the business owner of the database application. This can only be a user object, not a role, group, or container.

**Application Owner:** Select a user object in the Identity Vault that is the application owner of the database application. This can only be a user object, not a role, group, or container.

19 Click Next.

20 On the Entitlements Information page, specify a name for the Account Entitlement Value field, then click Next.

21 (Conditional) This page is displayed only if you selected to install the Account Tracking groups of packages. On the Account Tracking page, fill in the following fields:

**Connected Database:** Specify the connected database application.

**Synchronization Model:** Specify the mode of data synchronization.

**NOTE:** Ensure that you don’t change the setting that you selected earlier in the Package Configuration Wizard. If you change it after installing the package in a driver object, make sure that you change the SyncModel in the Publication Mode GCV.

**Object Class:** This field is populated based on your selection in the Synchronization Model. Specify the table or view in the connected database for which account tracking is enabled. By default, the value is `usr`.

**Realm:** Specify the name of the realm that uniquely identifies the location of user accounts in the connected database. For example, `mysql间接.usr`, where MySQL is the database name with the indirect data synchronization model, and `user` is the table or view in the connected database for which account tracking is enabled.

22 Click Next.

23 Review the summary of tasks that will be completed to create the driver, then click Finish.

24 After you have installed the driver object, you must change the configuration for your environment. Proceed to “Configuring the Driver Object” on page 47.

**Configuring the Driver Object**

After importing the packages and creating the driver object, you need to configure the driver to make it operational. There are many settings that can help you customize and optimize the driver. Although it is important for you to understand all of the settings, your first priority should be to configure the driver parameters located on the Driver Configuration page. For information about the driver parameters, see Chapter 6, “Configuring the JDBC Driver,” on page 51. After completing the configuration tasks, continue with the next section, Deploying the Driver Object.
NOTE: If the connected system is MS SQL Server database and if you have chosen a direct Synchronization Model option, ensure that you change the Key-Gen-Method option to Subscriber Generated in the Subscriber channel.

Deploying the Driver Object

After the driver object is created in Designer, it must be deployed into the Identity Vault.

1. In Designer, open your project.
2. In the Modeler, right-click the driver icon or the driver line, then select Live > Deploy.
3. If you are authenticated to the Identity Vault, skip to Step 5; otherwise, specify the following information:
   - **Host**: Specify the IP address or DNS name of the server hosting the Identity Vault.
   - **Username**: Specify the DN of the user object used to authenticate to the Identity Vault.
   - **Password**: Specify the user’s password.
4. Click OK.
5. Read the deployment summary, then click Deploy.
6. Read the successful message, then click OK.
7. Click Define Security Equivalence to assign rights to the driver object:
   The driver object requires rights to objects within the Identity Vault. The Admin user object is most often used to supply these rights. However, you might want to create a DriversUser (for example) and assign security equivalence to that user. For receiving events from the Identity Vault, ensure that driver object’s Security Equals DN has the following rights in the Identity Vault:
   - **Entry Rights**: The rights to create entries in the Identity Vault.
   - **Attributes Rights**: The rights to modify the attributes in the Identity Vault.
   7a. Click Add, then browse to and select the object with the correct rights.
   7b. Click OK twice.
   For more information about defining a Security Equivalent User in objects for drivers in the Identity Vault, see “Establishing a Security Equivalent User” in the NetIQ Identity Manager Security Guide.
8. Click Exclude Administrative Roles to exclude users that should not be synchronized:
   You should exclude any administrative User objects (for example, Admin and DriversUser) from synchronization.
   8a. Click Add, then browse to and select the user object you want to exclude.
   8b. Click OK.
   8c. Repeat Step 8a and Step 8b for each object you want to exclude.
   8d. Click OK.
9. Click OK.
Starting the Driver Object

When a driver is created, it is stopped by default. To make the driver work, you must start the driver. Identity Manager is an event-driven system, so after the driver is started, it won’t do anything until an event occurs. You can use iManager or dxevent commands to start the driver.

To start the driver:

1. If you are using the Remote Loader with the driver, make sure the Remote Loader driver instance is running.
2. In Designer, open your project.
3. In the Modeler, right-click the driver icon or the driver line, then select Live > Start Driver.
4. Continue with “Activating the Driver” on page 49.

Activating the Driver

The Identity Manager driver for JDBC is part of the Identity Manager Integration Module for Database. This integration module requires a separate activation. After purchasing the integration module, you will receive activation details in your NetIQ Customer Center.

If you create a new JDBC driver in a driver set that already includes an activated driver from this integration module, the new driver inherits the activation from the driver set.

If you create the driver in a driver set that has not been previously activated with this integration module, the driver will run in the evaluation mode for 90 days. You must activate the driver with this integration module during the evaluation period; otherwise, the driver will be disabled.

If driver activation has expired, the trace displays an error message indicating that you need to reactivate the driver to use it. For information on activation, refer to Activating Identity Manager in the NetIQ Identity Manager Overview and Planning Guide.

JDBC Driver Settings

You can change the driver options to align with your connected database. Table 5-1 summarizes the JDBC driver settings.

Table 5-1 JDBC Driver Settings

<table>
<thead>
<tr>
<th>Setting</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Driver name</td>
<td>The name of the driver that you want to display in the driver set.</td>
</tr>
<tr>
<td>Target database</td>
<td>The database that the driver connects to.</td>
</tr>
<tr>
<td>Driver is local/remote</td>
<td>Whether the driver runs locally or remotely on a Remote Loader.</td>
</tr>
<tr>
<td>Synchronization model</td>
<td>Whether the driver uses views to synchronize directly to existing tables of arbitrary structure or synchronize to intermediate staging tables of a particular structure.</td>
</tr>
<tr>
<td>Setting</td>
<td>Description</td>
</tr>
<tr>
<td>--------------------------------</td>
<td>--------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Third-party JDBC implementation</td>
<td>The class of the third-party JDBC file specific to the database being synchronized with Identity Manager. For more information, see &quot;JDBC Driver Class Names&quot; on page 171.</td>
</tr>
<tr>
<td>Data flow</td>
<td>Whether the authoritative source of data is the database, Identity Manager, or bidirectional (both the database and Identity Manager).</td>
</tr>
<tr>
<td>Database host IP address</td>
<td>The IP address of the database host.</td>
</tr>
<tr>
<td>Database port</td>
<td>The port that the driver shim uses to communicate with the database. If you don’t provide a port number, the Driver Configuration Wizard provides a default port number for the database that you selected at install time.</td>
</tr>
<tr>
<td>User container DN</td>
<td>The distinguished name (complete context) of the container where the database users are published. For example: data\company\users.</td>
</tr>
<tr>
<td>Group container DN</td>
<td>The distinguished name (complete context) of the container where the database groups are published. For example: data\company\groups.</td>
</tr>
<tr>
<td>Publication mode</td>
<td>Whether publication is triggered (default) or triggerless.</td>
</tr>
</tbody>
</table>

Creating a New Driver Object
Smart Configuration

The JDBC driver can recognize the supported set of third-party JDBC drivers and databases. Also, the driver can dynamically and automatically configure the majority of driver compatibility parameters so you don’t need to understand and explicitly set such parameters.

These features are implemented via the following four types of XML descriptor files, which describe a third-party JDBC driver or database to the JDBC driver.

- Third-party JDBC driver
- Third-party JDBC driver import
- Database
- Database import

In addition to predefined descriptor files, you can create custom descriptor files for a database or third-party JDBC driver.

- “Specifying Custom Descriptor Files” on page 51
- “Reserved Filenames for Descriptor Files” on page 52
- “Import Descriptor Files” on page 52
- “Descriptor File Locations” on page 52
- “Precedence” on page 53
- “Custom Descriptor Best Practices” on page 53
- “Descriptor File DTDs” on page 53

Specifying Custom Descriptor Files

You can force the driver to use a custom descriptor file for a database or third-party JDBC driver. To specify a custom database descriptor file, see “Database Descriptor Filename” on page 68. To specify a custom third-party driver descriptor file, see “JDBC Driver Descriptor Filename” on page 68. This is useful when multiple descriptor files exist for the same database or third-party JDBC driver. For the custom descriptor file to take effect, set the driver parameter as the jdbc-driver-descriptor.
Reserved Filenames for Descriptor Files

Descriptor filenames that ship with the driver begin with the underscore character ( _ ). Such filenames are reserved to ensure that descriptor files that ship with the driver do not conflict with custom descriptor files. Obviously, custom descriptor filenames must not begin with the underscore character.

Import Descriptor Files

Import descriptor files allow multiple, nonimport descriptor files to share content. This functionality reduces the size of nonimport descriptor files, minimizes the need for repetition of content, and increases maintainability. Import files cannot be imported across major types. That is, JDBC driver descriptors cannot import database imports, and database descriptors cannot import JDBC driver imports.

Furthermore, custom nonimport descriptors cannot import reserved descriptor imports. For example, if a custom third-party JDBC driver descriptor file named custom.xml tries to import a reserved third-party JDBC driver descriptor named _reserved.xml, an error is issued. These limitations accomplish the following:

- Ensure that no dependencies exist between reserved and custom import files
- Allow extension of existing reserved descriptor files in later versions of the driver

Descriptor File Locations

Descriptor files must be located in a .jar file whose name begins with the prefix “jdbc” (case-insensitive) and resides in the runtime classpath.

The following table identifies where to place descriptors within a descriptor .jar file:

<table>
<thead>
<tr>
<th>Descriptor Type</th>
<th>Directory Path</th>
</tr>
</thead>
<tbody>
<tr>
<td>Third-party JDBC driver</td>
<td>com/novell/nds/dirxml/driver/jdbc/db/descriptor/</td>
</tr>
<tr>
<td></td>
<td>driver</td>
</tr>
<tr>
<td>Third-party JDBC driver import</td>
<td>com/novell/nds/dirxml/driver/jdbc/db/descriptor/</td>
</tr>
<tr>
<td></td>
<td>import</td>
</tr>
<tr>
<td>Database</td>
<td>com/novell/nds/dirxml/driver/jdbc/db/descriptor/db</td>
</tr>
<tr>
<td>Database import</td>
<td>com/novell/nds/dirxml/driver/jdbc/db/descriptor/db/import</td>
</tr>
</tbody>
</table>

Reserved descriptor files are located in the JDBCConfig.jar file. To ensure that these reserved files are not overwritten when the JDBC driver is updated, place custom descriptors in a different .jar file.
Precedence

Parameters explicitly specified through a management console, such as iManager, always have precedence over parameters specified through descriptor files. Descriptor file parameters only take effect when a parameter is not set through the management console.

Parameters and other information specified in a nonimportable descriptor file always have precedence over information specified in descriptor import files. If a parameter or other information is duplicated within a descriptor file, the first instance of the parameter or information takes precedence over subsequent instances.

Among import files, precedence is determined by import order. Import files declared earlier in the import list take precedence over those that follow.

Custom Descriptor Best Practices

- Do not begin custom descriptor files name with the underscore (_ ) character.
- Place custom descriptor files in a jar file other than JDBCConfig.jar, and begin the filename with the prefix “jdbc” (case-insensitive).
- Do not use custom descriptors to import reserved import files (filenames that begin with the underscore character).

Descriptor File DTDs

The following sections contain DTDs for all descriptor file types. These DTDs can help you construct custom descriptor files.

<table>
<thead>
<tr>
<th>Table 6-2 Where to Find Descriptor DTDs</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Descriptor Type</strong></td>
</tr>
<tr>
<td>Third-party JDBC driver</td>
</tr>
<tr>
<td>Third-party JDBC driver import</td>
</tr>
<tr>
<td>Database</td>
</tr>
<tr>
<td>Database import</td>
</tr>
</tbody>
</table>

Configuration Parameters

- “Viewing Driver Parameters” on page 53
- “Deprecated Parameters” on page 54
- “Authentication Parameters” on page 54

Viewing Driver Parameters

1. In iManager, click Identity Manager > Identity Manager Overview.
2. Locate the driver set containing the driver, then click the driver’s icon and edit properties.
   iManager displays the driver’s configuration parameters.
**Deprecated Parameters**

The following parameters have been deprecated since version 1.6:

**Table 6-3  Deprecated Parameters**

<table>
<thead>
<tr>
<th>Tag Name</th>
<th>Justification</th>
</tr>
</thead>
<tbody>
<tr>
<td>connection-tester-class</td>
<td>The driver now dynamically creates a connection tester class at runtime, based upon information in XML descriptor files. This parameter is still operable, to ensure backwards compatibility. Its continued use, however, is discouraged.</td>
</tr>
<tr>
<td>connection-test-stmt</td>
<td>The driver now dynamically creates a connection tester class at runtime, based upon information in XML descriptor files. This parameter is still operable, to ensure backwards compatibility. Its continued use, however, is discouraged.</td>
</tr>
<tr>
<td>reconnect-interval</td>
<td>The reconnect interval is now fixed at 30 seconds on both channels.</td>
</tr>
</tbody>
</table>

**Authentication Parameters**

After you import the driver, provide authentication information for the target database.

- “Authentication ID” on page 54
- “Authentication Context” on page 54
- “Application Password” on page 55

**Authentication ID**

An Authentication ID is the name of the driver’s database user/login account. The installation SQL script for each database provides information on the database privileges required for this account to authenticate to a supported database. The scripts are located in the `install-dir\DirXMLUtilities\jdbc\sql\abbreviated-database-name\install` directory.

This value can be referenced in the Connection Properties parameter value via the token `{username}`. See "Connection Properties" on page 66.

The default value for the sample configuration is `idm`.

**Authentication Context**

The authentication context is the JDBC URL of the target database.

URL format and content are proprietary. They differ among third-party JDBC drivers. However, they have some similarities in content. Each URL, whatever the format, usually includes an IP address or DNS name, port number, and a database identifier. For the exact syntax and the content requirements of your driver, consult your third-party driver documentation.

For a list of JDBC URL syntaxes for supported third-party drivers, see “JDBC URL Syntaxes” on page 171.

**IMPORTANT**: Changing anything in this value other than URL properties forces a resynchronization of all objects when triggerless publication is used.
Application Password

An application password is the password for the driver’s database user/login account. The default value for the sample driver configuration is novell.

This value can be referenced in the Connection Properties parameter value via the token {$password}. See “Connection Properties” on page 66.

Driver Parameters

The Driver Parameters section lets you configure the driver-specific parameters. When you change driver parameters, you tune driver behavior to align with your network environment. The following table summarizes all driver-level parameters and their properties:

<table>
<thead>
<tr>
<th>Display Name</th>
<th>Tag Name</th>
<th>Sample Value</th>
<th>Default Value</th>
<th>Required</th>
</tr>
</thead>
<tbody>
<tr>
<td>Third-Party JDBC Driver Class Name</td>
<td>jdbc-class</td>
<td>oracle.jdbc.driver.OracleDriver</td>
<td>(none)</td>
<td>yes</td>
</tr>
<tr>
<td>Preserve white space in SQL statements?</td>
<td>preserve-sqlwhitespace</td>
<td>yes</td>
<td>no</td>
<td>yes</td>
</tr>
<tr>
<td>Synchronization Filter</td>
<td>sync-filter</td>
<td>schema (include by schema membership)</td>
<td>(none)</td>
<td>no</td>
</tr>
<tr>
<td>Time Syntax</td>
<td>time-syntax</td>
<td>1 (integer)</td>
<td>1 (integer)</td>
<td>no</td>
</tr>
<tr>
<td>State directory</td>
<td>state-dir</td>
<td>. (current directory)</td>
<td>. (current directory)</td>
<td>no</td>
</tr>
<tr>
<td>Use Minimal Number of Connections?</td>
<td>use-single-connection</td>
<td>0 (no)</td>
<td>(dynamic^3)</td>
<td>no</td>
</tr>
<tr>
<td>Connection Initialization Statements</td>
<td>connection-init</td>
<td>USE idm</td>
<td>(none)</td>
<td>no</td>
</tr>
<tr>
<td>Connection Properties</td>
<td>connection-properties</td>
<td>USER={$username}; PASSWORD={$password}</td>
<td>(dynamic^3)</td>
<td>no</td>
</tr>
<tr>
<td>JDBC Driver Descriptor Filename</td>
<td>jdbc-driver-descriptor</td>
<td>ora_client_thin.xml</td>
<td>(none)</td>
<td>no</td>
</tr>
<tr>
<td>Database Descriptor Filename</td>
<td>database-descriptor</td>
<td>ora_11i.xml</td>
<td>(none)</td>
<td>no</td>
</tr>
<tr>
<td>Enable Referential Attribute Support?</td>
<td>enable-refs</td>
<td>1 (yes)</td>
<td>1 (yes)</td>
<td>no</td>
</tr>
<tr>
<td>Enable Meta-Identifier Support?</td>
<td>enable-meta-identifiers</td>
<td>1 (yes)</td>
<td>1 (yes)</td>
<td>no</td>
</tr>
<tr>
<td>Use Manual Transactions?</td>
<td>use-manual-transactions</td>
<td>1 (yes)</td>
<td>(dynamic^2)</td>
<td>no</td>
</tr>
<tr>
<td>Transaction Isolation Level</td>
<td>transaction-isolation-level</td>
<td>read committed</td>
<td>(dynamic^3)</td>
<td>no</td>
</tr>
<tr>
<td>Display Name</td>
<td>Tag Name</td>
<td>Sample Value</td>
<td>Default Value</td>
<td>Required</td>
</tr>
<tr>
<td>-----------------------------------------</td>
<td>------------------------------</td>
<td>----------------------</td>
<td>---------------</td>
<td>----------</td>
</tr>
<tr>
<td>Reuse Statements?</td>
<td>reuse-statements</td>
<td>1 (reuse)</td>
<td>(dynamic&lt;sup&gt;3&lt;/sup&gt;)</td>
<td>no</td>
</tr>
<tr>
<td>Number of Returned Result Sets</td>
<td>handle-stmt-results</td>
<td>one</td>
<td>(dynamic&lt;sup&gt;3&lt;/sup&gt;)</td>
<td>no</td>
</tr>
<tr>
<td>Enable Statement-Level Locking?</td>
<td>enable-locking</td>
<td>1 (yes)</td>
<td>0 (no)</td>
<td>no</td>
</tr>
<tr>
<td>Force Username Case</td>
<td>force-username-case</td>
<td>upper (to uppercase)</td>
<td>(none)</td>
<td>no</td>
</tr>
<tr>
<td>Left Outer Join Operator</td>
<td>left-outer-join-operator</td>
<td>(+)</td>
<td>(dynamic&lt;sup&gt;3&lt;/sup&gt;)</td>
<td>no</td>
</tr>
<tr>
<td>Retrieve Minimal Metadata</td>
<td>minimal-metadata</td>
<td>0 (no)</td>
<td>(dynamic&lt;sup&gt;3&lt;/sup&gt;)</td>
<td>no</td>
</tr>
<tr>
<td>Function Return Method</td>
<td>function-return-method</td>
<td>result set</td>
<td>(dynamic&lt;sup&gt;3&lt;/sup&gt;)</td>
<td>no</td>
</tr>
<tr>
<td>Supports Schemas in Metadata Retrieval?</td>
<td>supports-schemas-in-metadata-retrieval</td>
<td>1 (yes)</td>
<td>(dynamic&lt;sup&gt;3&lt;/sup&gt;)</td>
<td>no</td>
</tr>
<tr>
<td>Sort Column Names By</td>
<td>column-position-comparator</td>
<td>com.novell.nds.dirxml.drive.jdbc.util.config.com.StringByteComparator (hexadecimal value)</td>
<td>(dynamic&lt;sup&gt;3&lt;/sup&gt;)</td>
<td>no</td>
</tr>
<tr>
<td>Schema Name</td>
<td>sync-schema</td>
<td>indirect</td>
<td>(none)</td>
<td>yes&lt;sup&gt;1&lt;/sup&gt;</td>
</tr>
<tr>
<td>Include Filter Expression</td>
<td>include-table-filter</td>
<td>IDM_.*</td>
<td>(none)</td>
<td>no</td>
</tr>
<tr>
<td>Exclude Filter Expression</td>
<td>exclude-table-filter</td>
<td>BIN$(22)$0</td>
<td>(none)</td>
<td>no</td>
</tr>
<tr>
<td>Table/View Names</td>
<td>sync-tables</td>
<td>usr</td>
<td>(none)</td>
<td>yes&lt;sup&gt;1&lt;/sup&gt;</td>
</tr>
<tr>
<td>Lock Statement Generator Class</td>
<td>lock-generator-class</td>
<td>com.novell.nds.dirxml.drive.jdbc.db.lock.OraLockGenerator</td>
<td>(dynamic&lt;sup&gt;3&lt;/sup&gt;)</td>
<td>no</td>
</tr>
</tbody>
</table>

<sup>1</sup> One of these mutually exclusive parameters must be present if the Synchronization Filter parameter is not present. See “Synchronization Filter” on page 61. <sup>2</sup> This default is derived dynamically at runtime from descriptor files and database metadata. <sup>3</sup> This default is derived dynamically from descriptor files at runtime.

Driver parameters fall into the following subcategories:

- “Uncategorized Parameters” on page 57
- “Database Scoping Parameters” on page 60
- “Connectivity Parameters” on page 65
- “Compatibility Parameters” on page 67
Uncategorized Parameters

- “Third-Party JDBC Driver Class Name” on page 57
- “Time Syntax” on page 57
- “State Directory” on page 59

Third-Party JDBC Driver Class Name

This parameter is the fully-qualified Java class name of your third-party JDBC driver.

The following table lists the properties of this parameter:

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tag Name</td>
<td>jdbc-class</td>
</tr>
<tr>
<td>Required?</td>
<td>yes</td>
</tr>
<tr>
<td>Case-Sensitive?</td>
<td>yes</td>
</tr>
<tr>
<td>Sample Value</td>
<td>oracle.jdbc.driver.OracleDriver</td>
</tr>
<tr>
<td>Default Value</td>
<td>(none)</td>
</tr>
</tbody>
</table>

For a list of supported third-party JDBC driver classnames, see “JDBC Driver Class Names” on page 171.

Time Syntax

The Time Syntax parameter specifies the format of time-related data types that the driver returns. The format can be any of the following options:

- “Return Database Time, Date, and Timestamp Values as 32-Bit Integers” on page 57
- “Return Database Time, Date, and Timestamp Values as Canonical Strings” on page 58
- “Return database Time, Date, and Timestamp Values in their Java String Representation as Returned by the Method toString():java.lang.String” on page 58

Return Database Time, Date, and Timestamp Values as 32-Bit Integers

This is the default.

eDirectory Time and Timestamp syntaxes are composed of unsigned, 32-bit integers that express the number of whole seconds that have elapsed since 12:00 a.m., January 1st, 1970 UTC. The maximum range of this data type is approximately 136 years. When interpreted as unsigned integers (as originally intended), these syntaxes are capable of expressing dates and times to the second in the range of 1970 to 2106. When interpreted as a signed integer, these syntaxes are capable of expressing dates and times to the second in the range of 1901 to 2038.
This option has two problems:

- Identity Vault Time and Timestamp syntaxes cannot express as large a date range as database Date or Timestamp syntaxes.
- Identity Vault Time and Timestamp syntaxes are granular to the second. Database Timestamp syntaxes are often granular to the nanosecond.

The second and third options overcome these two limitations.

Map the database Time, Date, and Timestamp values to eDirectory attributes of type Time or Timestamp.

**Return Database Time, Date, and Timestamp Values as Canonical Strings**

The following table shows abstract database data types and their corresponding canonical string representations:

<table>
<thead>
<tr>
<th>Database Types and Canonical String Representations</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Table 6-6</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>JDBC Data Type</th>
<th>Canonical String Format1</th>
</tr>
</thead>
<tbody>
<tr>
<td>java.sql.Time</td>
<td>HHMMSS</td>
</tr>
<tr>
<td>java.sql.Date</td>
<td>CCYYMMDD</td>
</tr>
<tr>
<td>java.sql.Timestamp</td>
<td>CCYYMDDHHMMSSNNNNNNNNNN</td>
</tr>
</tbody>
</table>

C = century, Y = year, M = month D = day, H = hour, M= minute, S = second, N = nano

These fixed-length formats collate in chronological order on any platform in any locale. Even though the precision of nanoseconds varies by database, the length of Timestamps does not.

Map the database Time, Date, and Timestamp values to attributes of type Numeric String.

**Return database Time, Date, and Timestamp Values in their Java String Representation as Returned by the Method toString():java.lang.String**

The following table shows abstract database data types and their corresponding Java String representations:

<table>
<thead>
<tr>
<th>Database Types and Java String Formats</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Table 6-7</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>JDBC Data Type</th>
<th>Java String Format1</th>
</tr>
</thead>
<tbody>
<tr>
<td>java.sql.Time</td>
<td>hh:mm:ss</td>
</tr>
<tr>
<td>java.sql.Date</td>
<td>yyyy-mm-dd</td>
</tr>
<tr>
<td>java.sql.Timestamp</td>
<td>yyyy-mm-dd hh:mm:ss.ffffffff</td>
</tr>
</tbody>
</table>

y= year, m= month, d= day, h= hour, m= minute, s= second, f= nano

These fixed-length formats collate in chronological order on any platform in any locale. The precision of nanoseconds, and therefore the length of Timestamps, varies by database.

Map the database Time, Date, and Timestamp values to attributes of type Case Ignore/Case Exact String.
The following table lists the properties of the Time Syntax parameter:

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tag Name</td>
<td>time-syntax</td>
</tr>
<tr>
<td>Required?</td>
<td>no</td>
</tr>
<tr>
<td>Default Value</td>
<td>1 (integer)</td>
</tr>
<tr>
<td>Legal Values</td>
<td>1 (integer) 2 (canonical string) 3 (java string)</td>
</tr>
<tr>
<td>Schema-Dependent?</td>
<td>True</td>
</tr>
</tbody>
</table>

**State Directory**

The State Directory parameter specifies where a driver instance should store state data. The state data is currently used for both triggered and triggerless publication. For more information, see Triggered Publication Parameters and Triggerless Publication Parameters. The state data might be used to store additional state information in the future.

Each driver instance can have a maximum of four state files with a unique file format, such as:

- jdbc_<driver instance guid> - Triggerless Publication (only used for Triggerless configured drivers)
- jdbc_<driver instance guid>_0 - Subscriber Query
- jdbc_<driver instance guid>_1 - Publisher Query
- jdbc_<driver instance guid>_2 - Subscriber Service Query

For example, jdbc_bd2a3dd5-d571-4171-a195-28869577b87e_0

Defunct state files (those belonging to deleted drivers) in the state directory are deleted each time a driver instance with the same state directory is started.

**Changes That Can Force Triggerless Publisher Resynchronization**

If you delete state files, the triggerless publisher will build new state files by resynchronizing. If you move the JDBC driver without moving the state files, the triggerless publisher builds new state files by resynchronizing. Changing to and from the Remote Loader is a move. Therefore, if you move the JDBC driver using triggerless publication and want to prevent a full resynchronization, also move the jdbc_<GUID> file in the state directory.

When you move your driver to a new server, the process includes creating a new driver object on the new server. The newly created driver object will have its own GUID. Therefore, copying the state files of the old driver to the new server does not work even if the driver versions are same (or have the same state file extensions). In order to prevent resynchronization, ensure that Triggerless Publication Legal Values 2 (process future changes only) option is set in the driver properties.

If more than two files exist in the specified state directory, you must look up the GUID to know which files belong to the driver instance being moved. To identify a driver instance’s state files, you can use DSTrace. For convenience, the Identity Manager engine traces each driver’s GUID in DSTrace on startup.
If no value is provided for the state directory parameter, or the value is a period (.), the state directory is the current directory. The current directory depends upon the following:

- The platform that the driver is running on
- Whether the driver is running locally or remotely

When a process is started, a default directory in the file system is assigned to it. The default directory is the current directory. If you don't supply a value, the default State Directory is the current directory (the one that the process is running in).

**Table 6-9  Default Directories**

<table>
<thead>
<tr>
<th>Platform or Environment</th>
<th>Default Directory</th>
</tr>
</thead>
<tbody>
<tr>
<td>Linux and Solaris, for the Remote Loader</td>
<td>/opt/novell/dirxml</td>
</tr>
<tr>
<td>Linux and Solaris, for Identity Manager (local; not on the Remote Loader)</td>
<td>/var/opt/novell/eDirectory/data/dib/</td>
</tr>
<tr>
<td>Windows, for the Remote Loader</td>
<td>novell\remoteloader</td>
</tr>
<tr>
<td>Windows, for Identity Manager (local; not on the Remote Loader)</td>
<td>c:\novell\nds\dibfiles</td>
</tr>
</tbody>
</table>

The current directory might be different for a custom installation.

No data is lost when resynchronization occurs, although additional data might remain. For example, because deletes are not captured, users that were deleted in the database during the move will not be disabled/deleted (depending upon the policy).

Moving the driver is not to be undertaken whimsically. As a rule of thumb, don't move the driver unless you must do so.

**Properties**

The following table lists the properties of the State Directory parameter:

**Table 6-10  State Directory: Properties**

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tag Name</td>
<td>state-dir</td>
</tr>
<tr>
<td>Required?</td>
<td>no</td>
</tr>
<tr>
<td>Case-Sensitive?</td>
<td>platform-dependent</td>
</tr>
<tr>
<td>Sample Value</td>
<td>c:\novell\nds\DIBFiles</td>
</tr>
<tr>
<td>Default Value</td>
<td>. (current directory)</td>
</tr>
</tbody>
</table>

**Database Scoping Parameters**

- “Synchronization Filter” on page 61
- “Schema Name” on page 63
- “Include Filter Expression” on page 63
Synchronization Filter

The Synchronization Filter parameter determines which database objects, such as tables and views, are members of the synchronization schema (the set of tables/views visible to the driver at runtime). With the addition of this parameter, the driver can now run in two modes: schema-aware or schema-unaware.

Schema-Unaware Mode

When the Synchronization Filter parameter is present and set to empty (exclude all tables/views), the driver is schema-unaware. It does not retrieve table/view metadata on startup. Therefore, no metadata methods are required. See Appendix F, "java.sql.DatabaseMetaData Methods," on page 211.

When it is schema-unaware, the synchronization schema can be empty. Both the Schema Name and Sync Tables/Views parameters are completely ignored. Neither is required. Both can be absent, present, valued or valueless. See “Schema Name” on page 63 and “Table/View Names” on page 64.

In schema-unaware mode, the driver acts as a passthrough agent for embedded SQL. In this state, standard XDS events (for example, Add, Modify, and Delete) are ignored. See Chapter 12, "Embedded SQL Statements in XDS Events," on page 133. Also, triggered or triggerless publication no longer work.

Schema-Aware Mode

When the Synchronization Filter parameter is not present or set to a value other than empty (exclude all tables/views), the driver is schema-aware. It retrieves table/view metadata on a limited number of tables/views to facilitate data synchronization. You can cache metadata on all tables/views owned by a single database user (include by schema membership), or cache metadata on an explicit list of table/view names (include by table/view name). When schema-aware, the driver retrieves database table/view metadata on startup. For a list of required metadata methods, see Appendix F, “java.sql.DatabaseMetaData Methods,” on page 211.

When schema-aware, parameter Schema Name or Table/View Names must be present and have a value. Because these two parameters are mutually exclusive, only one parameter can have a value. See “Schema Name” on page 63 and “Table/View Names” on page 64.

The following table lists the parameters that require the driver to be schema-aware. When the driver is schema-unaware, these parameters do not have any effect on driver behavior.

<table>
<thead>
<tr>
<th>Parameter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lock Statement Generator Class</td>
</tr>
<tr>
<td>Enable Referential Attribute Support?</td>
</tr>
<tr>
<td>Enable Meta-Identifier Support?</td>
</tr>
<tr>
<td>Left Outer Join Operator</td>
</tr>
<tr>
<td>Retrieve Minimal Metadata</td>
</tr>
</tbody>
</table>
Configuring the JDBC Driver

The following table lists the properties of the Synchronization Filter parameter:

Table 6-12  Synchronization Filter: Properties

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tag Name</td>
<td>sync-filter</td>
</tr>
<tr>
<td>Required?</td>
<td>no</td>
</tr>
<tr>
<td>Case-Sensitive?</td>
<td>no</td>
</tr>
<tr>
<td>Sample Value</td>
<td>list</td>
</tr>
<tr>
<td>Legal Values</td>
<td>empty (exclude all tables/views), schema (include by schema membership), list (include by table/view name)</td>
</tr>
<tr>
<td>Default Value:</td>
<td>(none)</td>
</tr>
</tbody>
</table>
Schema Name

The Schema Name parameter identifies the database schema being synchronized. A database schema is analogous to the name of the owner of the tables or views being synchronized. For example, to synchronize two tables, `usr` and `grp`, each belonging to database user `idm`, you enter `idm` as this parameter’s value. For more information about the Schema Name use cases, see “Schema Name Use Cases” on page 201.

When using this parameter instead of Table/View Names, names of database objects are implicitly schema-qualified by the driver. As such, parameters referencing stored procedure, function, or table names do not need to be schema-qualified unless they reside in a schema other than the one specified here. In particular, Method and Timing (Table-Local) and Event Log Table Name are affected. See “Table/View Names” on page 64, “Method and Timing (Table-Local)” on page 82, and “Event Log Table Name” on page 89.

The following table lists the properties of the Schema Name parameter:

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tag Name</td>
<td>sync-schema</td>
</tr>
<tr>
<td>Required?</td>
<td>yes</td>
</tr>
<tr>
<td>Case-Sensitive?</td>
<td>See “Undelimited Identifier Case Sensitivity” on page 161.</td>
</tr>
<tr>
<td>Sample Value</td>
<td>indirect</td>
</tr>
<tr>
<td>Default Value:</td>
<td>(none)</td>
</tr>
</tbody>
</table>

When the Schema Name parameter is used without the Synchronization Filter parameter, the Table/View Names parameter must be left empty or omitted from a configuration. See “Synchronization Filter” on page 61 and “Table/View Names” on page 64.

Changing the value of the Schema Name parameter forces a resync of all objects when triggerless publication is used.

Include Filter Expression

The Include Filter Expression parameter is only operative when the Schema Name parameter is used. See “Schema Name” on page 63.

The following table lists the properties of the Include Filter Expression parameter:
Table 6-14 Include Filter Expression: Properties

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tag Name</td>
<td>include-table-filter</td>
</tr>
<tr>
<td>Required?</td>
<td>no</td>
</tr>
<tr>
<td>Case-Sensitive?</td>
<td>yes</td>
</tr>
<tr>
<td>Sample Value</td>
<td>idm_.* (all table/view names starting with “idm_.”)</td>
</tr>
<tr>
<td>Default Value</td>
<td>(none)</td>
</tr>
<tr>
<td>Legal Values</td>
<td>(any legal Java regular expression)</td>
</tr>
</tbody>
</table>

Exclude Filter Expression

This parameter is only operative when the Schema Name parameter is used. See “Schema Name” on page 63.

The following table lists the properties of the Exclude Filter Expression parameter:

Table 6-15 Exclude Filter Expression: Properties

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tag Name</td>
<td>exclude-table-filter</td>
</tr>
<tr>
<td>Required?</td>
<td>no</td>
</tr>
<tr>
<td>Case-Sensitive?</td>
<td>yes</td>
</tr>
<tr>
<td>Sample Value</td>
<td>bin.* (all table/view names starting with “bin”)</td>
</tr>
<tr>
<td>Default Value</td>
<td>(none)</td>
</tr>
<tr>
<td>Legal Values</td>
<td>(any legal Java regular expression)</td>
</tr>
</tbody>
</table>

Table/View Names

The Table/View Names parameter allows you to create a logical database schema by listing the names of the logical database classes to synchronize. Logical database class names are the names of parent tables and views. It is incorrect to list child table names.

This parameter is particularly useful for synchronizing with databases that do not support the concept of schema, such as MySQL, or when a database schema contains a large number of tables or views of which only a few are of interest. Reducing the number of table/view definitions cached by the driver can shorten startup time as well as reduce runtime memory utilization.

When using this parameter instead of Schema Name, you probably need to schema-qualify other parameters that reference stored procedure, function, or table names. In particular, the Method and Timing (Table-Local) and Event Log Table Name parameters are affected. See “Schema Name” on page 63, “Method and Timing (Table-Local)” on page 82 and “Event Log Table Name” on page 89.

The following table lists the properties of the Table/View Names parameter:
Table 6-16  Table/View Names: Properties

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tag Name</td>
<td>sync-tables</td>
</tr>
<tr>
<td>Required?</td>
<td>yes</td>
</tr>
<tr>
<td>Case-Sensitive?</td>
<td>See “Undelimited Identifier Case Sensitivity” on page 161.</td>
</tr>
<tr>
<td>Delimiters</td>
<td>semicolon, white space, comma</td>
</tr>
<tr>
<td>Sample Value</td>
<td>indirect.usr; indirect.grp</td>
</tr>
<tr>
<td>Default Value</td>
<td>(none)</td>
</tr>
</tbody>
</table>

When this parameter is used without the Synchronization Filter parameter, the Schema Name parameter must be left empty or omitted from a configuration. See “Synchronization Filter” on page 61 and “Schema Name” on page 63.

Changing anything in the Table/View Name parameter other than URL properties forces a resynchronization of all objects when triggerless publication is used.

Connectivity Parameters

- “Use Minimal Number of Connections?” on page 65
- “Connection Initialization Statements” on page 66
- “Connection Properties” on page 66

Use Minimal Number of Connections?

The Use Minimal Number of Connections? parameter specifies whether the driver should use two instead of three database connections.

By default, the driver uses three connections: one for subscription, and two for publication. The Publisher channel uses one of its two connections to query for events and the other to facilitate query-back operations.

When this parameter is set to Boolean True, the number of required database connections is reduced to two. One connection is shared between the Subscriber and Publisher channels. It is used to process subscription and publication query-back events. The other is used to query for publication events.

In previous versions, the driver was able to support bidirectional synchronization by using a single connection. The publication algorithm was redesigned to increase performance, enable support for future event processing, and to overcome limitations of the previous algorithm at the expense of requiring an additional connection.
Configuring the JDBC Driver

Table 6-17  Use Minimal Number of Connections?: Properties

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tag Name</td>
<td>use-single-connection</td>
</tr>
<tr>
<td>Required?</td>
<td>no</td>
</tr>
<tr>
<td>Default Value</td>
<td>(dynamic)</td>
</tr>
<tr>
<td>Legal Values</td>
<td>1, yes, true (yes) 0, no, false (no)</td>
</tr>
<tr>
<td>Schema-Dependent</td>
<td>False</td>
</tr>
</tbody>
</table>

The Default Value property is derived dynamically from descriptor files at runtime. Otherwise, the default value is Boolean False.

Setting this parameter to Boolean True reduces performance.

Connection Initialization Statements

The Connection Initialization Statements parameter specifies what SQL statements, if any, should be executed immediately after connecting to the target database. Connection initialization statements are useful for changing database contexts and setting session properties. These statements are executed each time the driver, irrespective of channel, connects or reconnects to the target database.

The following table lists the properties of this parameter:

Table 6-18  Connection Initialization Statements: Properties

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tag Name</td>
<td>connection-init</td>
</tr>
<tr>
<td>Required?</td>
<td>no</td>
</tr>
<tr>
<td>Case-Sensitive?</td>
<td>See “Undelimited Identifier Case Sensitivity” on page 161.</td>
</tr>
<tr>
<td>Delimiters</td>
<td>semicolon</td>
</tr>
<tr>
<td>Sample Value</td>
<td>USE idm; SET CHAINED OFF</td>
</tr>
<tr>
<td>Default Value</td>
<td>(none)</td>
</tr>
<tr>
<td>Schema-Dependent</td>
<td>False</td>
</tr>
</tbody>
</table>

Connection Properties

The Connection Properties parameter specifies authentication properties. This parameter is useful for specifying properties that cannot be set via the JDBC URL specified in the Authentication Context parameter. See “Authentication Context” on page 54.

The primary purpose of this parameter is to enable encrypted transport for third-party JDBC drivers. For a list of relevant connection properties, see “Sybase Adaptive Server Enterprise JConnect JDBC Driver” on page 183 and “Oracle Thin Client JDBC Driver” on page 179.

Connection properties are specified as key-value pairs. The key is specified as the value to the left of the “=” character. The value is the value to the right of the “=” character. You can specify multiple key-value pairs, but each pair must be delimited by the “;” character.
When you use the Connection Properties parameter, authentication information can be passed via the JDBC URL specified in the Authentication Context parameter or here. See "Authentication Context" on page 54.

If specified as connection properties, value tokens can be used as placeholders for the database username specified in the Authentication ID parameter and the password specified in the Application Password parameter. See “Authentication ID” on page 54 and “Application Password” on page 55. For username, the token is \{username\}. For password, the token is \{password\}.

The following table lists the properties of this parameter:

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tag Name</td>
<td>connection-properties</td>
</tr>
<tr>
<td>Required?</td>
<td>no</td>
</tr>
<tr>
<td>Case-Sensitive?</td>
<td>third-party JDBC driver-dependent</td>
</tr>
<tr>
<td>Delimiters</td>
<td>semicolon</td>
</tr>
<tr>
<td>Sample Value</td>
<td>user={username}; password={password}; oracle.jdbc.defaultNChar=true</td>
</tr>
<tr>
<td>Default Value</td>
<td>(none)</td>
</tr>
<tr>
<td>Schema-Dependent</td>
<td>False</td>
</tr>
</tbody>
</table>

Each connection property is a key value pair. You can add any number of connection properties in the driver configuration. You must append username and password (user=\{username\}; password=\{password\}) to the additional connection properties. Separate each connection property using delimiters.

**Compatibility Parameters**

- “JDBC Driver Descriptor Filename” on page 68
- “Database Descriptor Filename” on page 68
- “Use Manual Transactions?” on page 69
- “Transaction Isolation Level” on page 69
- “Reuse Statements?” on page 70
- “Number of Returned Result Sets” on page 71
- “Enable Statement-Level Locking?” on page 71
- “Lock Statement Generator Class” on page 72
- “Enable Referential Attribute Support?” on page 72
- “Enable Meta-Identifier Support?” on page 73
- “Force Username Case” on page 73
- “Left Outer Join Operator” on page 74
- “Retrieve Minimal Metadata” on page 74
- “Function Return Method” on page 75
- “Supports Schemas in Metadata Retrieval?” on page 75
JDBC Driver Descriptor Filename

The JDBC Driver Descriptor Filename parameter specifies the third-party JDBC descriptor file to use. Descriptor file names must not be prefixed with the underscore character (for example, _mysql_jdriver.xml) because such filenames are reserved. Place descriptor files in a jar file beginning with the case-insensitive prefix 'jdbc' (for example jdbcCustomConfig.jar) in the jar file's com/novell/nds/dirxml/driver/jdbc/db/descriptor/db directory.

The following table lists the properties of this parameter:

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tag Name</td>
<td>jdbc-driver-descriptor</td>
</tr>
<tr>
<td>Required?</td>
<td>no</td>
</tr>
<tr>
<td>Case-Sensitive?</td>
<td>platform-dependent</td>
</tr>
<tr>
<td>Sample Value</td>
<td>my_custom_jdbc_driver_descriptor.xml</td>
</tr>
<tr>
<td>Default Value</td>
<td>(none)</td>
</tr>
<tr>
<td>Schema-Dependent</td>
<td>False</td>
</tr>
</tbody>
</table>

Database Descriptor Filename

The Database Descriptor Filename parameter specifies the database descriptor file to use. Do not use the underscore character in prefixes to Descriptor filenames (for example, _mysql.xml). Such names are reserved. Place Descriptor files in a jar file beginning with the case-insensitive prefix "jdbc" (for example, JDBCConfig.jar). Also, place Descriptor files in the jar file's com/novell/nds/dirxml/driver/jdbc/db/descriptor/db directory.

The following table lists the properties of this parameter:

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tag Name</td>
<td>jdbc-driver-descriptor</td>
</tr>
<tr>
<td>Required?</td>
<td>no</td>
</tr>
<tr>
<td>Case-Sensitive?</td>
<td>platform-dependent</td>
</tr>
<tr>
<td>Sample Value</td>
<td>my_custom_database_descriptor.xml</td>
</tr>
<tr>
<td>Default Value</td>
<td>(none)</td>
</tr>
<tr>
<td>Schema-Dependent</td>
<td>False</td>
</tr>
</tbody>
</table>
Use Manual Transactions?

The Use Manual Transactions? parameter specifies whether to use manual or user-defined transactions.

This parameter is primarily used to enable interoperability with MySQL MyISAM table types, which do not support transactions.

When set to Boolean True, the driver uses manual transactions. When set to Boolean False, each statement executed by the driver is executed autonomously (automatically).

The following table lists the properties of this parameter:

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tag Name</td>
<td>use-manual-transactions</td>
</tr>
<tr>
<td>Required?</td>
<td>no</td>
</tr>
<tr>
<td>Case-Sensitive?</td>
<td>no</td>
</tr>
<tr>
<td>Default Value</td>
<td>(dynamic)</td>
</tr>
<tr>
<td>Legal Values</td>
<td>1, yes, true (yes) 0, no, false (no)</td>
</tr>
<tr>
<td>Schema-Dependent</td>
<td>False</td>
</tr>
</tbody>
</table>

The Default Value property is derived dynamically from descriptor files and database metadata at runtime.

To ensure data integrity, set this parameter to Boolean True whenever possible.

Transaction Isolation Level

The Transaction Isolation Level parameter sets the transaction isolation level for connections that the driver uses. Six values exist:

- unsupported
- none
- read uncommitted
- read committed
- repeatable read
- Serializable

Five of the values correspond to the public constants defined in the java.sql Interface Connection (http://java.sun.com/j2se/1.5.0/docs/api/java/sql/Connection.html).

Because some third-party drivers do not support setting a connection’s transaction isolation level to none, the driver also supports the additional non-standardized value of unsupported. PostgreSQL online documentation (http://www.postgresql.org/docs/current/static/transaction-iso.html) has one of the better, concise primers on what each isolation level actually means.
**IMPORTANT:** The list of supported isolation levels varies by database. For a list of supported transaction isolation levels for supported databases, see "Supported Transaction Isolation Levels" on page 161.

We recommend using a transaction isolation level of **read committed** because it is the minimum isolation level that prevents the driver from seeing uncommitted changes (dirty reads).

The following table lists the properties of this parameter:

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tag Name</td>
<td>transaction-isolation-level</td>
</tr>
<tr>
<td>Required?</td>
<td>no</td>
</tr>
<tr>
<td>Case-Sensitive?</td>
<td>no</td>
</tr>
<tr>
<td>Default Value</td>
<td>(dynamic)</td>
</tr>
<tr>
<td>Legal Values</td>
<td>unsupported, none, read uncommitted, read committed, repeatable read, serializable</td>
</tr>
<tr>
<td>Schema-Dependent</td>
<td>False</td>
</tr>
</tbody>
</table>

The Default Value property is derived dynamically from descriptor files at runtime. Otherwise, the default value is read committed.

**Reuse Statements?**

The Reuse Statements? parameter specifies whether one or more java.sql.Statement items are active at a time on a given connection. See [java.sql.Statement](http://java.sun.com/j2se/1.5.0/docs/api/java/sql/Statement.html).

This parameter is primarily used to enable interoperability with "Microsoft JDBC Driver for SQL Server" on page 175

When set to Boolean True, the driver allocates a Java SQL Statement once and then reuses it. When set to Boolean False, the driver allocates/deallocates statement objects each time they are used, ensuring that no more than one statement is active at a time on a given connection.

The following table lists the properties of this parameter:
**Table 6-24  Reuse Statements?: Properties**

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tag Name</td>
<td>reuse-statements</td>
</tr>
<tr>
<td>Required?</td>
<td>no</td>
</tr>
<tr>
<td>Case-Sensitive?</td>
<td>no</td>
</tr>
<tr>
<td>Default Value</td>
<td>(dynamic)</td>
</tr>
<tr>
<td>Legal Values</td>
<td>1, yes, true (yes) 0, no, false (no)</td>
</tr>
<tr>
<td>Schema-Dependent</td>
<td>False</td>
</tr>
</tbody>
</table>

The Default Vault is derived dynamically from descriptor files at runtime. Otherwise, the default value is Boolean True.

Setting this parameter to Boolean False degrades performance.

**Number of Returned Result Sets**

The Number of Returned Result Sets parameter specifies how many java.sql.ResultSet objects can be returned from an arbitrary SQL statement. See java.sql.ResultSet (http://java.sun.com/j2se/1.5.0/docs/api/java/sql/ResultSet.html).

This parameter is primarily used to avoid infinite loop conditions in "Oracle Thin Client JDBC Driver" on page 179 when evaluating the results of arbitrary SQL statements.

The following table lists the properties of this parameter:

**Table 6-25  Number of Returned Result Sets: Properties**

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tag Name</td>
<td>handle-stmt-results</td>
</tr>
<tr>
<td>Required?</td>
<td>no</td>
</tr>
<tr>
<td>Sample Value</td>
<td>one</td>
</tr>
<tr>
<td>Default Value</td>
<td>(dynamic)</td>
</tr>
<tr>
<td>Legal Values</td>
<td>none, no (none) single, one (one) multiple, many, yes (multiple)</td>
</tr>
<tr>
<td>Schema-Dependent</td>
<td>False</td>
</tr>
</tbody>
</table>

The Default Value property is derived dynamically from descriptor files at runtime. Otherwise, the default value is multiple, many, or yes.

**Enable Statement-Level Locking?**

The Enable Statement-Level Locking? parameter specifies whether the driver explicitly locks database resources before executing SQL statements.

The following table lists the properties of this parameter:
Table 6-26  Enable Statement-Level Locking?: Properties

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tag Name</td>
<td>enable-locking</td>
</tr>
<tr>
<td>Required?</td>
<td>no</td>
</tr>
<tr>
<td>Default Value</td>
<td>0 (no)</td>
</tr>
<tr>
<td>Legal Values</td>
<td>1, yes, true (yes) 0, no, false (no)</td>
</tr>
<tr>
<td>Schema-Dependent</td>
<td>True</td>
</tr>
</tbody>
</table>

Lock Statement Generator Class

The Lock Statement Generator Class parameter specifies which DBLockStatementGenerator implementation to use to generate the SQL statements necessary to explicitly lock database resources for a pending SQL statement. Information on the DBLockStatementGenerator interface is in the Java documents that ship with the driver.

The following table lists the properties of this parameter:

Table 6-27  Lock Statement Generator Class: Properties

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tag Name</td>
<td>lock-generator-class</td>
</tr>
<tr>
<td>Required?</td>
<td>no</td>
</tr>
<tr>
<td>Sample Value</td>
<td>com.novell.nds.dirxml.driver.jdbc.db.lock.OraLockGenerator</td>
</tr>
<tr>
<td>Default Value</td>
<td>(dynamic)</td>
</tr>
<tr>
<td>Legal Values</td>
<td>1, yes, true (yes) 0, no, false (no)</td>
</tr>
<tr>
<td>Schema-Dependent</td>
<td>True</td>
</tr>
</tbody>
</table>

The Default Value property is derived dynamically from descriptor files at runtime. Otherwise, the default value is com.novell.nds.dirxml.driver.jdbc.db.lock.DBLockGenerator.

Enable Referential Attribute Support?

The Enable Referential Attribute Support? parameter toggles whether the driver recognizes foreign key constraints between logical database classes. These are used to denote containment. Foreign key constraints between parent and child tables within a logical database class are unaffected.

When set to Boolean True, foreign key columns are interpreted as referential. When set to Boolean False, foreign key columns are interpreted as non-referential.

The primary purpose of this parameter is to ensure backward compatibility with the 1.0 version of the driver. For 1.0 compatibility, set this parameter to Boolean False.

The following table lists the properties of this parameter:
Table 6-28  Enable Referential Attribute Support?: Properties

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tag Name</td>
<td>enable-refs</td>
</tr>
<tr>
<td>Required?</td>
<td>no</td>
</tr>
<tr>
<td>Default Value</td>
<td>1 (yes)</td>
</tr>
<tr>
<td>Legal Values</td>
<td>1, yes, true (yes) 0, no, false (no)</td>
</tr>
<tr>
<td>Schema-Dependent</td>
<td>True</td>
</tr>
</tbody>
</table>

Enable Meta-Identifier Support?

The Enable Meta-Identifier Support? parameter toggles whether the driver interprets view column name prefixes such as pk_ and fk_ strictly as metadata. When interpreted as metadata, such prefixes are not considered part of the view column name.

For example, when meta-identifier support is enabled, column pk_idu has an effective column name of idu, prohibiting the existence of another column with the same effective name in the same view. When meta-identifier support is disabled, column pk_idu has the effective column name of pk_idu, allowing the existence of another column named idu. Furthermore, when meta-identifier support is enabled, a view with a primary key named pk_idu would conflict with a table having a primary key column named idu. When meta-identifier support is disabled, they would not conflict.

When set to Boolean True, view column prefixes are interpreted as metadata. When set to Boolean False, view column name prefixes are interpreted as part of the column name proper.

The primary purpose of this parameter is to ensure backward compatibility with the 1.5 version of the driver. For 1.5 compatibility, set this parameter to Boolean False.

The following table lists the properties of this parameter:

Table 6-29  Enable Meta-Identifier Support?: Properties

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tag Name</td>
<td>enable-meta-identifiers</td>
</tr>
<tr>
<td>Required?</td>
<td>no</td>
</tr>
<tr>
<td>Default Value</td>
<td>1 (yes)</td>
</tr>
<tr>
<td>Legal Values</td>
<td>1, yes, true (yes) 0, no, false (no)</td>
</tr>
<tr>
<td>Schema-Dependent</td>
<td>True</td>
</tr>
</tbody>
</table>

Force Username Case

The Force Username Case parameter changes the case of the driver’s username used to authenticate to the target database.

The primary purpose of this parameter is to enable interoperability with the Informix JDBC Driver when used against ANSI-compliant databases. See “Informix JDBC Driver” on page 174.

The following table lists the properties of this parameter:
Table 6-30  Force Username Case: Properties

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tag Name</td>
<td>force-username-case</td>
</tr>
<tr>
<td>Required?</td>
<td>no</td>
</tr>
<tr>
<td>Default Value</td>
<td>(don’t force)</td>
</tr>
<tr>
<td>Legal Values</td>
<td>lower (to lowercase), mixed (to mixed case), upper (to uppercase),</td>
</tr>
<tr>
<td></td>
<td>don’t force (default)</td>
</tr>
<tr>
<td>Schema-Dependent</td>
<td>False</td>
</tr>
</tbody>
</table>

Left Outer Join Operator

The Left Outer Join Operator parameter specifies the left outer join operator used in the triggerless publication query. It might be used for other purposes in the future.

The following table lists the properties of this parameter:

Table 6-31  Left Outer Join Operator: Properties

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tag Name</td>
<td>left-outer-join-operator</td>
</tr>
<tr>
<td>Required?</td>
<td>no</td>
</tr>
<tr>
<td>Default Value</td>
<td>(dynamic)</td>
</tr>
<tr>
<td>Legal Values</td>
<td>*= (+) LEFT OUTER JOIN</td>
</tr>
<tr>
<td>Schema-Dependent</td>
<td>True</td>
</tr>
</tbody>
</table>

The Default Value property is derived dynamically from descriptor files at runtime. Otherwise, the default value is LEFT OUTER JOIN.

Retrieve Minimal Metadata

When set to Boolean True, the driver calls only required metadata methods. When set to Boolean False, the driver calls required and optional metadata methods. For a list of required and optional metadata methods, refer to Appendix F, "java.sql.DatabaseMetaData Methods," on page 211. Optional metadata methods are required for multivalue and referential attribute synchronization.
Table 6-32  Retrieve Minimal Metadata: Properties

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tag Name</td>
<td>minimal-metadata</td>
</tr>
<tr>
<td>Required?</td>
<td>no</td>
</tr>
<tr>
<td>Default Value</td>
<td>(dynamic)</td>
</tr>
<tr>
<td>Legal Values</td>
<td>1, yes, true (yes) 0, no, false (no)</td>
</tr>
<tr>
<td>Schema-Dependent</td>
<td>True</td>
</tr>
</tbody>
</table>

The Default Value property is derived dynamically from descriptor files at runtime. Otherwise, the default value is Boolean False.

Setting this value to Boolean True improves startup time and third-party JDBC driver compatibility at the expense of functionality.

Function Return Method

The Function Return Method parameter specifies how data is retrieved from database functions.

The primary purpose of this parameter is to enable interoperability with the Informix JDBC driver. See “Informix JDBC Driver” on page 174.

When set to result set, function results are retrieved through a result set. When set to return value, the function result is retrieved as a single, scalar return value.

Table 6-33  Function Return Method: Properties

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tag Name</td>
<td>function-return-method</td>
</tr>
<tr>
<td>Required?</td>
<td>no</td>
</tr>
<tr>
<td>Default Value</td>
<td>(dynamic)</td>
</tr>
<tr>
<td>Legal Values</td>
<td>result set, return value (scalar return value)</td>
</tr>
<tr>
<td>Schema-Dependent</td>
<td>False</td>
</tr>
</tbody>
</table>

The Default Value property is derived dynamically from descriptor files at runtime.

Supports Schemas in Metadata Retrieval?

The Supports Schemas in Metadata Retrieval? parameter specifies whether schema names should be used when retrieving database metadata.

The primary purpose of this parameter is to enable interoperability with the Informix JDBC Driver when used against ANSI-compliant databases. See “Informix JDBC Driver” on page 174.

When set to Boolean True, schema names are used. When set to Boolean False, they are not.
Table 6-34  Supports Schemas in Metadata Retrieval?: Properties

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tag Name</td>
<td>supports-schemas-in-metadata-retrieval</td>
</tr>
<tr>
<td>Required?</td>
<td>no</td>
</tr>
<tr>
<td>Default Value</td>
<td>(dynamic)</td>
</tr>
<tr>
<td>Legal Values</td>
<td>1, yes, true (yes) 0, no, false (no)</td>
</tr>
<tr>
<td>Schema-Dependent</td>
<td>False</td>
</tr>
</tbody>
</table>

The Default Value property is derived dynamically from descriptor files at runtime. Otherwise, the default value is Boolean True.

Sort Column Names By

The Sort Column Names By parameter specifies how column position is to be determined for legacy databases that do not support sorting by column names.

The primary purpose of this parameter is to enable interoperability with legacy databases, such as DB2/AS400.

Sorting columns names by hexadecimal value ensures that if a driver instance is relocated to a different server, it continues to function without modification. Sorting column names by platform or locale string collation order is more intuitive, but might require configuration changes if a driver instance is relocated to a different server. In particular, log table column order and compound column name order might change. In the case of the latter, Schema-Mapping policies and object association values might need to be updated. In the case of the former, log table columns might have to be renamed.

It is also possible to specify any fully-qualified Java class name as long as the following occur:

- The Java class name implements the [java.util.Comparator](http://java.sun.com/j2se/1.5.0/docs/api/java/util/Comparator.html) interface.
- The Java class name accepts [java.lang.String](http://java.sun.com/j2se/1.5.0/docs/api/java/lang/String.html) arguments.
- The class is in the runtime classpath.

Table 6-35  Sort Column Names By: Properties

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tag Name</td>
<td>column-position-comparator</td>
</tr>
<tr>
<td>Required?</td>
<td>no</td>
</tr>
<tr>
<td>Default Value</td>
<td>(dynamic)</td>
</tr>
<tr>
<td>Legal Values</td>
<td>com.novell.nds.dirxml.driver.jdbc.util.config.comp.StringByteComparator(hexadecimal value), com.novell.nds.dirxml.driver.jdbc.util.config.comp.StringComparator(string collation order), (any java.util.Comparator that accepts java.lang.String arguments)</td>
</tr>
<tr>
<td>Schema-Dependent</td>
<td>True</td>
</tr>
</tbody>
</table>
The Default Value property is derived dynamically from descriptor files at runtime. Otherwise, the default value is com.novell.nds.dirxml.driver.jdbc.util.config.comp.StringByteComparator.

**IMPORTANT:** After you set this parameter for a given configuration, don’t change the parameter.

**Preserve white space in SQL statements?**

The Preserve white space in SQL statements? parameter specifies whether trailing spaces in the field names of the SQL statements should be removed or not.

The primary purpose of this parameter is to remove the unintentional trailing spaces from the field names.

If the option is set to no, the trailing spaces are removed from the fields. Set the option to yes, if you do not want to remove the trailing whitespaces.

**Table 6-36  Preserve white space in SQL statements?: Properties**

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tag Name</td>
<td>preserve-sql-whitespace</td>
</tr>
<tr>
<td>Required?</td>
<td>yes</td>
</tr>
<tr>
<td>Default Value</td>
<td>no</td>
</tr>
<tr>
<td>Legal Values</td>
<td>yes, no</td>
</tr>
<tr>
<td>Schema-Dependent</td>
<td>False</td>
</tr>
</tbody>
</table>

**NOTE:** When the Preserve white space in SQL statements? parameter is set to no, ensure that you do not add trailing spaces, because extra spaces are removed while formatting.

**Subscription Parameters**

The following table summarizes Subscriber-level parameters and their properties:

**Table 6-37  Subscriber-Level Parameters and Properties**

<table>
<thead>
<tr>
<th>Display Name</th>
<th>Tag Name</th>
<th>Sample Value</th>
<th>Default Value</th>
<th>Required</th>
</tr>
</thead>
<tbody>
<tr>
<td>Disable Subscriber?</td>
<td>disable</td>
<td>1 (yes)</td>
<td>0 (no)</td>
<td>no</td>
</tr>
<tr>
<td>Generation/Retrieval Method (Table-Global)</td>
<td>key-gen-method</td>
<td>auto</td>
<td>none (subscription event)</td>
<td>no</td>
</tr>
<tr>
<td>Retrieval Timing (Table-Global)</td>
<td>key-gen-timing</td>
<td>after (after row insertion)</td>
<td>before (before row insertion)</td>
<td>no</td>
</tr>
<tr>
<td>Method and Timing (Table-Local)</td>
<td>key-gen</td>
<td>usr(&quot;?=indirect.proc_idu()&quot;, before)</td>
<td>(none)</td>
<td>no</td>
</tr>
</tbody>
</table>
Configuring the JDBC Driver

This default for the Add Default Values on Insert property is derived dynamically from descriptor files at runtime.

Subscription parameters are in two subcategories:

- “Uncategorized Parameters” on page 78
- “Primary Key Parameters” on page 80

Uncategorized Parameters

- “Disable Subscriber?” on page 78
- “Disable Statement-Level Locking?” on page 79
- “Check Update Counts?” on page 79
- “Add Default Values on Insert?” on page 79

Disable Subscriber?

The Disable Subscriber? parameter specifies whether the Subscriber channel is disabled.

When this parameter is set to Boolean True, the Subscriber channel is disabled. When the parameter is set to Boolean False, the Subscriber channel is active.

<table>
<thead>
<tr>
<th>Display Name</th>
<th>Tag Name</th>
<th>Sample Value</th>
<th>Default Value</th>
<th>Required</th>
</tr>
</thead>
<tbody>
<tr>
<td>Disable Statement-Level Locking?</td>
<td>disable-locking</td>
<td>1 (yes)</td>
<td>0 (no)</td>
<td>no</td>
</tr>
<tr>
<td>Check Update Counts?</td>
<td>check-update-count</td>
<td>0 (no)</td>
<td>1 (yes)</td>
<td>no</td>
</tr>
<tr>
<td>Add Default Values on Insert?</td>
<td>add-default-values-on-view-insert</td>
<td>0 (no)</td>
<td>(dynamic)</td>
<td>no</td>
</tr>
</tbody>
</table>

This default for the Add Default Values on Insert property is derived dynamically from descriptor files at runtime.

Subscription parameters are in two subcategories:

- “Uncategorized Parameters” on page 78
- “Primary Key Parameters” on page 80

Uncategorized Parameters

- “Disable Subscriber?” on page 78
- “Disable Statement-Level Locking?” on page 79
- “Check Update Counts?” on page 79
- “Add Default Values on Insert?” on page 79

Disable Subscriber?

The Disable Subscriber? parameter specifies whether the Subscriber channel is disabled.

When this parameter is set to Boolean True, the Subscriber channel is disabled. When the parameter is set to Boolean False, the Subscriber channel is active.

Table 6-38 Disable Subscriber?: Properties

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tag Name</td>
<td>disable</td>
</tr>
<tr>
<td>Required?</td>
<td>no</td>
</tr>
<tr>
<td>Default Value</td>
<td>0 (no)</td>
</tr>
<tr>
<td>Legal Values</td>
<td>1, yes, true (yes) 0, no, false (no)</td>
</tr>
<tr>
<td>Schema-Dependent</td>
<td>False</td>
</tr>
</tbody>
</table>
**Disable Statement-Level Locking?**

The Disable Statement-Level Locking? parameter specifies whether database resources are explicitly locked on this channel before each SQL statement is executed. This parameter is active only if Enable Statement-Level Locking? is set to Boolean True.

When this parameter is set to Boolean True, database resources are explicitly locked. When this parameter is set to Boolean False, database resources are not explicitly locked.

*Table 6-39  Disable Statement-Level Locking?: Properties*

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tag Name</td>
<td>disable-locking</td>
</tr>
<tr>
<td>Required?</td>
<td>no</td>
</tr>
<tr>
<td>Default Value</td>
<td>0 (no)</td>
</tr>
<tr>
<td>Legal Values</td>
<td>1, yes, true (yes) 0, no, false (no)</td>
</tr>
<tr>
<td>Schema-Dependent</td>
<td>True</td>
</tr>
</tbody>
</table>

**Check Update Counts?**

The Check Update Counts? parameter specifies whether the Subscriber channel checks to see if a table was actually updated when `INSERT`, `UPDATE`, and `DELETE` statements executed against a table.

When set to Boolean True, update counts are checked. If nothing is updated, an exception is thrown. When set to Boolean False, update counts are ignored.

When statements are redefined in before-trigger logic, set his parameter to Boolean False

When using Microsoft SQL Server, use the default value, because errors in trigger logic (that might roll back a transaction) are not propagated back to the Subscriber channel.

*Table 6-40  Check Update Counts?: Properties*

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tag Name</td>
<td>check-update-count</td>
</tr>
<tr>
<td>Required?</td>
<td>no</td>
</tr>
<tr>
<td>Default Value</td>
<td>1 (yes)</td>
</tr>
<tr>
<td>Legal Values</td>
<td>1, yes, true (yes) 0, no, false (no)</td>
</tr>
<tr>
<td>Schema-Dependent</td>
<td>True</td>
</tr>
</tbody>
</table>

**Add Default Values on Insert?**

The Add Default Values on Insert? parameter specifies whether the Subscriber channel provides default values when executing an `INSERT` statement against a view.

The primary purpose of this parameter is to enable interoperability with Microsoft SQL Server 2000. This database requires that view columns constrained `NOT NULL` have a non-NULL value in an `INSERT` statement.
When this parameter is set to Boolean True, default values are provided for *INSERT* statements executed against views, and explicit values are not already available. When this parameter is set to Boolean False, default values are not provided.

### Table 6-41  Add Default Values on Insert?: Properties

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tag Name</td>
<td>add-default-values-on-view-insert</td>
</tr>
<tr>
<td>Required?</td>
<td>no</td>
</tr>
<tr>
<td>Default Value</td>
<td>(dynamic)</td>
</tr>
<tr>
<td>Legal Values</td>
<td>1, yes, true (yes) 0, no, false (no)</td>
</tr>
<tr>
<td>Schema-Dependent</td>
<td>True</td>
</tr>
</tbody>
</table>

The Default Value property is derived dynamically from descriptor files at runtime.

**Primary Key Parameters**

- “Generation/Retrieval Method (Table-Global)” on page 81
- “Retrieval Timing (Table-Global)” on page 81
- “Method and Timing (Table-Local)” on page 82

When processing `<add>` events, which map to *INSERT* statements, the Subscriber channel uses primary key values to create Identity Manager associations. These parameters specify how and when the Subscriber channel obtains the primary key values necessary to construct association values. How primary key values are obtained is the primary key generation/retrieval method. The retrieval timing indicates when primary key values are retrieved.

The following table identifies the supported methods and timings:

### Table 6-42  Supported Methods and Timings

<table>
<thead>
<tr>
<th>Method</th>
<th>Timing: before (row insertion)</th>
<th>Timing: after (row insertion)</th>
</tr>
</thead>
<tbody>
<tr>
<td>None (subscription event)</td>
<td>Y</td>
<td>N(^1)</td>
</tr>
<tr>
<td>Driver (Subscriber-generated)</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Auto (auto-generated/identity column)</td>
<td>N(^2)</td>
<td>Y</td>
</tr>
<tr>
<td>(stored procedure/function)</td>
<td>Y</td>
<td>Y</td>
</tr>
</tbody>
</table>

\(^1\) The Subscriber channel automatically overrides this timing and changes it to *before.*

\(^2\) The Subscriber channel automatically overrides this timing and changes it to *after.*
Generation/Retrieval Method (Table-Global)

The Generation/Retrieval Method (Table-Global) parameter specifies how primary key values are generated or retrieved for all parent tables and views. The Method and Timing parameter overrides this parameter on a per-table/view basis. See “Method and Timing (Table-Local)” on page 82.

When this parameter is set to none, primary key values are assumed to already exist in the subscription event. When this parameter is set to driver, primary key values are generated by one of the following:

- Using a `SELECT (MAX(pk_columnname)+1)` statement if retrieval timing is set to before
- Using a `SELECT MAX(pk_columnname)` statement if retrieval timing is set to after

For string column types, the Subscriber channel generates a value by using the return value of `System.currentTimeMillis()`. Other data types are not supported.

When this parameter is set to auto, primary key values are retrieved via the `java.sql.Statement.getGeneratedKeys():java.sql.ResultSet` method. The MySQL Connector/J JDBC driver is the only supported third-party JDBC driver that currently implements this method. See “MySQL Connector/J JDBC Driver” on page 178.

Table 6-43  Generation/Retrieval Method (Table-Global): Properties

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tag Name</td>
<td>key-gen-method</td>
</tr>
<tr>
<td>Required?</td>
<td>no</td>
</tr>
<tr>
<td>Default Value</td>
<td>none (subscription event)</td>
</tr>
<tr>
<td>Legal Values</td>
<td>none (subscription event), driver (Subscriber-generated), auto (auto-generated/identity column)</td>
</tr>
<tr>
<td>Schema-Dependent</td>
<td>True</td>
</tr>
</tbody>
</table>

Retrieval Timing (Table-Global)

The Retrieval Timing (Table-Global) parameter specifies when the Subscriber channel retrieves primary key values for all parent tables and views. The Method and Timing (Table-Local) parameter overrides this parameter. See “Method and Timing (Table-Local)” on page 82.

When this parameter is set to before, primary key values are retrieved before insertion. When this parameter is set to after, primary key values are retrieved after insertion.

Table 6-44  Retrieval Timing (Table-Global): Properties

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tag Name</td>
<td>key-gen-timing</td>
</tr>
<tr>
<td>Required?</td>
<td>no</td>
</tr>
<tr>
<td>Default Value</td>
<td>before (before row insertion)</td>
</tr>
<tr>
<td>Legal Values</td>
<td>before (before row insertion), after (after row insertion)</td>
</tr>
<tr>
<td>Schema-Dependent</td>
<td>True</td>
</tr>
</tbody>
</table>
Method and Timing (Table-Local)

The Method and Timing (Table-Local) parameter specifies the primary key generation/retrieval method and retrieval timing on a per parent table/view basis. It essentially maps a generation/retrieval method and retrieval timing to a table or view name. The syntax for this parameter mirrors a procedural programming language method call with multiple arguments (such as method-name(argument1, argument2)).

When using the Table/View Names parameter, you probably need to explicitly schema-qualify any tables, views, stored procedures or functions referenced in this parameter’s value. When you use the Schema Name parameter, then tables, views, stored procedures, or functions referenced in this parameter’s value are implicitly schema-qualified with that schema name. If tables, views, stored procedures, or functions referenced in this parameter’s value are located in a different schema than the implicit schema, they must be schema-qualified.

* “BNF” on page 82
* “Generation or Retrieval Method” on page 82
* “Retrieval Timing” on page 84

BNF

The BNF (Backus Naur Form (http://cui.unige.ch/db-research/Enseignement/analyseinfo/AboutBNF.html)) notation for this parameter’s value is the following:

```
<key-gen> ::= <table-or-view-name> "(" <generation-retrieval-method>,
            <retrieval-timing> ")" {[<delimiter>] <key-gen>}
<generation-retrieval-method> ::= none | driver | auto |
            """ <procedure-signature> """ | """ <function-signature> """
<table-or-view-name> ::= <legal-undelimited-database-table-or-view-
                        identifier>
<delimiter> ::= ";" | "," | <white-space>
<procedure-signature> ::= <schema-qualifier> "." <stored-routine-
                        name>("<argument-list>")
<function-signature> ::= "?=" <procedure-signature>
<schema-qualifier> ::= "?=" <procedure-signature>
<stored-routine-name> ::= <legal-undelimited-database-stored-routine-
                        identifier>
<argument-list> ::= <column-name>{"," <column-name>}
<column-name> ::= <column-from-table-or-view-name-previously-specified>
```

Generation or Retrieval Method

The generation or retrieval method specifies how primary key values are to be generated, if necessary, and retrieved. The possible methods are None, Driver, Auto, and Stored Procedure/Function:
None: By default, the Subscriber channel assumes that the Identity Vault is the authoritative source of primary key values and that the requisite values are already present in a given `<add>` event. If this is the case, no primary values need to be generated because they already exist. They only need to be retrieved from the current `<add>` event. This method is desirable when an eDirectory attribute, such as GUID, is explicitly schema-mapped to a parent table or view's primary key column.

Assuming the existence of a table named `usr` and a view named `view_usr` where the Identity Vault is the authoritative source of primary key values, this parameter's value would be similar to the following:

```
usr(none); view_usr(none)
```

When you use this method, we recommend mapping GUID rather than CN to a parent table or view's primary key column.

Driver: This method assumes that the driver is the authoritative source of primary key values for the specified parent table or view.

When prototyping or in the initial stages of deployment, it is often desirable to have the Subscriber channel generate primary key values before a stored procedure or function is written. You can also use this method against databases that do not support stored procedures or functions. When you use this method in a production environment, however, all SQL statements generated by an `<add>` event should be contained in a serializable transaction. For additional information, refer to “Transaction Isolation Level” on page 69.

Instead of making all transactions serializable, you can also set individual transaction isolation levels by using embedded SQL attributes. For additional information, refer to “Transaction Isolation Level” on page 140.

For any numeric column types, the Subscriber channel uses the following to generate primary key values:

- A simple `SELECT (MAX+1)` statement for before timing
- A `SELECT MAX()` statement for after timing

For string column types, the Subscriber channel generates a value by using the return value of `System.currentTimeMillis()`. Other data types are not supported.

Assuming the existence of a table named `usr` and a view named `view_usr`, where the database is the authoritative source of primary key values, this parameter's value would be similar to the following:

```
usr(driver); view_usr(driver)
```

When you use this method, we recommend that you omit primary key columns from Schema Mapping policies and channel filters.

Auto: This method assumes that the database is the authoritative source of primary key values for the specified parent table or view.

Some databases support identity columns that automatically generate primary key values for inserted rows. This method retrieves auto-generated primary key values through the JDBC 3 interface method `java.sql.Statement.getGeneratedKeys():java.sql.ResultSet`. The MySQL Connector/J JDBC driver is the only supported third-party JDBC driver that currently implements this method. See “MySQL Connector/J JDBC Driver” on page 178.

Assuming the existence of a table named `usr` and a view named `view_usr`, where the database is the authoritative source of primary key values, this parameter's value would be similar to the following:
When you use this method, we recommend that you omit primary key columns from Schema Mapping policies and channel filters.

**Stored-Procedure/Function:** This method assumes that the stored-procedure / function is the authoritative source of primary key values for the specified parent table or view.

Assuming

- The existence of a table named *usr* with a primary key column named *idu*
- A view named *view_usr* with a primary key values named *pk_idu*
- The existence of a database function *func_last_usr_idu* and stored procedure *sp_last_view_usr_pk_idu* that both return the last generated primary key value for their respective table/view

This parameter's value would be similar to the following:

```
usr("?=func_last_usr_idu()"); view_usr("sp_last_view_usr_pk_idu(pk_idu)"")
```

In the previous examples, a parameter is passed to the stored procedure. Parameters can also be passed to functions, but this is not usually necessary. Unlike functions, stored procedures usually return values through parameters. For stored procedures, primary key columns must be passed as **IN** parameters. Non-key columns must be passed as **IN** parameters.

For both stored procedures and functions, parameter order, number and data type must correspond to the order, number and data type of the parameters expected by the procedure or function.

When you use this method, we recommend that you omit primary key columns from Schema Mapping policies and channel filters.

### Retrieval Timing

The Retrieval Timing parameter specifies when primary key values are retrieved.

An `<add>` event always results in at least one **INSERT** statement against a parent table or view. This portion of this parameter specifies when primary key values are to be retrieved relative to the initial **INSERT** statement.

**Before:** This is the default setting. When this setting is specified, primary key values are retrieved before the initial **INSERT** statement.

This retrieval timing is supported for all generation/retrieval methods except **auto**. Retrieval timing is required for the **none** method.

**After:** When this setting is specified, primary key values are retrieved after the initial **INSERT** statement.

This retrieval timing is supported for all generation/retrieval methods except **none**. Retrieval timing is required for the **auto** method.

The following examples augment the previous ones by adding retrieval timing information:

```
usr(none, before); view_usr(none, before)
usr(driver, before); view_usr(driver, after)
usr(auto, after); view_usr(auto, after)
usr("?=func_last_usr_idu()", before); view_usr("sp_last_view_usr_pk_idu(pk_idu)", after)
```
The following table lists the properties of this parameter:

**Table 6-45  Retrieval Timing: Properties**

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tag Name</td>
<td>key-gen</td>
</tr>
<tr>
<td>Required?</td>
<td>no</td>
</tr>
<tr>
<td>Case-Sensitive?</td>
<td>See “Undelimited Identifier Case Sensitivity” on page 161.</td>
</tr>
<tr>
<td>Sample Value</td>
<td>usr(’?’=proc_idu(), before)</td>
</tr>
<tr>
<td>Default Value</td>
<td>(none)</td>
</tr>
<tr>
<td>Legal Values</td>
<td>(any string adhering to the BNF)</td>
</tr>
<tr>
<td>Schema-Dependent</td>
<td>True</td>
</tr>
</tbody>
</table>

**Publication Parameters**

The following table summarizes publisher-level parameters and their properties:

**Table 6-46  Publisher-Level Parameters and Properties**

<table>
<thead>
<tr>
<th>Display Name</th>
<th>Tag Name</th>
<th>Sample Value</th>
<th>Default Value</th>
<th>Required</th>
</tr>
</thead>
<tbody>
<tr>
<td>Disable Publisher?</td>
<td>disable</td>
<td>1 (yes)</td>
<td>0 (no)</td>
<td>no</td>
</tr>
<tr>
<td>Disable Statement-Level Locking?</td>
<td>disable-locking</td>
<td>1 (yes)</td>
<td>0 (no)</td>
<td>no</td>
</tr>
<tr>
<td>Publication Mode</td>
<td>publication-mode</td>
<td>2 (triggerless)</td>
<td>1 (triggered)</td>
<td>no</td>
</tr>
<tr>
<td>Event Log Table Name</td>
<td>log-table</td>
<td>indirect_process</td>
<td>(none)</td>
<td>yes¹</td>
</tr>
<tr>
<td>Delete Processed Rows?</td>
<td>delete-from-log</td>
<td>0 (no)</td>
<td>1 (yes)</td>
<td>no</td>
</tr>
<tr>
<td>Allow Loopback?</td>
<td>allow-loopback</td>
<td>1 (yes)</td>
<td>0 (no)</td>
<td>no</td>
</tr>
<tr>
<td>Enable Future Event Processing?</td>
<td>handle-future-events</td>
<td>1 (yes)</td>
<td>0 (no)</td>
<td>no</td>
</tr>
<tr>
<td>Startup Option</td>
<td>startup-option</td>
<td></td>
<td></td>
<td>no</td>
</tr>
<tr>
<td>Polling Interval (In Seconds)</td>
<td>polling-interval</td>
<td>60</td>
<td>10</td>
<td>no²</td>
</tr>
<tr>
<td>Publication Time of Day</td>
<td>time-of-day</td>
<td>15:30:00</td>
<td>(none)</td>
<td>no²</td>
</tr>
<tr>
<td>Post Polling Statements</td>
<td>post-poll-stmt</td>
<td>DELETE FROM direct.direct_process</td>
<td>(none)</td>
<td>no</td>
</tr>
<tr>
<td>Batch Size</td>
<td>batch-size</td>
<td>16</td>
<td>1</td>
<td>no</td>
</tr>
<tr>
<td>Query Limit (default 10000)</td>
<td>query-limit</td>
<td>1000</td>
<td>10000</td>
<td>no</td>
</tr>
</tbody>
</table>
Configuring the JDBC Driver

Required for triggered publication mode. These parameters are mutually exclusive.

Publication parameters fall into four major subcategories:

- "Uncategorized Parameters" on page 86
- "Triggered Publication Parameters" on page 89
- "Triggerless Publication Parameters" on page 90
- "Polling Parameters" on page 91

Uncategorized Parameters

- "Disable Publisher?" on page 86
- "Disable Statement-Level Locking?" on page 87
- "Publication Mode" on page 87
- "Enable Future Event Processing?" on page 87

Disable Publisher?

The Disable Publisher? parameter specifies whether the Publisher channel is disabled. When disabled, the Publisher channel does not query for database events. Unlike the Disable Subscriber? parameter, you can still issue database queries on the Publisher channel to facilitate alternative publication algorithms.

When this parameter is set to Boolean True, the Publisher channel is disabled. When this parameter is set to Boolean False, the Publisher channel is active.

Table 6-47  Disable Publisher?: Properties

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tag Name</td>
<td>disable</td>
</tr>
<tr>
<td>Required?</td>
<td>no</td>
</tr>
<tr>
<td>Default Value</td>
<td>0 (no)</td>
</tr>
<tr>
<td>Legal Values</td>
<td>1, yes, true (yes) 0, no, false (no)</td>
</tr>
<tr>
<td>Schema-Dependent</td>
<td>True</td>
</tr>
</tbody>
</table>
Disable Statement-Level Locking?

The Disable Statement-Level Locking? parameter specifies whether database resources should be explicitly locked on this channel before each SQL statement is executed. This parameter is only active if the Enable Statement-Level Locking? parameter is set to Boolean True.

When this parameter is set to Boolean True, database resources are explicitly locked. When this parameter is set to Boolean False, database resources are not explicitly locked.

Table 6-48  Disable Statement-Level Locking?: Properties

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tag Name</td>
<td>disable-locking</td>
</tr>
<tr>
<td>Required?</td>
<td>no</td>
</tr>
<tr>
<td>Default Value</td>
<td>0 (no)</td>
</tr>
<tr>
<td>Legal Values</td>
<td>1, yes, true (yes) 0, no, false (no)</td>
</tr>
<tr>
<td>Schema-Dependent</td>
<td>True</td>
</tr>
</tbody>
</table>

Publication Mode

The Publication Mode parameter specifies which publication algorithm is used.

When set to 1 (triggered), the Publisher channel polls the event log table for events. When set to 2 (triggerless), the Publisher channel searches all tables/views in the synchronization schema for changes, and synthesizes events.

The following table lists the properties of this parameter:

Table 6-49  Publication Mode: Properties

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tag Name</td>
<td>publication-mode</td>
</tr>
<tr>
<td>Required?</td>
<td>no</td>
</tr>
<tr>
<td>Default Value</td>
<td>1 (triggered)</td>
</tr>
<tr>
<td>Legal Values</td>
<td>1 (triggered) 2 (triggerless)</td>
</tr>
<tr>
<td>Schema-Dependent</td>
<td>True</td>
</tr>
</tbody>
</table>

Enable Future Event Processing?

For triggered publication, Enable Future Event Processing? specifies whether rows in the event log table are ordered and processed by insertion order (the record_id column) or chronologically (the event_time column).

When this parameter is set to Boolean False, rows in the event log table are published by order of insertion. When this parameter is set to Boolean True, rows in the event log table are published chronologically.
For triggerless publication, Enable Future Event Processing specifies whether database local time is published with each event. This additional information can be used to force a retry of future-dated events. In order for this to work, a column specifying when an event should be processed must be part of each logical database class utilizing this feature and placed in the Publisher filter as a notification-only attribute.

Database local time is published as an attribute on each XDS event (for example, add, modify, delete). The attribute name is `jdbc:database-local-time`, where the `jdbc` namespace prefix is bound to `urn:dirxml:jdbc`. The format is the Java string representation of a `java.sql.Timestamp`: `yyyy-mm-dd hh:mm:ss.fffffffff`. Depending upon the value of the Time Syntax parameter, the value indicating when an event should be processed can be published as an integer, as a canonical string, or as a Java string. See “Time Syntax” on page 57.

Regardless of the publication syntax, this value can be parsed and compared to the database local time value. The following table maps the time syntax to the appropriate parse method.

**Table 6-50  Mapping Time Syntax to Parse Methods**

<table>
<thead>
<tr>
<th>Time Syntax</th>
<th>Parse Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>integer</td>
<td><code>java.sql.Timestamp(long)</code> (<a href="http://java.sun.com/j2se/1.5.0/docs/api/java/sql/Timestamp.html">http://java.sun.com/j2se/1.5.0/docs/api/java/sql/Timestamp.html</a>)</td>
</tr>
<tr>
<td>java string</td>
<td><code>java.sql.Timestamp.valueOf(java.lang.String):java.sql.Timestamp</code> (<a href="http://java.sun.com/j2se/1.5.0/docs/api/java/sql/Timestamp.html">http://java.sun.com/j2se/1.5.0/docs/api/java/sql/Timestamp.html</a>)</td>
</tr>
</tbody>
</table>

After both time values are in a common `Timestamp` object representation, they can be compared by using the following methods:

- `com.novell.nds.dirxml.driver.jdbc.db.TimestampUtil.before(java.sql.Timestamp, java.sql.Timestamp):boolean`
- `com.novell.nds.dirxml.driver.jdbc.db.TimestampUtil.after(java.sql.Timestamp, java.sql.Timestamp):boolean`

An example policy is provided in Appendix L, “Policy Example: Triggerless Future Event Processing,” on page 227.

When this parameter is set to Boolean True, local database time is published with each event. When this parameter is set to Boolean False, this information is omitted.

The following table lists the properties of this parameter:

**Table 6-51  Enable Future Event Processing?: Properties**

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tag Name</td>
<td>handle-future-events</td>
</tr>
<tr>
<td>Required?</td>
<td>no</td>
</tr>
<tr>
<td>Default Value</td>
<td>0 (no)</td>
</tr>
<tr>
<td>Legal Values</td>
<td>1, yes, true (yes) 0, no, false (no)</td>
</tr>
<tr>
<td>Schema-Dependent</td>
<td>True</td>
</tr>
</tbody>
</table>
Triggered Publication Parameters

The JDBC driver can use any of four triggered publication parameters.

- “Event Log Table Name” on page 89
- “Delete Processed Rows?” on page 89
- “Allow Loopback?” on page 90

Event Log Table Name

The Event Log Table Name parameter specifies the name of the event log table where publication events are stored.

The table specified here must conform to the definition of Chapter 11, “The Event Log Table,” on page 121.

When using “Table/View Names” on page 64, you should explicitly schema-qualify this table name. When you use “Schema Name” on page 63, this table name is implicitly schema-qualified with that schema name. If this table is located in a schema other than the implicit schema, it must be schema-qualified.

The following table lists the properties of this parameter:

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tag Name</td>
<td>log-table</td>
</tr>
<tr>
<td>Required?</td>
<td>no</td>
</tr>
<tr>
<td>Case-Sensitive?</td>
<td>See “Undelimited Identifier Case Sensitivity” on page 161.</td>
</tr>
<tr>
<td>Sample Value</td>
<td>eventlog</td>
</tr>
<tr>
<td>Default Value</td>
<td>(none)</td>
</tr>
<tr>
<td>Schema-Dependent</td>
<td>True</td>
</tr>
</tbody>
</table>

This parameter is required if “Publication Mode” on page 87 is set to 1 (triggered publication).

Delete Processed Rows?

The Delete Processed Rows? parameter specifies whether processed rows are deleted from the event log table.

When this parameter is set to a Boolean True, processed rows are deleted. When this parameter is set to Boolean False, processed row’s status field values are updated.

To mitigate the performance hit caused when processed rows remain in the event log table, we recommend periodically moving the rows into a history table. Do one of the following:

- Call a clean-up stored procedure via the parameter “Post Polling Statements” on page 93.
- Place a before-delete trigger on the event log table to intercept delete events executed against the event log table and to move deleted rows to a history table before they are deleted from the event log table.
The following table lists the properties of this parameter:

**Table 6-53  Delete Processed Rows?: Properties**

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tag Name</td>
<td>delete-from-log</td>
</tr>
<tr>
<td>Required?</td>
<td>no</td>
</tr>
<tr>
<td>Default Value</td>
<td>0 (no)</td>
</tr>
<tr>
<td>Legal Values</td>
<td>1, yes, true (yes) 0, no, false (no)</td>
</tr>
<tr>
<td>Schema-Dependent</td>
<td>True</td>
</tr>
</tbody>
</table>

Setting this parameter to Boolean False degrades publication performance unless processed rows are periodically removed from the event log table.

**Allow Loopback?**

The Allow Loopback? parameter specifies whether events caused by the driver's database user account should be published.

When this parameter is set to Boolean True, loopback events are published. When this parameter is set to Boolean False, loopback events are ignored.

The following table lists the properties of this parameter:

**Table 6-54  Allow Loopback?: Properties**

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tag Name</td>
<td>allow-loopback</td>
</tr>
<tr>
<td>Required?</td>
<td>no</td>
</tr>
<tr>
<td>Default Value</td>
<td>0 (no)</td>
</tr>
<tr>
<td>Legal Values</td>
<td>1, yes, true (yes) 0, no, false (no)</td>
</tr>
<tr>
<td>Schema-Dependent</td>
<td>True</td>
</tr>
</tbody>
</table>

Setting this parameter to Boolean True might degrade performance because extraneous events might be published.

**Triggerless Publication Parameters**

The Startup Option parameter specifies what happens when a triggerless publisher starts.
### Table 6-55  Startup Option: Settings and Results

<table>
<thead>
<tr>
<th>Setting</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>All objects are assumed to have changed and are republished.</td>
</tr>
<tr>
<td>2</td>
<td>Past and present changes are ignored.</td>
</tr>
<tr>
<td>3</td>
<td>All past and present changes are published.</td>
</tr>
</tbody>
</table>

The following table lists the properties of this parameter:

### Table 6-56  Startup Option: Properties

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tag Name</td>
<td>startup-option</td>
</tr>
<tr>
<td>Required?</td>
<td>no</td>
</tr>
<tr>
<td>Default Value</td>
<td>1 (process all changes)</td>
</tr>
<tr>
<td>Legal Values</td>
<td>1 (resync all objects) 2 (process future changes only) 3 (process all changes)</td>
</tr>
<tr>
<td>Schema-Dependent</td>
<td>True</td>
</tr>
</tbody>
</table>

The following configuration changes can force a full resynchronization:

- Changing anything in the Authentication Context parameter other than URL properties forces a resynchronization of all objects when triggerless publication is used.
- Changing the value of the Schema Name parameter or the Table/View Names parameter forces a resynchronization of all objects when triggerless publication is used.
- Changing the State Directory parameter value.
- Moving or deleting state files. See “Changes That Can Force Triggerless Publisher Resynchronization” on page 59.
- Changing the table/view structure in the database (in particular, changing the position or type of key columns).

### Polling Parameters

- “Polling Interval (In Seconds)” on page 92
- “Publication Time of Day” on page 92
- “Post Polling Statements” on page 93
- “Batch Size” on page 93
- “Query Limit (default 10000)” on page 94
- “Heartbeat Interval (In Minutes)” on page 94
Polling Interval (In Seconds)

The Polling Interval (In Seconds) parameter specifies how many seconds of inactivity elapse between polling cycles.

The following table lists the properties of this parameter:

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tag Name</td>
<td>polling-interval</td>
</tr>
<tr>
<td>Required?</td>
<td>no</td>
</tr>
<tr>
<td>Default Value</td>
<td>10 (seconds)</td>
</tr>
<tr>
<td>Legal Values</td>
<td>1-604800 (1 week)</td>
</tr>
<tr>
<td>Schema-Dependent</td>
<td>True</td>
</tr>
</tbody>
</table>

We recommend that you set this value to no less than 10 seconds.

Publication Time of Day

The Publication Time of Day parameter specifies at what time, each day, publication begins. Time is understood to mean server local time (the time on the server where the driver is running). You can specify a single time each day, or multiple times.

The following table lists the properties of this parameter:

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tag Name</td>
<td>time-of-day</td>
</tr>
<tr>
<td>Required?</td>
<td>no</td>
</tr>
<tr>
<td>Sample Value (Single time)</td>
<td>13:00:00 (1PM)</td>
</tr>
<tr>
<td>Sample Value (Multiple times)</td>
<td>13:00:00 (1 PM), 16:00:00 (4 PM), 20:00:00 (8PM)</td>
</tr>
<tr>
<td>Default Value</td>
<td>(none)</td>
</tr>
<tr>
<td>Legal Values</td>
<td>hh:mm:ss (h = hour, m = minute, s = second)</td>
</tr>
<tr>
<td>Schema-Dependent</td>
<td>True</td>
</tr>
</tbody>
</table>

This parameter overrides the parameter Polling Interval (In Seconds). See “Polling Interval (In Seconds)” on page 92.
Post Polling Statements

The Post Polling Statements parameter specifies the SQL statements that are executed at the end of each active polling cycle. An active polling cycle is one where some publication activity has occurred.

The primary purpose of this parameter is to allow cleanup of the event log table following publication activity.

You should explicitly schema-qualify any database objects (for example, tables, stored procedures, and functions) referenced in these statements.

The following table lists the properties of this parameter:

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tag Name</td>
<td>post-poll-stmt</td>
</tr>
<tr>
<td>Required?</td>
<td>no</td>
</tr>
<tr>
<td>Case-Sensitive?</td>
<td>See “Undelimited Identifier Case Sensitivity” on page 161.</td>
</tr>
<tr>
<td>Delimiters</td>
<td>semicolon</td>
</tr>
<tr>
<td>Sample Value</td>
<td>DELETE FROM direct.direct_process</td>
</tr>
<tr>
<td>Default Value</td>
<td>(none)</td>
</tr>
<tr>
<td>Legal Values</td>
<td>(any set of legal SQL statements)</td>
</tr>
<tr>
<td>Schema-Dependent</td>
<td>True</td>
</tr>
</tbody>
</table>

Batch Size

The Batch Size parameter specifies how many events are sent in a single publication document.

Basically, the larger the batch, the better the performance.

- Larger batches necessitate fewer trips across the network in both directions.
- More events in a single document require fewer trips from the Publisher channel to the Identity Manager engine (assuming that query-back events are not being used).
- Larger batches minimize the number of trips from the Publisher channel to the database (assuming that the third-party JDBC driver and database support batch processing).
- Larger batches require fewer commits to state files in the local file system.

Commits can also be costly.

This parameter defines an upper bound. The Publisher channel might override the specified value under certain conditions. The upper bound of 128 was chosen to minimize the likelihood of overflowing the Java heap and to mitigate delaying termination of the Publisher thread on driver shutdown.

The following table lists the properties of this parameter:
Table 6-60  Batch Size: Properties

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tag Name</td>
<td>batch-size</td>
</tr>
<tr>
<td>Required?</td>
<td>no</td>
</tr>
<tr>
<td>Default Value</td>
<td>1</td>
</tr>
<tr>
<td>Legal Values</td>
<td>1 to 128</td>
</tr>
<tr>
<td>Schema-Dependent</td>
<td>True</td>
</tr>
</tbody>
</table>

**Query Limit (default 10000)**

The Query Limit specifies the maximum number of events that should read from connected system per polling cycle. The default is 10000 events.

Table 6-61  Query Limit (default 10000): Properties

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tag Name</td>
<td>query limit</td>
</tr>
<tr>
<td>Required?</td>
<td>yes</td>
</tr>
<tr>
<td>Default Value</td>
<td>10000</td>
</tr>
<tr>
<td>Legal Values</td>
<td>0 to 2,147,483,647 (java.lang.Integer.MAX_VALUE)</td>
</tr>
<tr>
<td>Schema-Dependent</td>
<td>False</td>
</tr>
</tbody>
</table>

**Heartbeat Interval (In Minutes)**

The Heartbeat Interval (In Minutes) parameter specifies how many minutes the Publisher channel can be inactive before it sends a heartbeat document. In practice, more than the number of minutes specified can elapse. That is, this parameter defines a lower bound. The Publisher channel sends a heartbeat document only if the Publisher channel has been inactive for the specified number of minutes. Any publication document sent is, in effect, a heartbeat document.

The following table lists the properties of this parameter:

Table 6-62  Heartbeat Interval (In Minutes): Properties

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tag Name</td>
<td>pub-heartbeat-interval</td>
</tr>
<tr>
<td>Required?</td>
<td>no</td>
</tr>
<tr>
<td>Default Value</td>
<td>0</td>
</tr>
<tr>
<td>Legal Values</td>
<td>0 to 2,147,483,647 (java.lang.Integer.MAX_VALUE)</td>
</tr>
<tr>
<td>Schema-Dependent</td>
<td>False</td>
</tr>
</tbody>
</table>
Trace Levels

To see debugging output from the driver, add a DirXML-DriverTraceLevel attribute value from 1 to 7 on the driver set containing the driver instance. This attribute is commonly confused with the DirXML-XSL TraceLevel attribute. For more information on driver set trace levels, refer to “Viewing Identity Manager Processes” in the NetIQ Identity Manager Driver Administration Guide.

The driver supports the following seven trace levels:

<table>
<thead>
<tr>
<th>Level</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Minimal tracing</td>
</tr>
<tr>
<td>2</td>
<td>Database properties</td>
</tr>
<tr>
<td>3</td>
<td>Connection status, SQL statements, event log records</td>
</tr>
<tr>
<td>4</td>
<td>Verbose output</td>
</tr>
<tr>
<td>5</td>
<td>Database resource allocation/deallocation; state file contents</td>
</tr>
<tr>
<td>6</td>
<td>JDBC API (invoked methods, passed arguments, returned values, etc.)</td>
</tr>
<tr>
<td>7</td>
<td>Third-party driver</td>
</tr>
</tbody>
</table>

Levels 6 and 7 are particularly useful for debugging third-party drivers.

Configuring Third-Party JDBC Drivers

The following guidelines help you configure third-party drivers. For specific configuration instructions, refer to your third-party driver’s documentation.

- Use the latest version of the driver.
- Third-party driver behavior might be configurable.
  In many cases, incompatibility issues can be resolved by adjusting the driver’s JDBC URL properties.
- When you work with international characters, you often must explicitly specify to third-party drivers the character encoding that the database uses.
  Do this by appending a property string to the end of the driver’s JDBC URL.
  Properties usually consist of a property keyword and character encoding value (for example, jdbc:odbc:mssql;charset=Big5). The property keyword might vary among third-party drivers.
  The possible character encoding values are defined by Sun. For more information, refer to Sun’s Supported Encoding Web site (http://java.sun.com/j2se/1.5.0/docs/guide/intl/encoding.doc.html).

The following table lists the recommended settings for maximum driver compatibility. These settings are useful when you use an unsupported third-party driver during initial configuration.
Table 6-64  Recommended Settings for Third-Party JDBC Drivers

<table>
<thead>
<tr>
<th>Parameter Name</th>
<th>Compatibility Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Synchronization filter</td>
<td>empty</td>
</tr>
<tr>
<td>Reuse statements?</td>
<td>0 (no)</td>
</tr>
<tr>
<td>Use manual transactions?</td>
<td>0 (no)</td>
</tr>
<tr>
<td>Use minimal number of connections?</td>
<td>yes</td>
</tr>
<tr>
<td>Retrieve minimal metadata?</td>
<td>1 (yes)</td>
</tr>
<tr>
<td>Number of returned result sets</td>
<td>one</td>
</tr>
</tbody>
</table>

Configuring jTDS Support for the JDBC Driver

The JDBC driver can be configured to support jTDS classes. The jTDS classes (jTDS jar files) improve the performance of the driver. The following table defines the set of databases and the driver classes that support the jTDS jar files:

<table>
<thead>
<tr>
<th>Database Name</th>
<th>Class Name</th>
<th>Connection URL</th>
<th>Jar File Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>MS SQL version 2000/2005</td>
<td>net.sourceforge.jtds.jdbc.Driver</td>
<td>jdbc:jtds:sqlserver://&lt;server&gt;:&lt;port1433&gt;;DatabaseName=&lt;database&gt;</td>
<td>jtds-1.2.2.jar</td>
</tr>
<tr>
<td>Sybase</td>
<td>net.sourceforge.jtds.jdbc.Driver</td>
<td>jdbc:jtds:sybase://&lt;server&gt;:&lt;port5000&gt;;DatabaseName=&lt;database&gt;</td>
<td>jtds-1.2.2.jar</td>
</tr>
</tbody>
</table>

Use the latest jTDS jar file available (jtds-1.2.2.jar).

Place the jar file in the specific directory path for the platform being used. For information on placing the jar files, refer to “Supported Third-Party Jar File Placement” on page 172.
Upgrading an Existing Driver

The following sections provide information to help you upgrade an existing driver:

- “What’s New” on page 97
- “Working with MapDB 3.0.5” on page 98
- “Considerations for Upgrading the Driver With Different Identity Manager and MapDB Versions” on page 98
- “Upgrading the Driver” on page 99

What’s New

What’s New in Version 4.2.1.0

This version of the driver does not provide any new features.

What’s New in Version 4.2.0.0

This version of the driver extends support for ZoomDB. The driver state files will be maintained using ZoomDB starting from this version.

What’s New in Version 4.1.0.1

This version of the driver does not provide any new features.

What’s New in Version 4.1.0

This version of the driver provides the following features:

- Identity Manager 4.7 provides support for MapDB 3.0.5. To ensure that your driver works correctly with Identity Manager 4.7 engine, see “Working with MapDB 3.0.5” on page 98.
- The driver now supports the Subscriber Service channel. This channel enables you to separately process the out-of-band queries without interrupting the normal flow of cached events. For example, the Subscriber Service channel can separately process code map refresh, data collection, and queries triggered from dxcmd. This helps to improve the performance of the driver. For more information, see Improving Driver Performance Using Subscriber Service Channel in the NetIQ Identity Manager Driver Administration Guide.
Working with MapDB 3.0.5

NetIQ recommends that you review the following sections before upgrading your driver to work with Identity Manager 4.7 engine:

- “Understanding Identity Manager 4.7 Engine Support for Driver Versions” on page 98
- “Manually Removing the MapDB Cache Files” on page 98

Understanding Identity Manager 4.7 Engine Support for Driver Versions

- Drivers shipped with Identity Manager 4.7 are compatible with Identity Manager 4.7 Engine or Remote Loader. You must perform the following actions to complete the driver upgrade:
  1. Upgrade the Identity Manager Engine.
  2. (Conditional) Upgrade the Remote Loader.
  3. Upgrade the driver.
  4. Manually remove the MapDB state cache files from the Identity Vault’s DIB directory. For more information, see “Manually Removing the MapDB Cache Files” on page 98.

- Drivers shipped before Identity Manager 4.7 are not compatible with Identity Manager 4.7 Engine or Remote Loader.

- Drivers shipped with Identity Manager 4.7 are not backward compatible with Identity Manager 4.6.x Engine or Remote Loader.

- Drivers shipped with Identity Manager 4.7 are not backward compatible with Identity Manager 4.5.x Engine or Remote Loader.

Manually Removing the MapDB Cache Files

The Identity Manager engine upgrade process removes the existing MapDB driver work cache files (dx*) from the Identity Vault’s DIB directory (/var/opt/novell/eDirectory/data/dib or C:\Novell\NDS\DIBFiles). You must manually remove the existing MapDB state cache files for the driver after upgrading the driver. The MapDB state cache files for the JDBC driver are represented in the following format:

jdbc_<driver instance guid>_*

where * is the name of the state cache file. For example, jdbc_<driver instance guid>_0 or jdbc_<driver instance guid>_1.t

This action ensures that your driver works correctly with Identity Manager 4.7 engine.

Considerations for Upgrading the Driver With Different Identity Manager and MapDB Versions

If the newer driver includes a different version of state file persistence API (MapDB or ZoomDB), then the upgraded driver in a triggerless mode can no longer make use of the state files from the old driver. The below table provides details about the state persistence API versions that can help you determine whether the existing state files will continue to work with the newer driver version.
Upgrading an Existing Driver

NOTE: Prior to Identity Manager 4.x, the extension of driver state files was `<tao number>.db` or `.lg`.

### Upgrading the Driver

The driver upgrade process involves upgrading the installed driver packages and updating the existing driver files. These are independent tasks and can be separately planned for a driver. For example, you can update the driver packages and choose not to update the driver files at the same time. However, you are recommended to complete all the update steps within a short amount of time to ensure that the driver has the latest updates.

- "Upgrading the Installed Packages" on page 100
- "Updating the Driver Files" on page 100

Before starting the upgrade process, ensure that you have taken a back-up of the current driver configuration.
Upgrading the Installed Packages

1. Download the latest available packages.
   To configure Designer to automatically read the package updates when a new version of a package is available, click Windows > Preferences > NetIQ > Package Manager > Online Updates in Designer. However, if you need to add a custom package to the Package Catalog, you can import the package .jar file. For more information about creating custom packages, see Developing Packages in the NetIQ Designer for Identity Manager Administration Guide.

2. Upgrade the installed packages.
   2a. Open the project containing the driver.
   2b. Right-click the driver for which you want to upgrade an installed package, then click Driver > Properties.
   2c. Click Packages.
       If there is a newer version of a package, there is a check mark displayed in the Upgrades column.
   2d. Click Select Operation for the package that indicates there is an upgrade available.
   2e. From the drop-down list, click Upgrade.
   2f. Select the version that you want to upgrade to, then click OK.

       **NOTE:** Designer lists all versions available for upgrade.

   2g. Click Apply.
   2h. (Conditional) Fill in the fields with appropriate information to upgrade the package, then click Next.
       Depending on which package you selected to upgrade, you must fill in the required information to upgrade the package.
   2i. Read the summary of the packages that will be installed, then click Finish.
   2j. Review the upgraded package, then click OK to close the Package Management page.

       For detailed information, see the Upgrading Installed Packages in the NetIQ Designer for Identity Manager Administration Guide.

Updating the Driver Files

This section provides general instructions for updating the driver files. For information about updating the driver files to a specific version, search for that driver patch in the Patch Finder Download Page and follow the instructions from the Readme file that accompanies the driver patch release.

To update the driver files:

1. Stop the driver instance by using iManager, Designer, or dxcmd by performing one of the following actions:
   - If the driver is running locally, stop the driver instance and the Identity Vault.
   - If the driver is running with a Remote Loader instance, stop the driver and the Remote Loader instance.

       For example, go to a command prompt on Linux and run ndsmanage stopall

2. Download the driver patch file to a temporary folder on your server.
3. Extract the contents of the driver patch file.
4 Update the driver files:
   • **Linux**: Open a command prompt and run the following command to upgrade the existing RPM:
     
     ```bash
     rpm -U (image-path)/netiq-DXMLRESTJDBC.rpm
     ```
   • **Windows**: Navigate to the `<Extracted Driver Patch File Temporary Location>`\windows folder and copy the JDBCDriverShim.jar file to `<IdentityManager installation>`\RemoteLoader\lib folder.

5 (Conditional) If the driver is running locally, start the Identity Vault and the driver instance.
   For example, open a command prompt on Linux and run `ndsmanage startall`

6 (Conditional) If the driver is running with a Remote Loader, start the Remote Loader and the driver instance.
Managing the Driver

As you work with the JDBC driver, there are a variety of management tasks you might need to perform, including the following:

- Starting, stopping, and restarting the driver
- Viewing driver version information
- Using Named Passwords to securely store passwords associated with the driver
- Monitoring the driver’s health status
- Backing up the driver
- Inspecting the driver’s cache files
- Viewing the driver’s statistics
- Using the DirXML Command Line utility to perform management tasks through scripts
- Securing the driver and its information
- Synchronizing objects
- Migrating and resynchronizing data
- Activating the driver

Because these tasks, as well as several others, are common to all Identity Manager drivers, they are included in one reference, the NetIQ Identity Manager Driver Administration Guide.
High-Level View

The following table shows a high-level view of how the driver maps NetIQ Identity Vault objects to database objects.

<table>
<thead>
<tr>
<th>Identity Vault Object</th>
<th>Database Object</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tree</td>
<td>Schema</td>
</tr>
<tr>
<td>Class</td>
<td>Table/View</td>
</tr>
<tr>
<td>Attribute</td>
<td>Column</td>
</tr>
<tr>
<td>Association</td>
<td>Primary Key</td>
</tr>
</tbody>
</table>

Logical Database Classes

A logical database class is the set of tables or the view used to represent an eDirectory™ class in a database. A logical database class can consist of a single view or one parent table and zero or more child tables.

The name of a logical database class is the name of the parent table or view.

Indirect Synchronization

In an indirect synchronization model, the driver maps the following:
Table 9-2  Mappings in Indirect Synchronization

<table>
<thead>
<tr>
<th>Identity Vault Object</th>
<th>Database Object</th>
</tr>
</thead>
<tbody>
<tr>
<td>Classes</td>
<td>Tables</td>
</tr>
<tr>
<td>Attributes</td>
<td>Columns</td>
</tr>
<tr>
<td>1 Class</td>
<td>1 parent table</td>
</tr>
<tr>
<td></td>
<td>and</td>
</tr>
<tr>
<td></td>
<td>0 or more child tables</td>
</tr>
<tr>
<td>Single-value attribute</td>
<td>Parent table column</td>
</tr>
<tr>
<td>Multivalue attribute</td>
<td>Parent table column (holding delimited values)</td>
</tr>
<tr>
<td></td>
<td>or</td>
</tr>
<tr>
<td></td>
<td>Child table column (preferred)</td>
</tr>
</tbody>
</table>

- “Mapping eDirectory Classes to Logical Database Classes” on page 106
- “Parent Tables” on page 108
- “Parent Table Columns” on page 108
- “Child Tables” on page 109
- “Referential Attributes” on page 110
- “Single-Value Referential Attributes” on page 110
- “Multivalue Referential Attributes” on page 111

Mapping eDirectory Classes to Logical Database Classes

In the following example, the logical database class `usr` consists of the following:

- One parent table `usr`
- Two child tables: `usr_phone` and `usr_faxno`.

Logical class `usr` is mapped to the eDirectory class User.

CREATE TABLE indirect.usr
(
  idu INTEGER NOT NULL,
  fname VARCHAR2(64),
  lname CHAR(64),
  pwdminlen NUMBER(4),
  pwdexptime DATE,
  disabled NUMBER(1),
  username VARCHAR2(64),
  loginame VARCHAR2(64),
  photo LONG RAW,
  manager INTEGER,
  CONSTRAINT pk_usr_idu PRIMARY KEY (idu),
  CONSTRAINT fk_usr_manager FOREIGN KEY (manager)
    REFERENCES indirect.usr(idu)
)
CREATE TABLE indirect.usr_phone
{
    idu      INTEGER       NOT NULL,
    phoneno  VARCHAR2(64)  NOT NULL,
    CONSTRAINT fk_phone_idu FOREIGN KEY (idu)
    REFERENCES indirect.usr(idu)
}

CREATE TABLE indirect.usr_fax
{
    idu    INTEGER       NOT NULL,
    faxno  VARCHAR2(64)  NOT NULL,
    CONSTRAINT fk_fax_idu FOREIGN KEY (idu)
    REFERENCES indirect.usr(idu)
}

<rule name="Schema Mapping Rule">
  <attr-name-map>
    <class-name>
      <nds-name>User</nds-name>
      <app-name>indirect.usr</app-name>
    </class-name>
    <attr-name class-name="User">
      <nds-name>Given Name</nds-name>
      <app-name>fname</app-name>
    </attr-name>
    <attr-name class-name="User">
      <nds-name>Surname</nds-name>
      <app-name>lname</app-name>
    </attr-name>
    <attr-name class-name="User">
      <nds-name>Password Expiration Time</nds-name>
      <app-name>pwdexptime</app-name>
    </attr-name>
    <attr-name class-name="User">
      <nds-name>jpegPhoto</nds-name>
      <app-name>photo</app-name>
    </attr-name>
    <attr-name class-name="User">
      <nds-name>Password Minimum Length</nds-name>
      <app-name>pwdminlen</app-name>
    </attr-name>
    <attr-name class-name="User">
      <nds-name>Facsimile Telephone Number</nds-name>
      <app-name>usr_fax.faxno</app-name>
    </attr-name>
    <attr-name class-name="User">
      <nds-name>Telephone Number</nds-name>
      <app-name>usr_phone.phoneno</app-name>
    </attr-name>
    <attr-name class-name="User">
      <nds-name>Login Disabled</nds-name>
      <app-name>disabled</app-name>
    </attr-name>
  </attr-name-map>
</rule>
Parent Tables

Parent tables are tables with an explicit primary key constraint that contains one or more columns. In a parent table, an explicit primary key constraint is required so that the driver knows which fields to include in an association value.

```
CREATE TABLE indirect.usr
{
    idu INTEGER NOT NULL,
    -- ...
    CONSTRAINT pk_usr_idu PRIMARY KEY (idu)
}
```

The following table contains sample data for table `indirect.usr`.

<table>
<thead>
<tr>
<th>idu</th>
<th>fname</th>
<th>lname</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>John</td>
<td>Doe</td>
</tr>
</tbody>
</table>

The resulting association for this row is

```
idu=1,table=usr,schema=indirect
```

The case of database identifiers in association values is determined dynamically from database metadata at runtime.

Parent Table Columns

Parent table columns can contain only one value. As such, they are ideal for mapping single-value eDirectory attributes, such as mapping the single-value eDirectory attribute Password Minimum Length to the single-value parent table column `pwdminlen`.

Parent table columns are implicitly prefixed with the schema name and name of the parent table. It is not necessary to explicitly table-prefix parent table columns. For example, `indirect.usr.fname` is equivalent to `fname` for schema mapping purposes.

```
<rule name="Schema Mapping Rule">
  <attr-name-map>
    <class-name>
      <nds-name>User</nds-name>
      <app-name>indirect.usr</app-name>
    </class-name>
    <attr-name class-name="User">
      <nds-name>Given Name</nds-name>
      <app-name>fname</app-name>
    </attr-name>
  </attr-name-map>
</rule>
```

Large binary and string data types should usually be mapped to parent table columns. To map to a child table column, data types must be comparable in SQL statements. Large data types usually cannot be compared in SQL statements.

Large binary and string data types can be mapped to child table columns if the following occur:

- Each `<remove-value>` event on these types is transformed in a policy into a `<remove-all-values>` element
- An `<add-value>` element follows each `<remove-value>` event
**Child Tables**

A child table is a table that has a foreign key constraint on its parent table’s primary key, linking the two tables together. The columns that comprise the child table’s foreign key can have different names than the columns in the parent table’s primary key.

The following example shows the relationship between parent table `usr` and child tables `usr_phone` and `usr_faxno`:

```sql
CREATE TABLE indirect.usr
(
    idu  INTEGER  NOT NULL,
    -- ...
    CONSTRAINT pk_usr_idu  PRIMARY KEY (idu)
)

CREATE TABLE indirect.usr_phone
(
    idu      INTEGER       NOT NULL,
    phoneno  VARCHAR2(64)  NOT NULL,
    CONSTRAINT fk_phone_idu FOREIGN KEY (idu) REFERENCES indirect.usr(idu)
)

CREATE TABLE indirect.usr_fax
(
    idu    INTEGER       NOT NULL,
    faxno  VARCHAR2(64)  NOT NULL,
    CONSTRAINT fk_fax_idu FOREIGN KEY (idu) REFERENCES indirect.usr(idu)
)
```

In a child table, constrain all columns NOT NULL.

The first constrained column in a child table identifies the parent table. In the above example, the constrained column in child table `usr_phone` is `idu`. The only purpose of this column is to relate tables `usr_phone` and `usr`. Because constrained columns do not contain any useful information, omit them from publication triggers and Schema Mapping policies.

The unconstrained column is the column of interest. It represents a single, multivalue attribute. In the above example, the unconstrained columns are `phoneno` and `faxno`. Because unconstrained columns can hold multiple values, they are ideal for mapping multivalue eDirectory attributes (for example, mapping the multivalue eDirectory attribute Telephone Number to `usrphone.phoneno`).

The following table contains sample data for `indirect.usr_phone`.

<table>
<thead>
<tr>
<th>idu</th>
<th>phoneno</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>111-1111</td>
</tr>
<tr>
<td>1</td>
<td>222-2222</td>
</tr>
</tbody>
</table>

Like parent table columns, child table columns are implicitly schema-prefixed. Unlike parent table columns, however, a child table column name must be explicitly prefixed with the child table name (for example, `usr_phone.phoneno`). Otherwise, the driver implicitly interprets column `phoneno` (the parent table column) as `usr.phoneno`, not the child table column `usr_phone.phoneno`. 

Table 9-3  Sample Data
Map each multivalue eDirectory attribute to a different child table.

**Referential Attributes**

You can represent referential containment in the database by using foreign key constraints. Referential attributes are columns within a logical database class that refer to the primary key columns of parent tables in the same logical database class or those of other logical database classes.

**Single-Value Referential Attributes**

You can relate two parent tables through a single-value parent table column. This column must have a foreign key constraint pointing to the other parent table’s primary key. The following example relates a single parent table `usr` to itself:

```
CREATE TABLE indirect.usr
(
    idu       INTEGER  NOT NULL,
    -- ...
    manager   INTEGER,
    CONSTRAINT pk_usr_idu PRIMARY KEY (idu),
    CONSTRAINT fk_usr_manager FOREIGN KEY (manager) REFERENCES indirect.usr(idu)
)
```

**NOTE:** Single-valued referential columns should be nullable.

```xml
<rule name="Schema Mapping Rule">
  <attr-name-map>
    <class-name>
      <nds-name>User</nds-name>
      <app-name>indirect.usr</app-name>
    </class-name>
    <attr-name class-name="User">
      <nds-name>manager</nds-name>
      <app-name>manager</app-name>
    </attr-name>
  </attr-name-map>
</rule>
```
In the above example, each user can have only one manager who himself is a user.

**Multivalue Referential Attributes**

You can relate two parent tables through a common child table. This child table must have a column constrained by a foreign key pointing to the other parent table's primary key. The following example relates two parent tables `usr` and `grp` through a common child table `member`.

```sql
CREATE TABLE indirect.usr
{
    idu  INTEGER  NOT NULL,
    -- ...
    CONSTRAINT pk_usr_idu PRIMARY KEY (idu)
}

CREATE TABLE indirect.grp
{
    idg  INTEGER  NOT NULL,
    -- ...
    CONSTRAINT pk_grp_idg PRIMARY KEY (idg)
}

CREATE TABLE indirect.grp_member
{
    idg  INTEGER  NOT NULL,
    idu  INTEGER  NOT NULL,
    CONSTRAINT fk_member_idg FOREIGN KEY (idg) REFERENCES indirect.grp(idg),
    CONSTRAINT fk_member_idu FOREIGN KEY (idu) REFERENCES indirect.usr(idu)
}

Constrain all columns in a child table NOT NULL.
```

The first constrained column in a child table determines which logical database class the child table belongs to. In the above example, `grp_member` is considered to be part of logical database class `grp`. `grp_member` is said to be a proper child of `grp`. The second constrained column in a child table is the multivalue referential attribute.

In the following example, the order of the constrained columns has been reversed so that `grp_member` is part of class `usr`. To more accurately reflect the relationship, table `grp_member` has been renamed to `usr_mbr_of`.
CREATE TABLE indirect.usr
{
    idu  INTEGER  NOT NULL,
    -- ...
    CONSTRAINT pk_usr_idu PRIMARY KEY (idu)
}

CREATE TABLE indirect.grp
{
    idg  INTEGER  NOT NULL,
    -- ...
    CONSTRAINT pk_grp_idg PRIMARY KEY (idg)
}

CREATE TABLE indirect.usr_mbr_of
{
    idu  INTEGER  NOT NULL,
    idg  INTEGER  NOT NULL,
    CONSTRAINT fk_mbr_of_idu FOREIGN KEY (idu) REFERENCES indirect.usr(idu) ON
    DELETE CASCADE,
    CONSTRAINT fk_mbr_of_idg FOREIGN KEY (idg)
    REFERENCES indirect.grp(idg) ON DELETE CASCADE
}

<rule name="Schema Mapping Rule">
    <attr-name-map>
        <class-name>
            <nds-name>Group</nds-name>
            <app-name>indirect.grp</app-name>
        </class-name>
        <class-name>
            <nds-name>User</nds-name>
            <app-name>indirect.usr</app-name>
        </class-name>
        <attr-name class-name="User">
            <nds-name>Group Membership</nds-name>
            <app-name>usr_mbr_of.idg</app-name>
        </attr-name>
    </attr-name-map>
</rule>

In databases that have no awareness of column position (such as DB2/AS400), order is determined by sorting column names by string or hexadecimal value. For additional information, see “Sort Column Names By” on page 76.

In general, it is necessary to synchronize only bidirectional, multivalue, referential attributes as part of one class or the other, not both. If you want to synchronize referential attributes for both classes, construct two child tables, one for each class. For example, if you want to synchronize eDirectory attributes Group Membership and Member, you need two child tables.

In practice, when you synchronize User and Group classes, we recommend that you synchronize the Group Membership attribute of class User instead of the Member attribute of class Group. Synchronizing the group memberships of a user is usually more efficient than synchronizing all members of a group.

**Direct Synchronization**

In a direct synchronization model, the driver maps the following:
Table 9-4  Mappings in Direct Synchronization

<table>
<thead>
<tr>
<th>Identity Vault Object</th>
<th>Database Object</th>
</tr>
</thead>
<tbody>
<tr>
<td>Classes</td>
<td>Views</td>
</tr>
<tr>
<td>Attributes</td>
<td>View Columns</td>
</tr>
<tr>
<td>Class</td>
<td>View</td>
</tr>
<tr>
<td>Single-value attribute</td>
<td>View Column</td>
</tr>
<tr>
<td>Multivalue attribute</td>
<td>View Column</td>
</tr>
</tbody>
</table>

The update capabilities of views vary between databases. Most databases allow views to be updated when they are comprised of a single base table. (That is, they do not join multiple tables.) If views are read-only, they cannot be used for subscription. Some databases allow update logic to be defined on views in instead-of-triggers, which allow a view to join multiple base tables and still be updateable.

For a list of databases that support instead-of-triggers, see “Database Features” on page 158. Instead-of-trigger logic can be simulated, regardless of database capability using embedded SQL. See “Virtual Triggers” on page 138.

- “View Column Meta-Identifiers” on page 113
- “Primary Key Columns” on page 115
- “Schema Mapping” on page 115

View Column Meta-Identifiers

A view is a logical table. Unlike tables, views do not physically exist in the database. As such, views usually cannot have traditional primary key/foreign key constraints. To simulate these constructs, the JDBC driver embeds constraints and other metadata in view column names. The difference between these constraints and traditional ones is that the former are not enforced at the database level. They are an application-level construct.

For example, to identify to the driver which fields to use when constructing association values, place a primary key constraint on a parent table. The corollary to this for a view is to prefix one or more column names with pk_ (case-insensitive).

The following table lists the constraint prefixes that can be embedded in view column names.

Table 9-5  Constraint Prefixes

<table>
<thead>
<tr>
<th>Constraint Prefixes (case-insensitive)</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>pk_</td>
<td>primary key</td>
</tr>
<tr>
<td>fk_</td>
<td>foreign key</td>
</tr>
<tr>
<td>sv_</td>
<td>single-value</td>
</tr>
<tr>
<td>mv_</td>
<td>multivalue</td>
</tr>
</tbody>
</table>

The following example views contain all of these constraint prefixes. These are examples and not the actual samples. Therefore, they should not be used in the driver implementation. The real samples are bundled with the Identity Manager media.
CREATE VIEW direct.view_usr
{
    pk_idu, -- primary key column; implicitly single-valued
    sv.fname, -- single-valued column
    mv.phoneno, -- multi-valued column
    fk_idu_manager, -- self-referential foreign key column; refers
                      --   to primary key column idu in view_usr;
                      --   implicitly single-valued
    fk_mv__idg__mbr_of -- extra-referential foreign key column; refers
                         --   to primary key column idg in view_grp;
                         --   multi-valued
}
AS
-- ...

CREATE VIEW direct.view_grp
{
    pk_idg, -- primary key column; implicitly single-valued
    fk_mv__idu__mbr -- extra-referential foreign key column; refers
                      --   to primary key column idu in view_usr;
                      --   multi-valued
}
AS
-- ...

BNF

The BNF (Backus Naur Form (http://cui.unige.ch/db-research/Enseignement/analyseinfo/AboutBNF.html)) notation for view column meta-identifiers:

<view-column-name> ::= [<meta-info>] <column-name>
<column-name> ::= <legal-unquoted-database-identifier>
<meta-info> ::= <referential> | <non-referential>
<non-referential> ::= [<single-value> | <multiple-value>]
<single-value> ::= "sv_"
<multiple-value> ::= "mv_"
<referential> ::= <primary-key> | <foreign-key>
<primary-key> ::= "pk_" [<single-value>] [<column-group-id>] [<referenced-column-name>]
<column-group-id> ::= <non-negative-integer> "_
<referenced-column-name> ::= "_" <column-name> "_
<foreign-key> ::= "fk_" [<non-referential>] [<column-group-id>] <referenced-column-name>

Normalized Forms

By default, all view column names are single-valued. Therefore, explicitly specifying the sv_prefix in a view column name is redundant. For example, sv_fname and fname are equivalent forms of the same column name.
Also, primary key column names implicitly refer to themselves. Therefore, it is redundant to specify the referenced column name. For example, \texttt{pk\_idu} is equivalent to \texttt{pk\_idu\_idu}.

The JDBC driver uses two normalized forms of view meta-identifiers:

- **Database native form**
  
  Database native form is the column name as declared in the database. This form is usually much more verbose than schema mapping form, and contains all necessary meta information.

- **Schema mapping form**
  
  Schema mapping form is returned when the driver returns the application schema. This form is much more concise than database native form because much of the meta information included in database native form is represented in XDS XML and not in the identifier.

  The referential prefixes \texttt{pk\_} and \texttt{fk\_} are the only meta information preserved in schema mapping form. This limitation ensures backward compatibility.

The following table provides examples of each form:

<table>
<thead>
<tr>
<th>Database Native Form</th>
<th>Schema Mapping Form</th>
</tr>
</thead>
<tbody>
<tr>
<td>\texttt{pk_idu}</td>
<td>\texttt{pk_idu}</td>
</tr>
<tr>
<td>\texttt{sv_fname}</td>
<td>\texttt{fname}</td>
</tr>
<tr>
<td>\texttt{mv_phoneno}</td>
<td>\texttt{phoneno}</td>
</tr>
<tr>
<td>\texttt{fk_mv_idg_mbr_of}</td>
<td>\texttt{fk_mbr_of}</td>
</tr>
</tbody>
</table>

### Equivalent Forms

A view column name without meta information is called its “effective” name, which is similar to a directory object’s “effective” rights. For the driver, view column name equivalency is determined without respect to meta information by default. For example, \texttt{pk\_idu} is equivalent to \texttt{idu}, and \texttt{fk\_mv\_idg\_mbr\_of} is equivalent to \texttt{mbr\_of}. Any variant form of a view meta column identifier can be passed to the driver at runtime. For backward compatibility reasons, meta information can be treated as part of the effective view column name. See “Enable Meta-Identifier Support?” on page 73.

### Primary Key Columns

Primary key column names must be unique among all views in the synchronization schema.

### Schema Mapping

Schema mapping conventions for views and view columns are equivalent to that used for parent tables and parent table columns.
Synchronizing Primary Key Columns

When the database is the authoritative source of primary key columns, generally omit the columns from the Publisher and Subscriber filters, Schema Mapping policies, and publication triggers.

When the Identity Vault is the authoritative source of primary key columns, include the columns in the Subscriber filter and Schema Mapping policies, but omit the columns from the Publisher filter and publication triggers. Also, GUID rather than CN is recommended for use as a primary key. CN is a multivalue attribute and can change. GUID has a single value and is static.

Synchronizing Multiple Classes

When synchronizing multiple eDirectory classes, synchronize each class to a different parent table or view. Each logical database class must have a unique primary key column name. The Publisher channel uses this common column name to identify all rows in the event log table pertaining to a single logical database class. For example, both the logical database classes `usr` and `grp` have a unique primary key column name.

```
CREATE TABLE usr
(
    idu   INTEGER         NOT NULL,
    lname VARCHAR2(64)  NOT NULL,
    --...
    CONSTRAINT pk_usr_idu PRIMARY KEY(idu)
);

CREATE TABLE grp
(
    idg  INTEGER  NOT NULL,
    --...
    CONSTRAINT pk_grp_idg PRIMARY KEY(idg)
);
```

Mapping Multivalue Attributes to Single-Value Database Fields

By default, the driver assumes that all eDirectory attributes mapped to parent table columns or view columns have a single value. Because the driver is unaware of the eDirectory schema, it has no way of knowing whether an eDirectory attribute has a single value or has multiple values. Accordingly, multivalue and single-value attribute mappings are handled identically.

The driver implements the Most Recently Touched (MRT) algorithm with regard to single-value parent table or view columns. An MRT algorithm ensures that the most recently added attribute value or most recently deleted attribute value is stored in the database. The algorithm is adequate if the attribute in question has a single value.

If the attribute has multiple values, the algorithm has some undesirable consequences. When a value is deleted from a multivalue attribute, the database field it is mapped to is set to NULL and remains NULL until another value is added. The preferred solution to this undesirable behavior is to extend the eDirectory schema so that only single-value attributes are mapping to parent table or view columns.

Other solutions include the following:

- For indirect synchronization, map each multivalue attribute to its own child table.
For both direct or indirect synchronization, use a policy to delimit multiple values before inserting them into a table or view column.

Implement a first or last value per replica policy in style sheets by using methods provided in the `com.novell.nds.indirect.driver.jdbc.util.MappingPolicy` class. Under a first-value-per-replica (FPR) policy, the first attribute value on the eDirectory replica is always synchronized. Under a last-value-per-replica (LPR) policy, the last attribute value on a replica is always synchronized. By using global configuration values, you can configure the sample driver configuration to use either FPR or LPR mapping policies. Multivalue to single-value attribute mapping policies are contained in the Subscriber Command Transformation policy container. The sample driver configuration maps the multivalue eDirectory attributes Given Name and Surname to the single-value columns `fname` and `lname` respectively.
10 Mapping XDS Events to SQL Statements

- “Mapping XDS Events for Indirect Synchronization” on page 119
- “Mapping XDS Events for Direct Synchronization” on page 119

Mapping XDS Events for Indirect Synchronization

The following table summarizes how the Subscriber channel maps XDS events to DML SQL statements for indirect synchronization:

<table>
<thead>
<tr>
<th>XML Event</th>
<th>SQL Equivalent</th>
</tr>
</thead>
</table>
| <add>     | ❍ 0 or more select statements, depending upon the matching policy.  
               ❍ 1 parent table insert statement for all single value <add-attr> elements.  
               ❍ 0 or 1 stored procedure/function calls to retrieve primary key values before or after the parent table insert statement.  
               ❍ 1 child table insert statement for each multivalue <add-attr> element. |
| <modify>  | ❍ 1 parent table update statement for each single value <add-value> or <remove-value> element.  
               ❍ 1 child table insert statement for each multivalue <add-value> element.  
               ❍ 1 child table delete statement for each <remove-value> element. |
| <delete>  | ❍ 1 parent table delete statement.  
               ❍ 1 delete statement for each child table. |
| <query>   | ❍ 1 parent table select statement.  
               ❍ 1 select statement for each child table. |
| <move>    | ❍ 0 statements unless bound to embedded SQL statements. |
| <rename>  | ❍ 0 statements unless bound to embedded SQL statements. |
| <modify-password> | ❍ 0 statements unless bound to embedded SQL statements. |
| <check-object-password> | ❍ 0 statements unless bound to embedded SQL statements. |

Mapping XDS Events for Direct Synchronization

The following table summarizes how the Subscriber channel maps XDS events to DML SQL statements for direct synchronization:
### Table 10-2  Mapping XDS Events for Direct Synchronization

<table>
<thead>
<tr>
<th>XML Event</th>
<th>SQL Equivalent</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>&lt;add&gt;</code></td>
<td>• 0 or more select statements, depending upon the matching policy.</td>
</tr>
<tr>
<td></td>
<td>• 1 view insert statement for all single value <code>&lt;add-attr&gt;</code> element.</td>
</tr>
<tr>
<td></td>
<td>• 0 or 1 stored procedure/function call to retrieve primary key values before or after the view insert statement.</td>
</tr>
<tr>
<td></td>
<td>• 1 view insert statement for each multivalue <code>&lt;add-attr&gt;</code> element.</td>
</tr>
<tr>
<td><code>&lt;modify&gt;</code></td>
<td>• 1 view update statement for each single value <code>&lt;add-value&gt;</code> or <code>&lt;remove-value&gt;</code> element.</td>
</tr>
<tr>
<td></td>
<td>• 1 view insert statement for each multivalue <code>&lt;add-value&gt;</code> element.</td>
</tr>
<tr>
<td></td>
<td>• 1 view delete statement for each <code>&lt;remove-value&gt;</code> element.</td>
</tr>
<tr>
<td><code>&lt;delete&gt;</code></td>
<td>• 1 view delete statement.</td>
</tr>
<tr>
<td><code>&lt;query&gt;</code></td>
<td>• 1 view select statement.</td>
</tr>
<tr>
<td><code>&lt;move&gt;</code></td>
<td>• 0 statements unless bound to embedded SQL statements.</td>
</tr>
<tr>
<td><code>&lt;rename&gt;</code></td>
<td></td>
</tr>
<tr>
<td><code>&lt;modify-password&gt;</code></td>
<td></td>
</tr>
<tr>
<td><code>&lt;check-object-password&gt;</code></td>
<td></td>
</tr>
</tbody>
</table>
The Event Log Table

The event log table stores publication events. This section describes the structure and capabilities of the event log table.

You can customize the name of the event log table and its columns to avoid conflicts with reserved database keywords. The order, number, and data types of its columns, however, are fixed. In databases that are unaware of column position, order is determined by the Sort Column Names By parameter. See “Sort Column Names By” on page 76.

Events in this table can be ordered either by order of insertion (the record_id column) or chronologically (the event_time column). Ordering events chronologically allows event processing to be delayed. To order publication events chronologically, set the Enable Future Event Processing parameter to Boolean True. See “Enable Future Event Processing?” on page 87.

- “Event Log Columns” on page 121
- “Event Types” on page 124

Event Log Columns

This section describes columns in the event log table. Columns are ordered by position.

- “record_id” on page 121
- “table_key” on page 121
- “status” on page 122
- “event_type” on page 122
- “event_time” on page 123
- “perpetrator” on page 123
- “table_name” on page 123
- “column_name” on page 123
- “old_value” on page 123
- “new_value” on page 124

record_id

The record_id column is used to uniquely identify rows in the event log table and order publication events. This column must contain sequential, ascending, positive, unique integer values. Gaps between record_id values no longer prematurely end a polling cycle.

table_key

Format values for this column are exactly the same in all triggers for a logical database class. The BNF or Backus Naur Form (http://cui.unige.ch/db-research/Enseignement/analyseinfo/AboutBNF.html) of this parameter is defined below:
The Event Log Table

<table-key> ::= <unique-row-identifier> {"+"<unique-row-identifier>}

<unique-row-identifier> ::= <primary-key-column-name> "=" <value>

For example, for the *usr* table referenced throughout this chapter, this column’s value might be *idu=1*.

For the *view_usr* view referenced throughout this chapter, this column’s value might be *pk_empno=1*.

For a hypothetical compound primary key (one containing multiple columns), this column’s value might be *pkey1=value1+pkey2=value2*.

If primary key values placed in the table_key field contain any of the special characters {;\'+"=\<\>}, where { } contain the set of special characters, delimit the value with double quotes. You also need to escape the double quote character " as \" and the literal escape character \ as \\ when they are contained inside a pair of double quotes.

For a hypothetical primary key containing special characters, this column’s value might be *pkey=";\'+\"=\\<\>"*. (Note the double quotes and escaped characters.)

Differences in padding or formatting might result in out-of-order event processing. For performance reasons, remove any unnecessary white space from numeric values. For example, *idu=1* is preferred over *idu= 1*.

### status

The *status* column indicates the state of a given row. The following table lists permitted values:

<table>
<thead>
<tr>
<th>Character Value</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>new</td>
</tr>
<tr>
<td>S</td>
<td>success</td>
</tr>
<tr>
<td>W</td>
<td>warning</td>
</tr>
<tr>
<td>E</td>
<td>error</td>
</tr>
<tr>
<td>F</td>
<td>fatal</td>
</tr>
</tbody>
</table>

To be processed, all rows inserted into the event log table must have a *status* value of N. The remainder of the status characters are used solely by the Publisher channel to designate processed rows. All other characters are reserved for future use.

Status values are case sensitive.

### event_type

Values in this column must be between 1 and 8. All other numbers are reserved for future use.

The following table describes each event type:
Table 11-2  Event Types

<table>
<thead>
<tr>
<th>Event Type</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>insert field</td>
</tr>
<tr>
<td>2</td>
<td>update field</td>
</tr>
<tr>
<td>3</td>
<td>update field (remove all values)</td>
</tr>
<tr>
<td>4</td>
<td>delete row</td>
</tr>
<tr>
<td>5</td>
<td>insert row (query-back)</td>
</tr>
<tr>
<td>6</td>
<td>update row (query-back)</td>
</tr>
<tr>
<td>7</td>
<td>insert field (query-back)</td>
</tr>
<tr>
<td>8</td>
<td>update field (query-back)</td>
</tr>
</tbody>
</table>

For additional information on this field, see “Event Types” on page 124.

**event_time**

This column serves as an alternative ordering column to `record_id`. It contains the effective date of the event. It must not be NULL. For this column to become the ordering column, set the Enable Future Event Processing parameter to Boolean True. See “Enable Future Event Processing?” on page 87.

**perpetrator**

This column identifies the database user who instigated the event. A NULL value is interpreted as a user other than the driver user. Rows with a NULL value or value not equal to the driver’s database username are published. Rows with a value equal to the driver’s database username are not published unless the Allow Loopback Publisher parameter is set to Boolean True. See “Allow Loopback?” on page 90.

**table_name**

The name of the table or view where the event occurred.

**column_name**

The name of the column that was changed. This column is used only for per-field (1-3, 7-8) event types. Nevertheless, it must always be present in the event log table. If it is missing, the Publisher channel cannot start.

**old_value**

The field’s old value. This column is used only for per-field, non-query-back event types (1-3). Nevertheless, it must always be present in the event log table. If it is missing, the Publisher channel cannot start.
**new_value**

The field's new value. This column is used only by per-field, non-query-back event types (1-3). Nevertheless, it must always be present in the event log table. If it is missing, the Publisher channel cannot start.

**Event Types**

The following table describes each event type:

*Table 11-3  Event Types*

<table>
<thead>
<tr>
<th>Event Type</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>insert field</td>
</tr>
<tr>
<td>2</td>
<td>update field</td>
</tr>
<tr>
<td>3</td>
<td>update field (remove all values)</td>
</tr>
<tr>
<td>4</td>
<td>delete row</td>
</tr>
<tr>
<td>5</td>
<td>insert row (query-back)</td>
</tr>
<tr>
<td>6</td>
<td>update row (query-back)</td>
</tr>
<tr>
<td>7</td>
<td>insert field (query-back)</td>
</tr>
<tr>
<td>8</td>
<td>update field (query-back)</td>
</tr>
</tbody>
</table>

Event types are in four major categories. Some categories overlap. The following table describes each category and indicates which event types are members:

*Table 11-4  Event Categories and Types*

<table>
<thead>
<tr>
<th>Event Category</th>
<th>Event Types</th>
</tr>
</thead>
<tbody>
<tr>
<td>Per-field (attribute)</td>
<td>1, 2, 3, 7, 8</td>
</tr>
<tr>
<td>Per-row (object)</td>
<td>4, 5, 6</td>
</tr>
<tr>
<td>Non-query-back</td>
<td>1, 2, 3, 4</td>
</tr>
<tr>
<td>Query-back</td>
<td>5, 6, 7, 8</td>
</tr>
<tr>
<td>Per-field, non-query-back</td>
<td>1, 2, 3</td>
</tr>
<tr>
<td>Per-field, query-back</td>
<td>7, 8</td>
</tr>
<tr>
<td>Per-row, non-query-back</td>
<td>4</td>
</tr>
<tr>
<td>Per-row, query-back</td>
<td>5, 6</td>
</tr>
</tbody>
</table>

In general, a combination of event types from each category yields the best trade-off in terms of space, time, implementation complexity, and performance.
Per-field event types are more granular, require more space, and are more complex to implement than per-row event types. Per-row events are less granular, require less space, and are easier to implement than per-field event types.

Query-back event types use less space but require more time to process than non-query-back event types. Non-query-back event types use more space but require less time to process than query-back event types.

Query-back event types take precedence over their non-query-back counterparts. Non-query-back events are ignored if a query-back event is logged for the same field or object. For example, if an event of type 2 (update-field, non-query-back) and 8 (update-field, query-back) are logged on the same field, the type 2 event is ignored in favor of the type 8 event.

Furthermore, query-back row event types take precedence over query-back field event types. For example, if an event type 8 (update field, query-back) and a event type 6 (update row query-back) are logged on the same object, the type 8 event is ignored in favor of the type 6 event.

Query-back events are ignored by the Publisher if the database object no longer exists. They are dependent upon the database object still being available at processing time. Therefore, logged query-back adds and modifies (event types 5, 6, 7, 8) have no effect once the database object they refer to is deleted.

The following table shows the basic correlation between publication event types and the XDS XML generated by the Publisher channel.

**Table 11-5 Basic Correlation of Publication Event Types**

<table>
<thead>
<tr>
<th>Event Type</th>
<th>Resulting XDS</th>
</tr>
</thead>
<tbody>
<tr>
<td>insert</td>
<td>&lt;add&gt;</td>
</tr>
<tr>
<td>update</td>
<td>&lt;modify&gt;</td>
</tr>
<tr>
<td>delete</td>
<td>&lt;delete&gt;</td>
</tr>
</tbody>
</table>

The following example illustrates XML that the Publisher channel generates for events logged on the `usr` table for each possible event type.

```sql
CREATE TABLE indirect.usr
(
    idu INTEGER NOT NULL,
    fname VARCHAR2(64),
    photo LONGRAW,
    --...
    CONSTRAINT pk_usr_idu PRIMARY KEY(idu)
);
```

The following table shows the initial contents of `usr` after a new row has been inserted:

**Table 11-6 An Inserted Row in the `usr` Table**

<table>
<thead>
<tr>
<th>idu</th>
<th>fname</th>
<th>lname</th>
<th>photo</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Jack</td>
<td>Frost</td>
<td>0xAAAA</td>
</tr>
</tbody>
</table>

The following table shows the current contents of `usr` after the row has been updated:
Table 11-7  An Updated Row in the *usr* Table

<table>
<thead>
<tr>
<th>idu</th>
<th>fname</th>
<th>lname</th>
<th>photo</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>John</td>
<td>Doe</td>
<td>0xBBBB</td>
</tr>
</tbody>
</table>

**Insert Field**

The table below shows the contents of the event log table after a new row is inserted into table *usr*. The value for column *photo* has been Base64-encoded. The Base64-encoded equivalent of 0xAAAA is qqo=.

Table 11-8  Event Log Table: Insert Field

<table>
<thead>
<tr>
<th>event_type</th>
<th>table</th>
<th>table_key</th>
<th>column_name</th>
<th>old_value</th>
<th>new_value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>usr</td>
<td>idu=1</td>
<td>fname</td>
<td>NULL</td>
<td>Jack</td>
</tr>
<tr>
<td>1</td>
<td>usr</td>
<td>idu=1</td>
<td>lname</td>
<td>NULL</td>
<td>Frost</td>
</tr>
<tr>
<td>1</td>
<td>usr</td>
<td>idu=1</td>
<td>photo</td>
<td>NULL</td>
<td>qqo=</td>
</tr>
</tbody>
</table>

The Publisher channel generates the following XML:

```
<add class-name="usr">
  <association>idu=1,table=usr,schema=indirect</association>
  <add-attr attr-name="fname">
    <value type="string">Jack</value>
  </add-attr>
  <add-attr attr-name="lname">
    <value type="string">Frost</value>
  </add-attr>
  <add-attr attr-name="photo">
    <value type="octet">qqo=</value>
  </add-attr>
</add>
```

**Update Field**

The following table shows the contents of the event log table after the row in table *usr* has been updated. The values for column *photo* has been Base64-encoded. The Base64-encoded equivalent of 0xBBBB is u7s=.

Table 11-9  Event Log Table: Update Field

<table>
<thead>
<tr>
<th>event_type</th>
<th>table</th>
<th>table_key</th>
<th>column_name</th>
<th>old_value</th>
<th>new_value</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>usr</td>
<td>idu=1</td>
<td>fname</td>
<td>Jack</td>
<td>John</td>
</tr>
<tr>
<td>2</td>
<td>usr</td>
<td>idu=1</td>
<td>lname</td>
<td>Frost</td>
<td>Doe</td>
</tr>
<tr>
<td>2</td>
<td>usr</td>
<td>idu=1</td>
<td>photo</td>
<td>qqo=</td>
<td>u7s=</td>
</tr>
</tbody>
</table>

The Publisher channel generates the following XML:

```
<add class-name="usr">
  <association>idu=1,table=usr,schema=indirect</association>
  <add-attr attr-name="fname">
    <value type="string">John</value>
  </add-attr>
  <add-attr attr-name="lname">
    <value type="string">Doe</value>
  </add-attr>
  <add-attr attr-name="photo">
    <value type="octet">u7s=</value>
  </add-attr>
</add>
```
<modify class-name="usr">
  <association>idu=1,table=usr,schema=indirect</association>
  <modify-attr attr-name="fname">
    <remove-value>
      <value type="string">Jack</value>
    </remove-value>
    <add-value>
      <value type="string">John</value>
    </add-value>
  </modify-attr>
  <modify-attr attr-name="lname">
    <remove-value>
      <value type="string">Frost</value>
    </remove-value>
    <add-value>
      <value type="string">Doe</value>
    </add-value>
  </modify-attr>
  <modify-attr attr-name="photo">
    <remove-value>
      <value type="octet">qqo=</value>
    </remove-value>
    <add-value>
      <value type="octet">u7s=</value>
    </add-value>
  </modify-attr>
</modify>

**Update Field (Remove-All-Values)**

The following table shows the contents of the event log table after the row in table `usr` has been updated. The value for column `photo` has been Base64-encoded.

<table>
<thead>
<tr>
<th>event_type</th>
<th>table</th>
<th>table_key</th>
<th>column_name</th>
<th>old_value</th>
<th>new_value</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>usr</td>
<td>idu=1</td>
<td>fname</td>
<td>Jack</td>
<td>John</td>
</tr>
<tr>
<td>3</td>
<td>usr</td>
<td>idu=1</td>
<td>lname</td>
<td>Frost</td>
<td>Doe</td>
</tr>
<tr>
<td>3</td>
<td>usr</td>
<td>idu=1</td>
<td>photo</td>
<td>qqq=</td>
<td>u7s=</td>
</tr>
</tbody>
</table>

The Publisher channel generates the following XML:
Delete Row

The table below shows the contents of the event log table after the row in table **usr** has been deleted.

**Table 11-11  Event Log Table: Delete Row**

<table>
<thead>
<tr>
<th>event_type</th>
<th>table</th>
<th>table_key</th>
<th>column_name</th>
<th>old_value</th>
<th>new_value</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>usr</td>
<td>idu=1</td>
<td>NULL</td>
<td>NULL</td>
<td>NULL</td>
</tr>
</tbody>
</table>

The Publisher channel generates the following XML:

```xml
<delete class-name="usr">
  <association>idu=1,table=usr,schema=indirect
</association>
</delete>
```

Insert Row (Query-Back)

The following table shows the contents of the event log table after a new row is inserted into table **usr**.

**Table 11-12  Event Log Table: Insert Row (Query-Back)**

<table>
<thead>
<tr>
<th>event_type</th>
<th>table</th>
<th>table_key</th>
<th>column_name</th>
<th>old_value</th>
<th>new_value</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>usr</td>
<td>idu=1</td>
<td>NULL</td>
<td>NULL</td>
<td>NULL</td>
</tr>
</tbody>
</table>

The Publisher channel generates the following XML. The values reflect the current contents of table **usr**, not the initial contents.
Update Row (Query-Back)

The table below shows the contents of the event log table after the row in table `usr` has been updated.

**Table 11-13 Event Log Table: Update Row (Query-Back)**

<table>
<thead>
<tr>
<th>event_type</th>
<th>table</th>
<th>table_key</th>
<th>column_name</th>
<th>old_value</th>
<th>new_value</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>usr</td>
<td>idu=1</td>
<td>NULL</td>
<td>NULL</td>
<td>NULL</td>
</tr>
</tbody>
</table>

The Publisher channel generates the following XML. The values reflect the current contents of table `usr`, not the initial contents.

```xml
<modify class-name="usr">
    <association>idu=1,table=usr,schema=indirect</association>
    <modify-attr attr-name="fname">
        <remove-all-values/>
        <add-value>
            <value type="string">John</value>
        </add-value>
    </modify-attr>
    <modify-attr attr-name="lname">
        <remove-all-values/>
        <add-value>
            <value type="string">Doe</value>
        </add-value>
    </modify-attr>
    <modify-attr attr-name="photo">
        <remove-all-values/>
        <add-value>
            <value type="octet">u7s=</value>
        </add-value>
    </modify-attr>
</modify>
```

Insert Field (Query-Back)

The following table shows the contents of the event log table after a new row is inserted into table `usr`. Old and new values are omitted because they are not used.
The Publisher channel generates the following XML. The values reflect the current contents of table `usr`, not the initial contents.

```xml
<add class-name="usr">
    <association>idu=1,table=usr,schema=indirect</association>
    <add-attr attr-name="fname">
        <value type="string">John</value>
    </add-attr>
    <add-attr attr-name="lname">
        <value type="string">Doe</value>
    </add-attr>
    <add-attr attr-name="photo">
        <value type="octet">u7s=</value>
    </add-attr>
</add>
```

**Update Field (Query-Back)**

The following table shows the contents of the event log table after the row in table `usr` has been updated. Old and new values are omitted because they are not used.

<table>
<thead>
<tr>
<th>event_type</th>
<th>table</th>
<th>table_key</th>
<th>column_name</th>
<th>old_value</th>
<th>new_value</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>usr</td>
<td>idu=1</td>
<td>fname</td>
<td>NULL</td>
<td>NULL</td>
</tr>
<tr>
<td>7</td>
<td>usr</td>
<td>idu=1</td>
<td>lname</td>
<td>NULL</td>
<td>NULL</td>
</tr>
<tr>
<td>7</td>
<td>usr</td>
<td>idu=1</td>
<td>photo</td>
<td>NULL</td>
<td>NULL</td>
</tr>
<tr>
<td>8</td>
<td>usr</td>
<td>idu=1</td>
<td>fname</td>
<td>NULL</td>
<td>NULL</td>
</tr>
<tr>
<td>8</td>
<td>usr</td>
<td>idu=1</td>
<td>lname</td>
<td>NULL</td>
<td>NULL</td>
</tr>
<tr>
<td>8</td>
<td>usr</td>
<td>idu=1</td>
<td>photo</td>
<td>NULL</td>
<td>NULL</td>
</tr>
</tbody>
</table>

The Publisher channel generates the following XML. The values reflect the current contents of table `usr`, not the initial contents.
<modify class-name="usr">
  <association>idu=1,table=usr,schema=indirect</association>
  <modify-attr attr-name="fname">
    <remove-all-values/>
    <add-value>
      <value type="string">John</value>
    </add-value>
  </modify-attr>
  <modify-attr attr-name="lname">
    <remove-all-values/>
    <add-value>
      <value type="string">Doe</value>
    </add-value>
  </modify-attr>
  <modify-attr attr-name="photo">
    <remove-all-values/>
    <add-value>
      <value type="octet">u7s=</value>
    </add-value>
  </modify-attr>
</modify>
Embedded SQL Statements in XDS Events

Embedded SQL allows you to embed SQL statements in XDS-formatted XML documents. You can use embedded SQL statements along with XDS events or use them alone. When embedded SQL statements are used alone, embedded SQL processing does not require that the driver know anything about tables/view in the target database. Therefore, the driver can run in schema-unaware mode. See “Synchronization Filter” on page 61. When using embedded SQL alone, you must establish associations manually. The driver won’t establish them for you.

When used in conjunction with XDS events, embedded SQL can act as a virtual database trigger. In the same way that you can install database triggers on a table and cause side effects in a database when certain SQL statements are executed, embedded SQL can cause side effects in a database in response to certain XDS events.

All examples in this section reference the following `indirect.usr` table.

```sql
CREATE TABLE indirect.usr
(
    idu INTEGER NOT NULL,
    fname VARCHAR2(64),
    lname VARCHAR2(64),

    CONSTRAINT pk_usr_idu PRIMARY KEY(idu)
);
```

- “Common Uses of Embedded SQL” on page 134
- “Embedded SQL Basics” on page 134
- “Token Substitution” on page 135
- “Virtual Triggers” on page 138
- “Manual vs. Automatic Transactions” on page 139
- “Transaction Isolation Level” on page 140
- “Statement Type” on page 140
- “SQL Queries” on page 142
- “Data Definition Language (DDL) Statements” on page 143
- “Logical Operations” on page 144
- “Implementing Password Set with Embedded SQL” on page 145
- “Implementing Modify Password with Embedded SQL” on page 145
- “Implementing Check Object Password” on page 146
- “Calling Stored Procedures and Functions” on page 146
- “Best Practices” on page 155
Common Uses of Embedded SQL

You can accomplish the following by embedding SQL in XDS events:

- Create database users or roles.
- Set, check, or modify user passwords.
- Manage database user or role privileges.

For examples of each, consult the User DDL Command Transformation style sheet on the Subscriber channel in the example driver configuration.

Embedded SQL Basics

- "Elements" on page 134
- "Namespaces" on page 134
- "Embedded SQL Example" on page 134

Elements

SQL is embedded in XDS events through the `<jdbc:statement>` and `<jdbc:sql>` elements. The `<jdbc:statement>` element can contain one or more `<jdbc:sql>` elements.

Namespaces

The namespace prefix `jdbc` used throughout this section is implicitly bound to the namespace `urn:dirxml:jdbc` when referenced outside of an XML document.

You must use namespace-prefixed embedded SQL elements and attributes. Otherwise, the driver does not recognize them. In all examples in this section, the prefix used is `jdbc`. In practice, the prefix can be whatever you want it to be, as long as it is bound to the namespace value `urn:dirxml:jdbc`.

The following XML example illustrates how to use and properly namespace-prefix embedded SQL elements. In the following example, the namespace declaration and namespace prefixes are bolded:

```xml
<input xmlns:jdbc="urn:dirxml:jdbc">
  <add class-name="usr">
    <add-attr name="lname">
      <value>Doe</value>
    </add-attr>
  </add>
  <jdbc:statement>
    <jdbc:sql>UPDATE indirect.usr SET fname = 'John'</jdbc:sql>
  </jdbc:statement>
</input>
```

Embedded SQL Example

The following XML example illustrates how to use the `<jdbc:statement>` and `<jdbc:sql>` elements and their interpretation. In the following example, embedded SQL elements are bolded:
Because the Subscriber channel resolves `<add>` events to one or more `INSERT` statements, the XML shown above resolves to:

```sql
SET AUTOCOMMIT OFF
INSERT INTO indirect.usr (lname) VALUES ('Doe');
COMMIT; -- explicit commit
UPDATE indirect.usr SET fname = 'John';
COMMIT; -- explicit commit
```

### Token Substitution

Rather than require you to parse field values from an association, the Subscriber channel supports token substitution in embedded SQL statements. In the following examples, tokens and the values they reference are bolded:

```xml
<input xmlns:jdbc="urn:dirxml:jdbc">
  <modify class-name="usr">
    <association idu=1, table=usr, schema=indirect</association>
    <modify-attr name="lname">
      <add-value>
        <value>DoeRaeMe</value>
      </add-value>
    </modify-attr>
  </modify>
</input>
```

```sql
jdbc:statement
  <jdbc:sql>UPDATE indirect.usr SET fname = 'John' WHERE idu = {$idu} </jdbc:sql>
</jdbc:statement>
```

Token placeholders must adhere to the XSLT attribute value template syntax `{ $field-name }`. Also, the referenced association element must precede the `<jdbc:statement>` element in the XDS document, or must be present as a child of the `<jdbc:statement>` element. Alternatively, instead of copying the association element as child of the `<jdbc:statement>` element, you could copy the src-entry-id of the element containing the association element onto the `<jdbc:statement>` element. Both approaches are bolded in the following examples:
The `{field-name}` token must refer to one of the naming RDN attribute names in the association value. The above examples have only one naming attribute: idu.

An `<add>` event is the only event where an association element is not required to precede embedded SQL statements with tokens because the association has not been created yet. Additionally, any embedded SQL statements using tokens must follow, not precede, the `<add>` event. For example:

```
<input xmlns:jdbc="urn:dirxml:jdbc">
  <add class-name="usr">
    <add-attr name="lname">
      <value>Doe</value>
    </add-attr>
  </add>
  <jdbc:statement>
    <jdbc:sql>UPDATE indirect.usr SET fname = 'John' WHERE idu = {$idu}</jdbc:sql>
  </jdbc:statement>
</input>
```

To prevent tracing of sensitive information, you can use the `{$$password}` token to refer to the contents of the immediately preceding `<password>` element within the same document. In the following example, the password token and the value it refers to are bolded:
Furthermore, you can also refer to the driver's database authentication password specified by the Application Password parameter as "{$$driver-password}". See "Application Password" on page 55. Named password substitution is not yet supported.

Just as with association elements, the referenced password element must precede the <jdbc:statement> element in the XDS document or must be present as a child of the <jdbc:statement> element. Alternatively, instead of copying the password element as child of the <jdbc:statement> element, you could copy the src-entry-id of the element containing the password element onto the <jdbc:statement> element. Both approaches are bolded in the following examples:

```xml
<jdbc:statement src-entry-id="0">
  <jdbc:sql>CREATE USER jdoe IDENTIFIED BY $$password</jdbc:sql>
</jdbc:statement>
</input>
```

```xml
<jdbc:statement src-entry-id="0">
  <jdbc:sql>CREATE USER jdoe IDENTIFIED BY $$password</jdbc:sql>
</jdbc:statement>
</input>
```
Virtual Triggers

In the same way that database triggers can fire before or after a triggering statement, embedded SQL can be positioned before or after the triggering XDS event. The following examples show how you can embed SQL before or after an XDS event.

Virtual Before Trigger

```xml
<input xmlns:jdbc="urn:dirxml:jdbc">
  <jdbc:statement>
    <association>idu=1,table=usr,schema=indirect</association>
    <jdbc:sql>UPDATE indirect.usr SET fname = 'John' WHERE idu = {$idu}</jdbc:sql>
  </jdbc:statement>
</input>
```

This XML resolves to:

```
SET AUTOCOMMIT OFF
UPDATE indirect.usr SET fname = 'John' WHERE idu = 1;
COMMIT; --explicit commit
UPDATE indirect.usr SET lname = 'Doe' WHERE idu = 1;
COMMIT; --explicit commit
```

Virtual After Trigger

```xml
<input xmlns:jdbc="urn:dirxml:jdbc">
  <modify class-name="usr">
    <association>idu=1,table=usr,schema=indirect</association>
    <modify-attr name="lname">
      <remove-all-values/>
      <add-value>
        <value>Doe</value>
      </add-value>
    </modify-attr>
  </modify>
  <jdbc:statement>
    <jdbc:sql>UPDATE indirect.usr SET fname = 'John' WHERE idu = {$idu}</jdbc:sql>
  </jdbc:statement>
</input>
```

This XML resolves to:

```
SET AUTOCOMMIT OFF
UPDATE indirect.usr SET lname = 'Doe' WHERE idu = 1;
COMMIT; --explicit commit
UPDATE indirect.usr SET fname = 'John' WHERE idu = 1;
COMMIT; --explicit commit
```
Manual vs. Automatic Transactions

You can manually group embedded SQL and XDS events by using two custom attributes:

- jdbc:transaction-type
- jdbc:transaction-id

jdbc:transaction-type

This attribute has two values: manual and auto. By default, most XDS events of interest (<add>, <modify>, and <delete>) are implicitly set to the manual transaction type. The manual setting enables XDS events to resolve to a transaction consisting of one or more SQL statement.

By default, embedded SQL events are set to auto transaction type because some SQL statements, such as DDL statements, cannot usually be included in a manual transaction. In the following example, the attribute is in bold text.

```xml
<input xmlns:jdbc="urn:dirxml:jdbc">
  <add class-name="usr" jdbc:transaction-type="auto">
    <add-attr name="lname">Doe</add-attr>
  </add>
  <jdbc:statement>
    <jdbc:sql>UPDATE indirect.usr SET fname = 'John' WHERE idu = {$idu}</jdbc:sql>
  </jdbc:statement>
</input>
```

This XML resolves to:

```
SET AUTOCOMMIT ON
INSERT INTO indirect.usr(lname) VALUES('Doe');
-- implicit commit
UPDATE indirect.usr SET fname = 'John' WHERE idu = 1;
-- implicit commit
```

jdbc:transaction-id

The Subscriber channel ignores this attribute unless the element’s jdbc:transaction-type attribute value defaults to or is explicitly set to manual. The following XML shows an example of a manual transaction. The attribute is in bold text.

```xml
<input xmlns:jdbc="urn:dirxml:jdbc">
  <add class-name="usr" jdbc:transaction-id="0">
    <add-attr name="lname">Doe</add-attr>
  </add>
  <jdbc:statement jdbc:transaction-type="manual">
    <jdbc:sql>UPDATE indirect.usr SET fname = 'John' WHERE idu = {$idu}</jdbc:sql>
  </jdbc:statement>
</input>
```

This XML resolves to:
null
Table 12-1  Methods for Executing SQL Statements

<table>
<thead>
<tr>
<th>Statement Type</th>
<th>Method Executed</th>
</tr>
</thead>
<tbody>
<tr>
<td>SELECT</td>
<td>java.sql.Statement.executeQuery(String query):java.sql.ResultSet</td>
</tr>
<tr>
<td>INSERT</td>
<td>java.sql.Statement.executeUpdate(String update):int</td>
</tr>
<tr>
<td>UPDATE</td>
<td>java.sql.Statement.executeUpdate(String update):int</td>
</tr>
<tr>
<td>DELETE</td>
<td>java.sql.Statement.executeUpdate(String update):int</td>
</tr>
<tr>
<td>CALL or EXECUTE SELECT</td>
<td>java.sql.Statement.execute(String sql):boolean</td>
</tr>
<tr>
<td>INSERT UPDATE DELETE</td>
<td>java.sql.Statement.executeUpdate(String update):int</td>
</tr>
</tbody>
</table>

The simplest solution is to map all SQL statements to the `java.sql.Statement.execute(String sql):boolean` method. By default, the Subscriber channel uses this method.

Some third-party drivers, particularly Oracle’s JDBC drivers, incorrectly implement the methods used to determine the number of result sets that this method generates. Consequently, the driver can get caught in an infinite loop leading to high CPU utilization. To circumvent this problem, you can use the `jdbc:type` attribute on any `<jdbc:statement>` element to map the SQL statements contained in it to the following methods instead of the default method:

- `java.sql.Statement.executeQuery(String query):java.sql.ResultSet`
- `java.sql.Statement.executeUpdate(String update):int`

The `jdbc:type` attribute has two values: `update` and `query`. For INSERT, UPDATE, or DELETE statements, set the value to `update`. For SELECT statements, set the value to `query`. In the absence of this attribute, the driver maps all SQL statements to the default method. If placed on any element other than `<jdbc:statement>`, this attribute is ignored.

Recommendations:

- Place the `jdbc:type="query"` attribute value on all SELECT statements.
- Place the `jdbc:type="update"` attribute value on all INSERT, UPDATE, and DELETE statements.
- Place no attribute value on stored procedure/function calls.

The following XML shows an example of the `jdbc:type` attribute. The attribute is in bold text.

```
<input xmlns:jdbc="urn:dirxml:jdbc">
  <add class-name="usr">
    <add-attr name="lname">
      <value>Doe</value>
    </add-attr>
  </add>
  <jdbc:statement jdbc:type="update">
    <jdbc:sql>UPDATE indirect.usr SET fname = 'John'
      WHERE idu = {$idu}</jdbc:sql>
  </jdbc:statement>
</input>
```
SQL Queries

To fully support the query capabilities of a database and avoid the difficulty of translating native SQL queries into an XDS format, the driver supports native SQL query processing. You can embed select statements in XDS documents in exactly the same way as any other SQL statement.

For example, assume that the table `usr` has the following contents:

<table>
<thead>
<tr>
<th>idu</th>
<th>fname</th>
<th>lname</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>John</td>
<td>Doe</td>
</tr>
</tbody>
</table>

Table 12-2  Example Contents

The XML document below results in an output document containing a single result set.

```xml
<input xmlns:jdbc="urn:dirxml:jdbc">
  <jdbc:statement jdbc:type="query">
    <jdbc:sql>SELECT * FROM indirect.usr</jdbc:sql>
  </jdbc:statement>
</input>

<output xmlns:jdbc="urn:dirxml:jdbc">
  <jdbc:result-set jdbc:number-of-rows="1">
    <jdbc:row jdbc:number="1">
      <jdbc:column jdbc:name="idu" jdbc:position="1" jdbc:type="java.sql.Types.BIGINT">
        <jdbc:value>1</jdbc:value>
      </jdbc:column>
      <jdbc:column jdbc:name="fname" jdbc:position="2" jdbc:type="java.sql.Types.VARCHAR">
        <jdbc:value>John</jdbc:value>
      </jdbc:column>
      <jdbc:column jdbc:name="lname" jdbc:position="3" jdbc:type="java.sql.Types.VARCHAR">
        <jdbc:value>Doe</jdbc:value>
      </jdbc:column>
    </jdbc:row>
  </jdbc:result-set>
  <status level="success"/>
</output>
```

SQL queries always produce a single `<jdbc:result-set>` element whether or not the result set contains any rows. If the result set is empty, the `jdbc:number-of-rows` attribute is set to zero.

You can embed more than one query in a document. SQL queries don’t require that the referenced tables/views in the synchronization schema be visible to the driver. However, XDS queries do.

If you are building an event to be sent via the Command Processor instead of part of the regular event flow, you need to build the XML in a noderset variable and use the Parse XML token before issuing the command. For more information, see “XML Parse” in the *NetIQ Identity Manager - Using Designer to Create Policies*.

Example logic XML:
NOTE: The queries on the Publisher channel with srcCommandProcessor are scheduled for execution on the Subscriber channel and the script processing does not wait for the result to become available.

Data Definition Language (DDL) Statements

Generally, it is not possible to run a Data Definition Language (DDL) statement in a database trigger because most databases do not allow mixed DML and DDL transactions. Although virtual triggers do not overcome this transactional limitation, they do allow DDL statements to be executed as a side effect of an XDS event.

For example:
This XML resolves to:

```
SET AUTOCOMMIT OFF
INSERT INTO indirect.usr (fname, lname) VALUES('John', 'Doe');
COMMIT; -- explicit commit
SET AUTOCOMMIT ON
CREATE USER jdoe IDENTIFIED BY novell;
-- implicit commit
```

Using the `<jdbc:transaction-id>` and `<jdbc:transaction-type>` attributes to group DML and DDL statements into a single transaction causes the transaction to be rolled back on most databases. Because DDL statements are generally executed as separate transactions, it is possible that the `insert` statement in the above example might succeed and the `create user` statement might roll back.

It is not possible, however, that the `insert` statement fails and the `create user` statement succeeds. The driver stops executing chained transactions at the point where the first transaction is rolled back.

**Logical Operations**

Because it is not generally possible to mix DML and DDL statements in a single transaction, a single event can consist of one or more transactions. You can use the `<jdbc:op-id>` and `<jdbc:op-type>` to group multiple transactions together into a single logical operation. When grouped in this way, all members of the operation are handled as a single unit with regard to status. If one member has an error, all members return the same status level. Similarly, all members share the same status type.

```
<add class-name="usr" jdbc:op-id="0" jdbc:op-type="password-set-operation">
    <add-attr name="fname">
        <value>John</value>
    </add-attr>
    <add-attr name="lname">
        <value>Doe</value>
    </add-attr>
    <password>Doe{$idu}</password>
</add>
</input>

<jdbc:statement jdbc:op-id="0">
    <jdbc:sql>CREATE USER jdoe IDENTIFIED BY {$$password}</jdbc:sql>
</jdbc:statement>
```

The `<jdbc:op-type>` attribute is ignored on all elements except the first element in a logical operation.
Implementing Password Set with Embedded SQL

Initially setting a password is usually accomplished by creating a database user account. Assuming that an `<add>` event is generated on the Subscriber channel, the following is an example of the output generated by XSLT style sheets that implement password set as a side effect of an XDS `<add>` event:

```xml
<add class-name="usr" jdbc:op-id="0"
     jdbc:op-type="password-set-operation">
  <add-attr name="fname">
    <value>John</value>
  </add-attr>
  <add-attr name="lname">
    <value>Doe</value>
  </add-attr>
  <password>Doe{$idu}</password>
</add>
<jdbc:statement jdbc:op-id="0">
  <jdbc:sql>CREATE USER jdoe IDENTIFIED BY {$$password}</jdbc:sql>
</jdbc:statement>
</input>
```

The `<add>` event is logically bound to the `CREATE USER` DDL statement by the `jdbc:op-id` and `jdbc:op-type` attributes.

The User DDL Command Transformation style sheet in the `example.xml` configuration file contains sample XSLT templates that bind user account creation DDL statements to `<add>` events for all databases that support them.

Implementing Modify Password with Embedded SQL

Modifying a password is usually accomplished by altering an existing database user account. Assuming that a `<modify-password>` event is generated on the Subscriber channel, the following is an example of the output generated by XSLT style sheets that implement modify-password:

```xml
<modify-password jdbc:op-id="0"
    jdbc:op-type="password-set-operation">
  <password>new password</password>
</modify-password>
<jdbc:statement jdbc:op-id="0">
  <jdbc:sql>ALTER USER jdoe IDENTIFIED BY {$$password}</jdbc:sql>
</jdbc:statement>
</input>
```

**NOTE:** Some databases, such as Sybase Adaptive Server Enterprise and Microsoft SQL Server, differentiate between user account names and login account names. Therefore, you might need to supply the login name instead of the username.

The `<modify-password>` event is logically bound to the `ALTER USER` DDL statement by the `jdbc:op-id` and `jdbc:op-type` attributes.

The User DDL Command Transformation style sheet in the `example.xml` configuration contains sample XSLT templates that bind password maintenance DDL statements to `<modify-password>` events for all databases that support them.
Implementing Check Object Password

Unlike password set, check object password does not require embedded SQL statements or attributes. Only a user account name is required. This could be obtained from an association value (assuming that associations are being maintained manually), a directory attribute, or a database field. If stored in the directory or database, a query must be issued to retrieve the value.

The example .xml configuration file stores database user account names in database fields.

**NOTE:** Some databases, such as Sybase Adaptive Server Enterprise and Microsoft SQL Server, differentiate between user account names and login account names. Therefore, you might need to store two names, not just one.

To implement check object password, append a `dest-dn` attribute value to the `<check-object-password>` event. In the following example, the `dest-dn` attribute is bolded:

```xml
<input xmlns:jdbc="urn:dirxml:jdbc">
  <check-object-password dest-dn="jdoe">
    <password>whatever</password>
  </check-object-password>
</input>
```

Calling Stored Procedures and Functions

The JDBC driver enables you to use stored procedures. The ability to use the `<jdbc:call-procedure>` and `<jdbc:call-function>` elements to call stored procedures from a policy has been tested only against Oracle and is supported only on that platform.

- “Using Embedded SQL to Call Stored Procedures or Functions” on page 146
- “Using the jdbc:call-procedure Element” on page 147
- “Using the jdbc:call-function Element” on page 151

Using Embedded SQL to Call Stored Procedures or Functions

You can call stored procedures or functions in one of two ways:

- Call the procedure or function by using a Statement object.
- Call the procedure by using a Callable Statement object.

**Example 1: Calling a Stored Procedure by Using a Statement**

```
<!-- call syntax is Oracle -->
<jdbc:statement>
  <jdbc:sql>CALL schema.procedure-name</jdbc:sql/>
</jdbc:statement>
```

**Example 2: Calling a Stored Procedure as a CallableStatement**

```
<!-- call syntax is vendor agnostic -->
<jdbc:statement>
  <jdbc:call-procedure jdbc:name="schema.procedure-name"/>
</jdbc:statement>
```
Example 3: Calling a Function by Using a Statement

```xml
<!-- call syntax is Informix -->
<jdbc:statement>
    <jdbc:sql>EXECUTE FUNCTION schema.function-name</jdbc:sql/>
</jdbc:statement>
```

Example 4: Calling a Function as a CallableStatement

```xml
<!-- call syntax is vendor agnostic -->
<jdbc:statement>
    <jdbc:call-function jdbc:name="schema.function-name"/>
</jdbc:statement>
```

The principle advantage of using the CallableStatement interface is that you do not need to know the proprietary call syntaxes of each database vendor or JDBC implementation. Other advantages include the following:

- It's much easier to build procedure or function calls in the Policy Builder.
- You can differentiate between Null and empty string parameter values.
- You can call functions on all database platforms.
  - Oracle, for instance, doesn't support calling functions by using a statement.
- You can retrieve Out parameter values from stored procedure calls.

Using the jdbc:call-procedure Element

Stored procedures do not necessarily require parameters. Only a name is required. If a database supports schemas, we recommend that you schema-qualify the name. If a schema qualifier isn't provided, how names are resolved depends upon your third-party JDBC implementation and might change, depending upon driver configuration settings.

The jdbc:call-procedure element must be wrapped in a jdbc:statement element.

- “Specifying a Procedure Name” on page 147
- “Passing In or In Out Parameter Values” on page 147
- “Handling Out or In Out Parameters” on page 149
- “Example Complex Stored Procedure Calls” on page 150

Specifying a Procedure Name

```xml
<jdbc:call-procedure jdbc:name="schema.procedure-name"/>
```

Passing In or In Out Parameter Values

The number of jdbc:param elements specified must match the number of param elements declared in the procedure. Only jdbc:param elements corresponding to In or In Out procedure parameters can have values. Out parameters (those that can't be passed values) must be represented by an empty jdbc:param element.

- “Calling a Procedure with No Parameters” on page 148
- “Calling a Procedure with a Null Parameter” on page 148
- “Calling a Procedure with an Empty String Parameter” on page 148
Embedded SQL Statements in XDS Events

- “Calling a Procedure with a Literal Value” on page 148
- “Calling a Procedure with an Out Parameter” on page 148

**Calling a Procedure with No Parameters**

```xml
<jdbc:statement>
  <jdbc:call-procedure jdbc:name="schema.procedure-name"/>
</jdbc:statement>
```

**Calling a Procedure with a Null Parameter**

```xml
<jdbc:call-procedure jdbc:name="schema.procedure-name">
  <!-- no value element = pass null -->
  <jdbc:param/>
</jdbc:call-procedure>
```

**Calling a Procedure with an Empty String Parameter**

```xml
<jdbc:call-procedure jdbc:name="schema.procedure-name">
  <!-- empty value element = pass empty string -->
  <jdbc:param>
    <jdbc:value/>
  </jdbc:param>
</jdbc:call-procedure>
```

Literals can be passed only to procedure parameters declared as In or In Out. Passed literals must be type-compatible with declared procedure parameters.

**Calling a Procedure with a Literal Value**

```xml
<jdbc:call-procedure jdbc:name="schema.procedure-name">
  <!-- non-empty value element = pass literal -->
  <jdbc:param>
    <jdbc:value>literal</jdbc:value>
  </jdbc:param>
</jdbc:call-procedure>
```

**Calling a Procedure with an Out Parameter**

Assuming that a procedure has two parameters, the first Out and the second In, you invoke the procedure as follows:

```xml
<jdbc:call-procedure jdbc:name="schema.procedure-name">
  <!-- the OUT param place -->
  <jdbc:param/>
  <!-- the IN param -->
  <jdbc:param>
    <jdbc:value>literal</jdbc:value>
  </jdbc:param>
</jdbc:call-procedure>
```
Handling Out or In Out Parameters

Stored procedures with Out or In Out parameters can return values. These values are returned by the driver and are accessible to policies. Out or In Out parameters values are returned at the same position as their corresponding declared parameter.

Also, to facilitate correlation of procedure calls and output parameter values, Out parameters contain the same event-ID value as the procedure call that generated them. This is particularly useful when multiple calls are made in the same document.

- "Null or No Return Value" on page 149
- "Empty String Return Value" on page 149
- "Literal Return Value" on page 149

Null or No Return Value

Assuming that a procedure has a single Out or In parameter, the following output is generated:

```xml
<output>
    <!-- no value element = OUT param returned null or IN param -->
    <jdbc:out-parameters event-id="0" jdbc:number-of-params="1">
        <jdbc:param/>
    </jdbc:out-parameters>
    <status event-id="0" level="success"/>
</output>
```

Empty String Return Value

Assuming that a procedure has a single Out or In Out parameter, the following output is generated:

```xml
<output>
    <!-- empty value element = returned empty string -->
    <jdbc:out-parameters event-id="0" jdbc:number-of-params="1">
        <jdbc:param>
            <jdbc:value/>
        </jdbc:param>
    </jdbc:out-parameters>
    <status event-id="0" level="success"/>
</output>
```

Literal Return Value

Assuming that a procedure has a single Out or In Out parameter, the following output is generated:

```xml
<output>
    <!-- no-empty value element = returned literal value -->
    <jdbc:out-parameters event-id="0" jdbc:number-of-params="2">
        <jdbc:param>
            <jdbc:value>literal</jdbc:value>
        </jdbc:param>
    </jdbc:out-parameters>
    <status event-id="0" level="success"/>
</output>
```
Example Complex Stored Procedure Calls

- “Procedure Declaration” on page 150
- “Procedure Call from Policy” on page 150
- “Procedure Output to Policy” on page 151

Procedure Declaration

This procedure uses Oracle PSQL syntax.

CREATE PROCEDURE indirect.p1(i1 IN VARCHAR2, io2 IN OUT VARCHAR2, o3 OUT INTEGER, i4 IN VARCHAR2) AS BEGIN
SELECT 'literal' INTO io2 FROM DUAL;
SELECT 1 INTO o3 FROM DUAL;
END p1;

Procedure Call from Policy

```xml
<jdbc:statement event-id="0">
  <jdbc:call-procedure jdbc:name="indirect.p1">
    <!-- i1 IN VARCHAR2 -->
    <jdbc:param>
      <!-- pass empty string -->
      <jdbc:value/>
    </jdbc:param>
    <!-- io2 IN OUT VARCHAR2 -->
    <jdbc:param>
      <!-- pass literal -->
      <jdbc:value>literal</jdbc:value>
    </jdbc:param>
    <!-- o3 OUT INTEGER -->
    <jdbc:param/>
    <!-- param placeholder -->
    <jdbc:param/>
    <!-- o4 IN VARCHAR2 -->
    <jdbc:param/>
    <!-- pass null -->
    <jdbc:param/>
  </jdbc:call-procedure>
</jdbc:statement>
```
Procedure Output to Policy

<output>
  <jdbc:out-parameters event-id="0" jdbc:number-of-params="2">
    <jdbc:param>
      <jdbc:param jdbc:name="IO2"
        jdbc:param-type="INOUT"
        jdbc:position="2"
        jdbc:sql-type="java.sql.Types.VARCHAR">
        <jdbc:value>literal</jdbc:value>
    </jdbc:param>
    <jdbc:param jdbc:name="O3"
      jdbc:param-type="OUT"
      jdbc:position="3"
      jdbc:sql-type="java.sql.Types.DECIMAL">
      <jdbc:value>1</jdbc:value>
    </jdbc:param>
  </jdbc:out-parameters>
  <status event-id="0" level="success"/>
</output>

Using the jdbc:call-function Element

Functions do not necessarily require parameters. Only a name is required. If a database supports schemas, we recommend that you schema-qualify the name. If a schema qualifier isn't provided, how names are resolved depends upon your third-party JDBC implementation and might change depending upon driver configuration settings.

The jdbc:call-function element must be wrapped in a jdbc:statement element.

- “Specifying a Function Name” on page 151
- “Passing In Parameter Values” on page 151
- “Calling a Function with No Parameter” on page 151
- “Calling a Function with a Null Parameter” on page 152
- “Calling a Function with an Empty String Parameter” on page 152
- “Calling a Function with a Literal Value” on page 152
- “Handling Function Results” on page 152
- “Example Complex Function Calls” on page 154

Specifying a Function Name

  <jdbc:call-function jdbc:name="schema.function-name"/>

Passing In Parameter Values

The number of jdbc:param elements specified must match the number of params declared in the function.

Calling a Function with No Parameter

  <jdbc:call-function jdbc:name="schema.function-name"/>
Calling a Function with a Null Parameter

```
<jdbc:call-function jdbc:name="schema.function-name">
   <!-- no value element = null -->
   <jdbc:param/>
</jdbc:call-procedure>
```

Calling a Function with an Empty String Parameter

```
<jdbc:call-function jdbc:name="schema.function-name">
   <!-- empty value element = pass empty string -->
   <jdbc:param>
      <jdbc:value/>
   </jdbc:param>
   <jdbc:param>
</jdbc:call-procedure>
```

Literals can be passed to function parameters declared as In. Passed literals must be type-compatible with declared function parameters.

Calling a Function with a Literal Value

```
<jdbc:call-function jdbc:name="schema.function-name">
   <!-- non-empty value element = pass literal -->
   <jdbc:param>
      <jdbc:value>literal</jdbc:value>
   </jdbc:param>
   <jdbc:param>
</jdbc:call-procedure>
```

Handling Function Results

Unlike stored procedures, functions do not support Out or In Out parameters. They can, however, return a single, scalar value (such as an integer or string) or return a result set. Also, to facilitate correlation of function calls and results, results contain the same event-id value as the function call that generated them. This is particularly useful when multiple calls are made in the same document.

- “Scalar Return Value” on page 152
- “Empty Set” on page 153
- “Non-Empty Results Set” on page 153
- “Multiple Result Sets” on page 153
- “Oracle Results Set” on page 153
- “Returning Result Sets as Out Parameters” on page 153
- “Special Attributes” on page 154

Scalar Return Value

Scalar return values are returned by using the same syntax as stored procedure Out parameters. The scalar return value is always returned in the first parameter position.

```
<output>
   <jdbc:out-parameters event-id="0" jdbc:number-of-params="1">
      <jdbc:param jdbc:name="return value"
```


Empty Set

Assuming that a function returns no results set or an empty result set, the following output is generated:

```xml
<output>
  <jdbc:result-set event-id="0" jdbc:number-of-rows="0"/>
  <status event-id="0" level="success"/>
</output>
```

Non-Empty Results Set

Assuming a function returns a non-empty result set, output similar to the following is generated:

```xml
<output>
  <jdbc:result-set event-id="0" jdbc:number-of-rows="1">
    <jdbc:row jdbc:number="1">
      <jdbc:column jdbc:name="SYSDATE" jdbc:position="1" jdbc:type="java.sql.Types.TIMESTAMP">
        <jdbc:value>2007-01-03 14:52:20.0</jdbc:value>
      </jdbc:column>
    </jdbc:row>
  </jdbc:result-set>
  <status event-id="0" level="success"/>
</output>
```

Multiple Result Sets

Multiple result sets are returned in the order returned by the function. They all share a common event-id value.

```xml
<output>
  <jdbc:result-set event-id="0" jdbc:number-of-rows="0"/>
  <jdbc:result-set event-id="0" jdbc:number-of-rows="0"/>
  <status event-id="0" level="success"/>
</output>
```

Oracle Results Set

Oracle's JDBC implementation uses a proprietary mechanism to return a single result set from a function. To return a result set from an Oracle function, you need to explicitly set the `jdbc:return-type` value to `OracleTypes.CURSOR` on the `jdbc:call-function` element.

Returning Result Sets as Out Parameters

See the special attribute "jdbc:return-format" on page 154.
Special Attributes

jdbc:return-format

This attribute can be placed on the jdbc:call-function element to format the first row of a returned results set as stored procedure Out parameters of the result.

This works only when the jdbc:return-type attribute isn't used.

```xml
<jdbc:statement>
  <jdbc:call-function jdbc:name="schema.function-name"
    jdbc:return-format="return value">
  </jdbc:call-function>
</jdbc:statement>
</input>
```

jdbc:return-type

This attribute can be placed on the jdbc:call-function element to allow Oracle functions to return a result set.

```xml
<jdbc:statement>
  <jdbc:call-function jdbc:name="schema.function"
    return-type="OracleTypes.CURSOR">
  </jdbc:call-function>
</jdbc:statement>
</input>
```

Example Complex Function Calls

- “Function Declaration” on page 154
- “Function Call from a Policy” on page 154
- “Function Results to a Policy” on page 155

Function Declaration

This declaration is for Oracle PSQL syntax.

```sql
CREATE OR REPLACE FUNCTION indirect.f1(i1 IN VARCHAR2, i2 IN INTEGER)
  RETURN VARCHAR2
AS
  o_idu VARCHAR2(32);
BEGIN
  SELECT 'literal' INTO o_idu FROM DUAL;
  RETURN o_idu;
END f1;
```

Function Call from a Policy

```xml
<jdbc:statement>
  <jdbc:call-function
    jdbc:name="schema.function"
    return-type="OracleTypes.CURSOR">
  </jdbc:call-function>
</jdbc:statement>
```
Function Results to a Policy

<output>
  <jdbc:out-parameters event-id="0" jdbc:number-of-params="1">
    <jdbc:param jdbc:name="return value"
      jdbc:param-type="OUT"
      jdbc:position="1"
      jdbc:sql-type="java.sql.Types.VARCHAR">
      <jdbc:value>literal</jdbc:value>
    </jdbc:param>
  </jdbc:out-parameters>
  <status event-id="0" level="success"/>
</output>

Best Practices

For performance reasons, it is better to call a single stored procedure/function that contains multiple SQL statements than to embed multiple statements in an XDS document.

In the following examples, the single stored procedure or function is preferred.

Single Stored Procedure

<input xmlns:jdbc="urn:dirxml:jdbc">
  <add class-name="usr">
    <add-attr name="fname">
      <value>John</value>
    </add-attr>
    <add-attr name="lname">
      <value>Doe</value>
    </add-attr>
  </add>
  <jdbc:statement>
    <jdbc:sql>CALL PROCEDURE set_name('John', 'Doe')</jdbc:sql>
  </jdbc:statement>
</input>
Multiple Embedded Statements

```xml
<input xmlns:jdbc="urn:dirxml:jdbc">
  <add class-name="usr">
    <add-attr name="lname">
      <value>Doe</value>
    </add-attr>
  </add>
  <jdbc:statement>
    <jdbc:sql>UPDATE indirect.usr SET fname = 'John' WHERE idu = {$idu}</jdbc:sql>
  </jdbc:statement>
  <jdbc:statement>
    <jdbc:sql>UPDATE indirect.usr SET lname = 'Doe' WHERE idu = {$idu}</jdbc:sql>
  </jdbc:statement>
</input>
```

The syntax used to call stored procedures or functions varies by database. For additional information, see "Syntaxes for Calling Stored Procedures and Functions" on page 160.
13 Supported Databases

- “Database Interoperability” on page 157
- “Supported Databases” on page 157
- "Database Characteristics" on page 158

Database Interoperability

The Identity Manager Driver for JDBC is designed to inter-operate with a specific set of JDBC driver implementations, instead of a specific set of databases. Consequently, the list of supported databases is primarily driven by the capabilities of supported third-party JDBC drivers. A secondary factor is testing resources.

Supported Databases

The following databases or database versions have been tested and are recommended for use with this product:

Table 13-1  Supported Databases

<table>
<thead>
<tr>
<th>Database</th>
<th>Minor Version</th>
</tr>
</thead>
<tbody>
<tr>
<td>IBM DB2 Universal Database (UDB)</td>
<td>9.0 or later</td>
</tr>
<tr>
<td>Informix Dynamic Server (IDS)</td>
<td>11.0 or later</td>
</tr>
<tr>
<td>MySQL</td>
<td>5.5.x or later</td>
</tr>
<tr>
<td></td>
<td>5.6.x or later</td>
</tr>
<tr>
<td>Oracle</td>
<td>11g Release 2 (11.2) or later, 12c</td>
</tr>
<tr>
<td>PostgreSQL</td>
<td>9.4.x or later</td>
</tr>
<tr>
<td></td>
<td>9.5.x or later</td>
</tr>
<tr>
<td></td>
<td>9.6.x or later</td>
</tr>
<tr>
<td></td>
<td>10.x or later</td>
</tr>
<tr>
<td></td>
<td>9.6.3</td>
</tr>
<tr>
<td>Sybase Adaptive Server Enterprise (ASE)</td>
<td>15.0 or later</td>
</tr>
<tr>
<td>MariaDB</td>
<td>10.2.13</td>
</tr>
</tbody>
</table>
You can use the JDBC driver with other databases or database versions. However, NetIQ does not support them. To interoperate with the JDBC driver, a database must meet the following requirements:

- Support the SQL-92 entry level grammar.
- Be JDBC-accessible.

## Database Characteristics

- "Database Features" on page 158
- "Current Time Stamp Statements" on page 159
- "Syntaxes for Calling Stored Procedures and Functions" on page 160
- "Left Outer Join Operators" on page 160
- "Undelimited Identifier Case Sensitivity" on page 161
- "Supported Transaction Isolation Levels" on page 161
- "Commit Keywords" on page 162
- "IBM DB2 Universal Database (UDB)" on page 162
- "Informix Dynamic Server (IDS)" on page 163
- "Microsoft SQL Server" on page 164
- "MySQL/MariaDB" on page 165
- "Oracle" on page 166
- "PostgreSQL" on page 167
- "Sybase Adaptive Server Enterprise (ASE)" on page 167

## Database Features

**Table 13-2 Database Features**

<table>
<thead>
<tr>
<th>Database</th>
<th>Schemas</th>
<th>Views</th>
<th>Identity Columns</th>
<th>Sequences</th>
<th>Stored Procedures</th>
<th>Functions</th>
<th>Triggers</th>
<th>Instead-Of-Triggers</th>
</tr>
</thead>
<tbody>
<tr>
<td>IBM DB2</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>N</td>
<td>Y(^1)</td>
<td>Y(^1)</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>UDB 9.x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Informix</td>
<td>Y</td>
<td>Y</td>
<td>Y(^2)</td>
<td>N</td>
<td>Y(^3)</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>IDS 11.x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MS SQL</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>N</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>MySQL</td>
<td>Y</td>
<td>Y</td>
<td>Y(^4)</td>
<td>N</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>N</td>
</tr>
<tr>
<td>5.5.x and 5.6.x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
1 DB2 natively supports stored procedures or functions written in Java. To write procedures by using the native SQL procedural language, install a C compiler on the database server.

2 The Informix identity column keyword is SERIAL8.

3 Informix stored procedures cannot return values through OUT parameters.

4 The identity column keyword is AUTO_INCREMENT for MySQL and MariaDB.

5 You can use a PostgreSQL sequence object to provide default values for primary key columns, effectively simulating an identity column.

6 PostgreSQL has a native construct called rules. This construct can be used to effectively simulate triggers and instead-of-triggers. It also supports the use of triggers or instead-of-triggers written in a variety of procedural programming languages.

**Current Time Stamp Statements**

The following table lists SQL statements used to retrieve the current date and time by database:
Table 13-3  Time Stamp Statements

<table>
<thead>
<tr>
<th>Database</th>
<th>Current Time Stamp Statement</th>
<th>ANSI-Compliant</th>
</tr>
</thead>
<tbody>
<tr>
<td>IBM DB2 UDB</td>
<td>SELECT (CURRENT_TIMESTAMP) FROM SYSIBM.SYSDUMMY1 FETCH FIRST 1 ROW ONLY</td>
<td>No</td>
</tr>
<tr>
<td>Informix IDS</td>
<td>SELECT FIRST 1 (CURRENT YEAR TO FRACTION(5)) FROM INFORMIX.SYSTABLES</td>
<td>No</td>
</tr>
<tr>
<td>MSSQL</td>
<td>SELECT (CURRENT_TIMESTAMP)</td>
<td>Yes</td>
</tr>
<tr>
<td>MySQL/MariaDB</td>
<td>SELECT (CURRENT_TIMESTAMP)</td>
<td>Yes</td>
</tr>
<tr>
<td>Oracle</td>
<td>SELECT (SYSDATE) FROM SYS.DUAL</td>
<td>No</td>
</tr>
<tr>
<td>PostgreSQL</td>
<td>SELECT (CURRENT_TIMESTAMP)</td>
<td>Yes</td>
</tr>
<tr>
<td>Sybase ASE</td>
<td>SELECT GETDATE()</td>
<td>No</td>
</tr>
</tbody>
</table>

Syntaxes for Calling Stored Procedures and Functions

The following table lists the syntaxes for calling a stored procedure or function by database vendor. There’s also a vendor-neutral JDBC escape syntax (see JDBC Escape Syntax (http://edocs.bea.com/wls/docs81/jdbc_drivers/sqlescape.html)). Whenever possible, it is more secure to call a stored procedure or function by using the jdbc:call-function or jdbc:call-procedure syntax. See “Calling Stored Procedures and Functions” on page 146.) Other syntaxes should be used only when specifying procedure or function calls in driver parameters (for example, “Post Polling Statements” on page 93 and “Connection Initialization Statements” on page 66).

Table 13-4  Calling a Stored Procedure or Function

<table>
<thead>
<tr>
<th>Database</th>
<th>Stored Procedure/Function JDBC Call Syntax</th>
</tr>
</thead>
<tbody>
<tr>
<td>IBM DB2 UDB</td>
<td>{call schema-name.procedure-name(parameter-list)}</td>
</tr>
<tr>
<td>Informix IDS</td>
<td>EXECUTE [PROCEDURE</td>
</tr>
<tr>
<td>MSSQL</td>
<td>EXECUTE schema-name.procedure-name(parameter-list)</td>
</tr>
<tr>
<td>MySQL/MariaDB</td>
<td>CALL schema-name.procedure-name(parameter-list)</td>
</tr>
<tr>
<td>Oracle</td>
<td>CALL schema-name.procedure-name(parameter-list)</td>
</tr>
<tr>
<td>PostgreSQL</td>
<td>SELECT schema-name.procedure-name(parameter-list)</td>
</tr>
<tr>
<td>Sybase ASE</td>
<td>EXECUTE schema-name.procedure-name(parameter-list)</td>
</tr>
</tbody>
</table>

1 Oracle’s JDBC implementation does not support calling functions as a string.

Left Outer Join Operators

The following table lists outer join operators by database.
Table 13-5  Outer Join Operators

<table>
<thead>
<tr>
<th>Database</th>
<th>Left Outer Join Operator</th>
<th>ANSI-Compliant</th>
</tr>
</thead>
<tbody>
<tr>
<td>IBM DB2 UDB</td>
<td>LEFT OUTER JOIN</td>
<td>Yes</td>
</tr>
<tr>
<td>Informix IDS</td>
<td>LEFT OUTER JOIN</td>
<td>Yes</td>
</tr>
<tr>
<td>MSSQL 2005</td>
<td>LEFT OUTER JOIN</td>
<td>Yes</td>
</tr>
<tr>
<td>MySQL/MariaDB</td>
<td>LEFT OUTER JOIN</td>
<td>Yes</td>
</tr>
<tr>
<td>Oracle</td>
<td>LEFT OUTER JOIN</td>
<td>Yes</td>
</tr>
<tr>
<td>PostgreSQL</td>
<td>LEFT OUTER JOIN</td>
<td>Yes</td>
</tr>
<tr>
<td>Sybase ASE</td>
<td>*=</td>
<td>No</td>
</tr>
</tbody>
</table>

Undelimited Identifier Case Sensitivity

Table 13-6  Case Sensitivity for Undelimited Identifiers

<table>
<thead>
<tr>
<th>Database</th>
<th>Case-Sensitive?</th>
</tr>
</thead>
<tbody>
<tr>
<td>IBM DB2 UDB</td>
<td>No</td>
</tr>
<tr>
<td>Informix IDS</td>
<td>No</td>
</tr>
<tr>
<td>MSSQL</td>
<td>No</td>
</tr>
<tr>
<td>MySQL/MariaDB</td>
<td>Yes</td>
</tr>
<tr>
<td>Oracle</td>
<td>No</td>
</tr>
<tr>
<td>PostgreSQL</td>
<td>No</td>
</tr>
<tr>
<td>Sybase ASE</td>
<td>Yes</td>
</tr>
</tbody>
</table>

Supported Transaction Isolation Levels

Table 13-7  Supported Transaction Isolation Levels

<table>
<thead>
<tr>
<th>Database</th>
<th>None</th>
<th>Read Uncommitted</th>
<th>Read Committed</th>
<th>Repeatable Read</th>
<th>Serializable</th>
<th>URL</th>
</tr>
</thead>
<tbody>
<tr>
<td>IBM DB2 UDB</td>
<td>N</td>
<td>Y</td>
<td>Y¹</td>
<td>Y</td>
<td>Y</td>
<td></td>
</tr>
</tbody>
</table>

Supported Databases

1 This is the default isolation level for this database. 2 Can be set, but it is aliased to a supported isolation level.

Commit Keywords

The following table identifies the commit keywords for supported databases:

<table>
<thead>
<tr>
<th>Database</th>
<th>Commit Keyword</th>
</tr>
</thead>
<tbody>
<tr>
<td>IBM DB2 UDB</td>
<td>COMMIT</td>
</tr>
<tr>
<td>Informix IDS</td>
<td>COMMIT WORK(^1)</td>
</tr>
<tr>
<td>MSSQL</td>
<td>GO</td>
</tr>
<tr>
<td>MySQL/MariaDB</td>
<td>COMMIT</td>
</tr>
<tr>
<td>Oracle</td>
<td>COMMIT</td>
</tr>
<tr>
<td>PostgreSQL</td>
<td>COMMIT</td>
</tr>
<tr>
<td>Sybase ASE</td>
<td>GO</td>
</tr>
</tbody>
</table>

\(^1\) For logging and ANSI-compliant databases. Non-logging databases do not support transactions.

IBM DB2 Universal Database (UDB)

- “Database Properties” on page 163
- “Dynamic Defaults” on page 163
- “Known Issues” on page 163
Database Properties

Table 13-9  Properties for IBM DB2 UDB

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current Timestamp Statement</td>
<td>SELECT (CURRENT TIMESTAMP) FROM SYSIBM.SYSDUMMY1 FETCH FIRST 1 ROW ONLY</td>
</tr>
<tr>
<td>Case-Sensitive?</td>
<td>No</td>
</tr>
<tr>
<td>Commit Keyword</td>
<td>COMMIT</td>
</tr>
<tr>
<td>Left Outer Join Operator</td>
<td>LEFT OUTER JOIN</td>
</tr>
</tbody>
</table>

Dynamic Defaults

The following table lists database compatibility parameters that the JDBC driver implicitly sets at runtime. Do not explicitly override these settings.

Table 13-10  Dynamically Configured IBM DB2 Universal Database Settings

<table>
<thead>
<tr>
<th>Display Name</th>
<th>Tag Name</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current Timestamp Statement:</td>
<td>current-timestamp-</td>
<td>SELECT (CURRENT TIMESTAMP) FROM SYSIBM.SYSDUMMY1 FETCH FIRST 1 ROW ONLY</td>
</tr>
<tr>
<td>Timestamp Translator class:</td>
<td>time-translator-class</td>
<td>com.novell.nds.dirxml.driver.jdbc.db.DB2Timestamp</td>
</tr>
</tbody>
</table>

Known Issues

The timestamp format is proprietary. See “Known Issues” on page 168.

Informix Dynamic Server (IDS)

- “Database Properties” on page 164
- “Dynamic Defaults” on page 164
- “Known Issues” on page 164
Database Properties

Table 13-11  Settings for Informix Dynamic Server

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current Timestamp Statement</td>
<td>SELECT FIRST 1 (CURRENT YEAR TO FRACTION(5)) FROM INFORMIX.SYSTABLES</td>
</tr>
<tr>
<td>Case-Sensitive?</td>
<td>No</td>
</tr>
<tr>
<td>Commit Keyword</td>
<td>COMMIT WORK¹</td>
</tr>
<tr>
<td>Left Outer Join Operator</td>
<td>LEFT OUTER JOIN</td>
</tr>
</tbody>
</table>

¹ For logging and ANSI-compliant databases. Nonlogging databases do not support transactions.

Dynamic Defaults

The following table lists database compatibility parameters that the JDBC driver implicitly sets at runtime. Do not explicitly overwrite these settings.

Table 13-12  Dynamically Configured Informix Dynamic Server Settings

<table>
<thead>
<tr>
<th>Display Name</th>
<th>Tag Name</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current Timestamp</td>
<td>current-timestamp-stmt</td>
<td>SELECT FIRST 1 (CURRENT YEAR TO FRACTION(5)) FROM INFORMIX.SYSTABLES</td>
</tr>
</tbody>
</table>

Known Issues

- NUMERIC or DECIMAL columns cannot be used as primary keys unless the scale (the number of digits to the right of the decimal point) is explicitly set to 0 when the table is created. By default, the scale is set to 255.
- DBAs cannot grant privileges to objects they don’t own.

Microsoft SQL Server

- "Database Properties" on page 165
- "Dynamic Defaults" on page 165
Database Properties

Table 13-13  Settings for Microsoft SQL Server

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current Timestamp Statement</td>
<td>SELECT (CURRENT_TIMESTAMP)</td>
</tr>
<tr>
<td>Case-Sensitive?</td>
<td>No</td>
</tr>
<tr>
<td>Commit Keyword</td>
<td>GO</td>
</tr>
</tbody>
</table>

Dynamic Defaults

The following table lists database compatibility parameters that the JDBC driver implicitly sets at runtime. Do not explicitly overwrite these settings.

Table 13-14  Dynamically Configured Microsoft SQL Server Settings

<table>
<thead>
<tr>
<th>Display Name</th>
<th>Tag Name</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Add default values on insert?</td>
<td>add-default-values-on-view-insert</td>
<td>True</td>
</tr>
</tbody>
</table>

MySQL/MariaDB

- “Database Properties” on page 165
- “Dynamic Defaults” on page 166
- “Known Issues” on page 166

Database Properties

Table 13-15  Settings for MySQL/MariaDB

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current Timestamp Statement</td>
<td>SELECT (CURRENT_TIMESTAMP)</td>
</tr>
<tr>
<td>Case-Sensitive?</td>
<td>Yes</td>
</tr>
<tr>
<td>Commit Keyword</td>
<td>COMMIT</td>
</tr>
<tr>
<td>Left Outer Join Operator</td>
<td>LEFT OUTER JOIN</td>
</tr>
</tbody>
</table>
Dynamic Defaults

The following table lists database compatibility parameters that are dynamically configured at runtime for this database.

Table 13-16  Dynamically Configured MySQL/MariaDB Settings

<table>
<thead>
<tr>
<th>Display Name</th>
<th>Tag Name</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supports schemas in metadata retrieval?</td>
<td>supports-schemas-in-metadata-retrieval</td>
<td>false</td>
</tr>
</tbody>
</table>

Known Issues

- TIMESTAMP columns, when they are updated after being initially set to 0 or NULL, are always set to the current date and time. To compensate for this behavior, we recommend that you map Identity Vault Time and Timestamp syntaxes to DATETIME columns.

Oracle

- "Database Properties" on page 166
- "Dynamic Defaults" on page 166
- "Limitations" on page 167

Database Properties

Table 13-17  Settings for Oracle

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current Timestamp Statement</td>
<td>SELECT (SYSDATE) FROM SYS.DUAL</td>
</tr>
<tr>
<td>Case-Sensitive?</td>
<td>No</td>
</tr>
<tr>
<td>Commit Keyword</td>
<td>COMMIT</td>
</tr>
<tr>
<td>Left Outer Join Operator</td>
<td>(+)</td>
</tr>
</tbody>
</table>

Dynamic Defaults

The following table lists database compatibility parameters that the JDBC driver implicitly sets at runtime. Do not explicitly overwrite these settings.
**Table 13-18  Dynamically Configured Oracle Settings**

<table>
<thead>
<tr>
<th>Display Name</th>
<th>Tag Name</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Left outer-join operator</td>
<td>left-outer-join-operator</td>
<td>(+)</td>
</tr>
<tr>
<td>Exclude filter expression</td>
<td>exclude-table-filter</td>
<td>BIN$.{22}==$0</td>
</tr>
<tr>
<td>Lock statement generator class</td>
<td>lock-generator-class</td>
<td>com.novell.nds.dirxml.driver.jdbc.db.lock.OraLockGenerator</td>
</tr>
</tbody>
</table>

The default exclusion filter omits dropped tables from the synchronization schema.

**Limitations**

LONG, LONG RAW, and BLOB columns cannot be referenced in a trigger. You can’t reference columns of these types by using the :NEW qualifier in a trigger, including instead-of-triggers.

**PostgreSQL**

- “Database Properties” on page 167
- “Known Issues” on page 167

**Database Properties**

**Table 13-19  Settings for PostgreSQL**

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current Timestamp Statement</td>
<td>SELECT (CURRENT_TIMESTAMP)</td>
</tr>
<tr>
<td>Case-Sensitive?</td>
<td>No</td>
</tr>
<tr>
<td>Commit Keyword</td>
<td>COMMIT</td>
</tr>
<tr>
<td>Left Outer Join Operator</td>
<td>LEFT OUTER JOIN</td>
</tr>
</tbody>
</table>

**Known Issues**

PostgreSQL does not support `<check-object-password>` events. You control authentication by manually inserting entries into the `pg_hba.conf` file.

**Sybase Adaptive Server Enterprise (ASE)**

- “Database Properties” on page 168
- “Dynamic Defaults” on page 168
- “Known Issues” on page 168
Database Properties

Table 13-20  Settings for Sybase ASE

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current Timestamp Statement</td>
<td>SELECT GETDATE()</td>
</tr>
<tr>
<td>Case-Sensitive?</td>
<td>Yes</td>
</tr>
<tr>
<td>Commit Keyword</td>
<td>GO</td>
</tr>
<tr>
<td>Left Outer Join Operator</td>
<td>*=</td>
</tr>
</tbody>
</table>

Dynamic Defaults

The following table lists database compatibility parameters that the JDBC driver implicitly sets at runtime. Do not explicitly overwrite these settings.

Table 13-21  Dynamically Configured Sybase ASE Settings

<table>
<thead>
<tr>
<th>Display Name</th>
<th>Tag Name</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current timestamp statement</td>
<td>current-timestamp-stmt</td>
<td>SELECT GETDATE()</td>
</tr>
<tr>
<td>Left outer-join operator</td>
<td>left-outer-join-operator</td>
<td>*=</td>
</tr>
<tr>
<td>Timestamp Translator class</td>
<td>time-translator-class</td>
<td>com.novell.nds.dirxml.driver.jdbc.db.SybaseTimestamp</td>
</tr>
</tbody>
</table>

Known Issues

- Padding and truncation of binary values.

To ensure ANSI-compliant padding and truncation behavior for binary values, make sure that binary column types (other than IMAGE) meet the following criteria:
  - They are exactly the size of the eDirectory™ attribute that maps to them.
  - They are constrained NOT NULL.
  - They are added to the Publisher and Subscriber Creation policies.

If they are constrained NULL, trailing zeros, which are significant to eDirectory, are truncated. If binary columns exceed the size of their respective eDirectory attributes, extra 0s are appended to the value.

The recommended solution is to use only the IMAGE data type when synchronizing binary values.

- DATETIME fractions of a second are rounded. Sybase Timestamps are at best accurate to 1/300th of a second (approximately.003 seconds). The database server rounds to the nearest 1/300th of a second as opposed to the nearest 1/1000th of a second (.001 seconds or 1 millisecond).
- Timestamp formats are proprietary.
Third-Party JDBC Drivers

- “Third-Party JDBC Driver Interoperability” on page 169
- “Third-Party JDBC Driver Types” on page 169
- “Supported Third-Party JDBC Drivers (Recommended)” on page 170
- “Supported Third-Party JDBC Drivers (Not Recommended)” on page 184
- “Deprecated Third-Party JDBC Drivers” on page 189
- “Other Third-Party JDBC Drivers” on page 189
- “Security Issues” on page 190

Third-Party JDBC Driver Interoperability

The Identity Manager JDBC driver is designed to interoperate with a specific set of third-party JDBC drivers, instead of a specific set of databases. In fact, the third-party JDBC driver, not the database, is the primary determinant of whether the JDBC driver works against any given database. As a general rule, if the JDBC driver interoperates well with a given third-party JDBC driver, it interoperates well with databases and database versions that the third-party driver supports.

We strongly recommend that you use the third-party JDBC drivers supplied by major enterprise database vendors whenever possible, such as those listed in “Supported Third-Party JDBC Drivers (Recommended)” on page 170. They are usually free, mature, and known to interoperate well with the JDBC driver and the databases they target. You can use other third-party drivers, but NetIQ does not support them.

In general, most third-party drivers are backward compatible. However, even if they are backward compatible, they are generally not forward compatible. Anytime a database server is upgraded, the third-party driver used with this product should probably be updated as well.

Also, as a general rule, we recommend that you use the latest version of a third-party driver, unless otherwise noted.

Third-Party JDBC Driver Types

The following sections describe four third-party JDBC driver types and explains the recommended type for use with the Identity Manager JDBC driver:

- “Driver Types” on page 169
- “Which Type To Use?” on page 170

Driver Types

There are four types of third-party drivers:

- **Type 1**: A third-party JDBC driver that is partially Java and communicates indirectly with a database server through a native ODBC driver.
Type 1 drivers serve as a JDBC-ODBC bridge. Sun provides a JDBC-ODBC bridge driver for experimental use and for situations when no other type of third-party JDBC driver is available.

- **Type 2:** A third-party JDBC driver that is part Java and communicates indirectly with a database server through its native client APIs.
- **Type 3:** A third-party JDBC driver that is pure Java and communicates indirectly with a database server through a middleware server.
- **Type 4:** A third-party JDBC driver that is pure Java and communicates directly with a database server.

### Which Type To Use?

Type 3 and 4 drivers are generally more stable than type 1 and 2 drivers. Type 1 and 2 drivers are generally faster than type 3 and 4 drivers. Type 2 and 3 drivers are generally more secure than type 1 and 4 drivers.

Because Identity Manager uses a directory as its datastore, and because databases are usually significantly faster than directories, performance isn’t a primary concern. Stability, however, is an issue. For this reason, we recommend that you use a type 3 or 4 third-party JDBC driver whenever possible.

Because third-party code is being executed within the environment, it is recommended to always use the Remote Loader to execute third-party code on its own to ensure the integrity of the directory process. This also makes upgrades of the shim or third-party code simple and safe because the directory does not need to be restarted.

### Supported Third-Party JDBC Drivers (Recommended)

This section discusses supported third-party drivers. Using one of these supported drivers is recommended.

- “Third-Party JDBC Driver Features” on page 171
- “JDBC URL Syntaxes” on page 171
- “JDBC Driver Class Names” on page 171
- “Supported Third-Party Jar File Placement” on page 172
- “IBM DB2 Universal Database Type 4 JDBC Driver” on page 172
- “Informix JDBC Driver” on page 174
- “Microsoft JDBC Driver for SQL Server” on page 175
- “JTDS JDBC Driver” on page 176
- “MySQL Connector/J JDBC Driver” on page 178
- “Oracle Thin Client JDBC Driver” on page 179
- “Oracle OCI JDBC Driver” on page 181
- “PostgreSQL JDBC Driver” on page 182
- “Sybase Adaptive Server Enterprise JConnect JDBC Driver” on page 183
- “MariaDB Connector/J JDBC Driver” on page 183

Additional drivers are supported but not recommended. For a list of these drivers, see “Supported Third-Party JDBC Drivers (Not Recommended)” on page 184.
Third-Party JDBC Driver Features

The following table summarizes third-party JDBC driver features:

**Table 14-1  Third-Party JDBC Driver Features**

<table>
<thead>
<tr>
<th>Driver</th>
<th>Supports Encrypted Transport?</th>
<th>Supports Retrieval of Auto-Generated Keys?</th>
</tr>
</thead>
<tbody>
<tr>
<td>IBM DB2 UDB Type 4</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Informix</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>MySQL Connector/J</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>jTDS</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Oracle Thin Client</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Oracle OCI</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>PostgreSQL</td>
<td>Yes, for JDBC 3 (Java 1.4) versions and later</td>
<td>No</td>
</tr>
<tr>
<td>Sybase jConnect</td>
<td>Yes</td>
<td>No</td>
</tr>
</tbody>
</table>

**JDBC URL Syntaxes**

The following table lists URL syntaxes for supported third-party JDBC drivers:

**Table 14-2  URL Syntaxes**

<table>
<thead>
<tr>
<th>Third-Party JDBC Driver</th>
<th>JDBC URL Syntax</th>
</tr>
</thead>
<tbody>
<tr>
<td>IBM DB2 UDB Type 4, Universal</td>
<td>jdbc:db2://ip-address:50000/database-name</td>
</tr>
<tr>
<td>Informix</td>
<td>jdbc:informix-sqli://ip-address:1526/database-name:informixserver=server-id</td>
</tr>
<tr>
<td>jTDS</td>
<td>jdbc:jtds:sqlserver://ip-address/database-name</td>
</tr>
<tr>
<td>MySQL Connector/J</td>
<td>jdbc:mysql://ip-address:3306/database-name</td>
</tr>
<tr>
<td>Oracle OCI</td>
<td>jdbc:oracle:oci8:@tns-name</td>
</tr>
<tr>
<td>Oracle Thin Client</td>
<td>sid - jdbc:oracle:thin:@ip-address:1521:&lt;sid&gt;</td>
</tr>
<tr>
<td></td>
<td>cdb - jdbc:oracle:thin:@ip-address:1521/&lt;service&gt;</td>
</tr>
<tr>
<td>PostgreSQL</td>
<td>jdbc:postgresql://ip-address:5432/database-name</td>
</tr>
<tr>
<td>Sybase jConnect</td>
<td>jdbc:sybase:Tds:ip-address:2048/database-name</td>
</tr>
</tbody>
</table>

This information is used in conjunction with the Authentication Context parameter. For information on this parameter, see "Authentication Context" on page 54.

**JDBC Driver Class Names**

The following table lists the fully qualified Java class names of supported third-party JDBC drivers:
Table 14-3  Class Names of Third-Party JDBC Drivers

<table>
<thead>
<tr>
<th>Third-Party JDBC Driver</th>
<th>Class Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>IBM DB2 UDB Type 4, Universal</td>
<td>com.ibm.db2.jcc.DB2Driver</td>
</tr>
<tr>
<td>Informix</td>
<td>com.informix.jdbc.IfxDriver</td>
</tr>
<tr>
<td>jTDS</td>
<td>net.sourceforge.jtds.jdbc.Driver</td>
</tr>
<tr>
<td>MySQL Connector/J</td>
<td>org.gjt.mm.mysql.Driver</td>
</tr>
<tr>
<td>Oracle OCI</td>
<td>oracle.jdbc.driver.OracleDriver</td>
</tr>
<tr>
<td>Oracle Thin Client</td>
<td>oracle.jdbc.driver.OracleDriver</td>
</tr>
<tr>
<td>PostgreSQL</td>
<td>org.postgresql.Driver</td>
</tr>
<tr>
<td>Sybase jConnect 6.0</td>
<td>com.sybase.jdbc3.jdbc.SybDriver</td>
</tr>
<tr>
<td>Sybase jConnect 7.0</td>
<td>com.sybase.jdbc4.jdbc.SybDriver</td>
</tr>
</tbody>
</table>

This information is used in conjunction with the JDBC Driver Class Name parameter. For information on this parameter, see “Third-Party JDBC Driver Class Name” on page 57.

Supported Third-Party Jar File Placement

The following tables identify the paths where third-party JDBC driver jar files should be placed on an Identity Manager or Remote Loader server, assuming default installation paths. Ensure to restart eDirectory, after placing the jar files in the corresponding directory, for the change to take effect.

Table 14-4  Locations for jar Files: Identity Manager Server

<table>
<thead>
<tr>
<th>Platform</th>
<th>Directory Path</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solaris, Linux, or AIX</td>
<td>/opt/novell/eDirectory/lib/dirxml/classes (eDirectory 8.8.x)</td>
</tr>
<tr>
<td>Windows</td>
<td>novell\NDS\lib</td>
</tr>
</tbody>
</table>

Table 14-5  Locations for jar Files: Remote Loader Server

<table>
<thead>
<tr>
<th>Platform</th>
<th>Directory Path</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solaris, Linux, or AIX</td>
<td>/opt/novell/eDirectory/lib/dirxml/classes (eDirectory 8.8.x)</td>
</tr>
<tr>
<td>Windows</td>
<td>novell\RemoteLoader\lib</td>
</tr>
</tbody>
</table>

IBM DB2 Universal Database Type 4 JDBC Driver

- “Driver Information” on page 173
- “Compatibility” on page 173
- “Security” on page 173
- “Known Issues” on page 173
Driver Information

Table 14-6  IBM DB2 Driver: Type 4

<table>
<thead>
<tr>
<th>Supported Database Versions</th>
<th>IBM DB2 9.7 or later</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class Name</td>
<td>com.ibm.db2.jcc.DB2Driver</td>
</tr>
<tr>
<td>Type</td>
<td>4</td>
</tr>
<tr>
<td>URL Syntax</td>
<td>jdbc:db2://ip-address:50000/database-name</td>
</tr>
<tr>
<td>Download Instructions</td>
<td>Download as part of the latest FixPack (recommended).</td>
</tr>
<tr>
<td></td>
<td>IBM Support &amp; Downloads (<a href="http://www.ibm.com/support/us/">http://www.ibm.com/support/us/</a>)</td>
</tr>
<tr>
<td></td>
<td>or</td>
</tr>
<tr>
<td></td>
<td>Copy the file from the database server.</td>
</tr>
<tr>
<td></td>
<td>file:///database-installation-directory/java</td>
</tr>
<tr>
<td>Filename</td>
<td>db2jcc.jar, db2jcc_license_cu.jar, db2jcc_javax.jar (optional)</td>
</tr>
<tr>
<td>Documentation URLs</td>
<td>DB2 Information Center (<a href="http://publib.boulder.ibm.com/infocenter/db2help">http://publib.boulder.ibm.com/infocenter/db2help</a>)</td>
</tr>
</tbody>
</table>

Unlike the type 3 driver, the type 4 driver has only a minimal set of defined error codes. This absence inhibits the JDBC driver’s ability to distinguish between connectivity, retry, authentication, and fatal error conditions.

Compatibility

The IBM DB2 driver is backward compatible. Database server updates are frequent. Driver updates are infrequent.

Security

The IBM DB2 driver supports a variety of authentication security mechanisms but does not support encrypted transport.

Known Issues

It’s very difficult to diagnose and remedy Java-related errors on the database server.

Numerous error conditions and error codes can arise when you attempt to install and execute user-defined stored procedures and functions written in Java. Diagnosing these can be time consuming and frustrating. A log file (db2diag.log on the database server) can often provide additional debugging information. In addition, all error codes are documented and available online.
Informix JDBC Driver

- “Driver Information” on page 174
- “Compatibility” on page 174
- “Security” on page 174
- “Required Parameter Settings for ANSI-Compliant Databases” on page 174
- “Dynamic Parameter Defaults” on page 175
- “Known Issues” on page 175

Driver Information

*Table 14-7  Informix JDBC Driver*

<table>
<thead>
<tr>
<th>Supported Database Versions</th>
<th>Dynamic Server 11.5 or later</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class Name</td>
<td><code>com.informix.jdbc.IfxDriver</code></td>
</tr>
<tr>
<td>Type</td>
<td>4</td>
</tr>
<tr>
<td>URL Syntax</td>
<td><code>jdbc:informix-sqli://ip-address:1526/databasename:informixserver=server-id</code></td>
</tr>
<tr>
<td>Download Instructions</td>
<td>Download URL (<a href="http://www-306.ibm.com/software/data/informix/tools/jdbc">http://www-306.ibm.com/software/data/informix/tools/jdbc</a>)</td>
</tr>
<tr>
<td>Filenames (11)</td>
<td><code>ifxjdbc.jar</code>, <code>jdbcx.jar</code> (optional)</td>
</tr>
<tr>
<td>Documentation URLs</td>
<td>Informix Information Center (<a href="http://publib.boulder.ibm.com/infocenter/ids9help/index.jsp">http://publib.boulder.ibm.com/infocenter/ids9help/index.jsp</a>)</td>
</tr>
</tbody>
</table>

For more information on Informix JDBC Driver, see Informix Library (http://www-306.ibm.com/software/data/informix/pubs/library/)

Compatibility

The Informix driver is backward compatible. Database server updates and driver updates are infrequent.

Security

The Informix driver does not support encrypted transport.

Required Parameter Settings for ANSI-Compliant Databases

The following table lists driver parameters that must be explicitly set for the JDBC driver to interoperate with the Informix driver against ANSI-compliant databases.
Dynamic Parameter Defaults

The following table lists driver compatibility parameters that the JDBC driver implicitly sets at runtime. Do not override these settings.

Table 14-9  Informix JDBC Settings Not to Override

<table>
<thead>
<tr>
<th>Display Name</th>
<th>Tag Name</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Function return method:</td>
<td>function-return-method</td>
<td>result set</td>
</tr>
<tr>
<td></td>
<td>See “Function Return Method” on page 75.</td>
<td></td>
</tr>
</tbody>
</table>

Known Issues

- Schema names cannot be used to retrieve metadata against an ANSI-compliant database. Set the driver compatibility parameter “Supports Schemas in Metadata Retrieval?” on page 75 to Boolean False. The database objects available for metadata retrieval are those visible to the database user who authenticated to the database. Schema qualifiers cannot be used to identify database objects. Therefore, to avoid naming collisions (such as owner1.table1, owner2.table1), give the database authentication user only SELECT privileges on objects being synchronized.

- When used against ANSI-compliant databases, usernames must be in uppercase. Set the driver compatibility parameter “Force Username Case” on page 73 to upper.

Microsoft JDBC Driver for SQL Server

- “Driver Information” on page 176
- “Compatibility” on page 176
- “Security” on page 176
- “URL Properties” on page 176
Driver Information

Table 14-10  Microsoft JDBC Driver for SQL Server Settings

<table>
<thead>
<tr>
<th>Supported Database Versions:</th>
<th>Microsoft SQL Server 2012 Service Pack 3 and later, Microsoft SQL Server 2014 Service Pack 2, Microsoft SQL Server 2016 Service Pack 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class Name</td>
<td>com.microsoft.sqlserver.jdbc.SQLServerDriver</td>
</tr>
<tr>
<td>Type</td>
<td>4</td>
</tr>
<tr>
<td>URL Syntax</td>
<td>jdbc:sqlserver://&lt;host&gt;[:&lt;port1433&gt;];databaseName=&lt;database&gt;</td>
</tr>
<tr>
<td>Download Instructions</td>
<td>Microsoft JDBC Driver for SQL Server</td>
</tr>
<tr>
<td>Filenames</td>
<td>sqljdbc42.jar</td>
</tr>
</tbody>
</table>

Compatibility

The Microsoft JDBC driver works with all supported versions of Microsoft SQL Server.

Security

The Microsoft JDBC driver supports encrypted transport.

NOTE: For more information on SSL encryption, see Connection String Options page.

URL Properties

Delimit URL properties by using a semicolon (;).

The following table lists values for the integratedSecurity URL property for JDBC driver for SQL Server.

Table 14-11  Values for the integratedSecurity URL Property

<table>
<thead>
<tr>
<th>Legal Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>false</td>
<td>The default value. JDBC authentication is used.</td>
</tr>
<tr>
<td>true</td>
<td>Windows process-level authentication is used.</td>
</tr>
</tbody>
</table>

jTDS JDBC Driver

- “Driver Information” on page 177
- “Limitations” on page 177
- “Compatibility” on page 177
- “Security” on page 177
- “URL Properties” on page 177
Driver Information

Table 14-12 jTDS Driver Settings

<table>
<thead>
<tr>
<th>Supported Database Versions:</th>
<th>Microsoft SQL Server 2005 Service Pack 1 or later, 2008 and 2008 R2, Sybase Adaptive Server Enterprise (ASE) 15 or later</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class Name</td>
<td>net.sourceforge.jtds.jdbc.Driver</td>
</tr>
<tr>
<td>Type</td>
<td>4 (2 if NTLM or SSO authentication is enabled)</td>
</tr>
<tr>
<td>URL Syntax</td>
<td>jdbc:jtds:sqlserver://ip-address/database-name</td>
</tr>
<tr>
<td></td>
<td>jdbc:jtds:sybase://ip-address/database-name</td>
</tr>
<tr>
<td>Download Instructions</td>
<td>The jTDS Project (<a href="http://jtds.sourceforge.net/">http://jtds.sourceforge.net/</a>)</td>
</tr>
<tr>
<td>Filenames</td>
<td>jtds-&lt;version&gt;.jar</td>
</tr>
</tbody>
</table>

Limitations

The jTDS JDBC driver does not support views or stored procedures. NetIQ Corporation recommends that you use the Microsoft 2000 JDBC driver when Subscribing to views.

Compatibility

The jTDS driver works with all versions of Microsoft SQL Server. It also supports all versions of Sybase ASE, but it has not been tested by NetIQ against that database server yet. Driver updates are infrequent.

Security

The jTDS driver supports encrypted transport.

URL Properties

Delimit URL properties by using a semicolon (;).

The following table lists values for the domain URL property for the jTDS driver.

Table 14-13 Values for the Domain URL Property

<table>
<thead>
<tr>
<th>Legal Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;any-domain-name&gt;</td>
<td>When a domain name is specified, either NTLM or SSO authentication can be used. NTLM authentication is selected when a username and password are supplied. SSO authentication is selected when a username and password are not supplied.</td>
</tr>
<tr>
<td>&lt;no-value&gt;</td>
<td>JDBC authentication is used.</td>
</tr>
</tbody>
</table>

The following table lists values for the SSL URL property for the jTDS driver.
### Table 14-14  Values for the SSL URL Property

<table>
<thead>
<tr>
<th>Legal Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>off</td>
<td>SSL is not used. This is the default.</td>
</tr>
<tr>
<td>request</td>
<td>SSL is used if the server supports it.</td>
</tr>
<tr>
<td>require</td>
<td>SSL is required. An exception is thrown if the server doesn’t support it.</td>
</tr>
<tr>
<td>authenticate</td>
<td>SSL is required. An exception is thrown if the server doesn’t support it. In addition, the server’s certificate must be signed by a trusted certificate authority.</td>
</tr>
</tbody>
</table>

### MySQL Connector/J JDBC Driver

- “Driver Information” on page 178
- “Compatibility” on page 178
- “Security” on page 179
- “Required Parameter Settings for MyISAM Tables” on page 179

#### Driver Information

**Table 14-15  MySQL Connector/J JDBC Driver Settings**

<table>
<thead>
<tr>
<th>Supported Database Versions</th>
<th>5.5.15 or later</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class Name</td>
<td>org.gjt.mm.mysql.Driver</td>
</tr>
<tr>
<td>Type</td>
<td>4</td>
</tr>
<tr>
<td>URL Syntax</td>
<td>jdbc:mysql://ip-address:3306/database-name</td>
</tr>
<tr>
<td>Download Instructions</td>
<td>Download and extract. The jar file is located in the extract-dir/mysql-connector-java-version directory.</td>
</tr>
<tr>
<td></td>
<td>MySQL Connector/J (<a href="http://www.mysql.com/products/connector/j/">http://www.mysql.com/products/connector/j/</a>)</td>
</tr>
<tr>
<td>Filename</td>
<td>mysql-connector-java-version-bin.jar</td>
</tr>
<tr>
<td>Documentation URLs</td>
<td>For more information on MySQL Connector/J Documentation, see MySQL Reference manual (<a href="http://dev.mysql.com/doc/refman/5.0/en/">http://dev.mysql.com/doc/refman/5.0/en/</a>)</td>
</tr>
<tr>
<td></td>
<td>For more information on Connecting Over SSL, see MySQL Reference manual (<a href="http://dev.mysql.com/doc/refman/5.0/en/">http://dev.mysql.com/doc/refman/5.0/en/</a>)</td>
</tr>
</tbody>
</table>

Also see “Generation/Retrieval Method (Table-Global)” on page 81.

### Compatibility

The Connector/J driver is backward compatible. Database server updates are frequent. Driver updates are infrequent.
Security

The Connector/J driver supports JSSE (Java Secure Sockets Extension) SSL-encrypted transport.

Required Parameter Settings for MyISAM Tables

The following table lists driver parameters that you must set so that the JDBC driver can interoperate with the Connector/J driver against MyISAM tables.

Table 14-16  Settings for MyISAM Tables

<table>
<thead>
<tr>
<th>Display Name</th>
<th>Tag Name</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Use manual transactions?</td>
<td>use-manual-transactions</td>
<td>false</td>
</tr>
</tbody>
</table>

Oracle Thin Client JDBC Driver

- “Driver Information” on page 179
- “Compatibility” on page 180
- “Security” on page 180
- “Dynamic Parameter Defaults” on page 180
- “Connection Properties” on page 180
- “Known Issues” on page 180

Driver Information

Table 14-17  Oracle Thin Client Settings

<table>
<thead>
<tr>
<th>Supported Database Versions</th>
<th>11g (Release 2 (11.2) or later), 12c</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class Name</td>
<td>oracle.jdbc.driver.OracleDriver</td>
</tr>
<tr>
<td>Type</td>
<td>4</td>
</tr>
</tbody>
</table>
| URL Syntax                  | sid - jdbc:oracle:thin:@ip-address:1521:<sid>  
                            | cdb - jdbc:oracle:thin:@ip-address:1521/<service> |
| Download Instructions       | Register for free and download.  
                            | For 11g, register at Oracle Technology Network.  
                            | For 12c, register at Oracle Technology Network.  |
| Filenames                   | For 11g, see the file names from Oracle Technology Network.  
                            | For 12c, see the file names from Oracle Technology Network.  |
| Documentation URLs          | For more information on Oracle Advanced Security, see Stanford University (http://www.stanford.edu/) page  
                            | For more information on JDBC FAQ, see Oracle Technology (http://www.oracle.com/technology/) page.  |
Compatibility

The Thin Client driver is backward compatible. Database server updates and driver updates are infrequent.

Oracle releases thin client drivers for various JVMs. Even though all of them work with this product, we recommend that you use the 1.6 version.

Security

The Thin Client driver supports Oracle Advanced Security encrypted transport.

Dynamic Parameter Defaults

The following table lists driver compatibility parameters that the JDBC driver implicitly sets at runtime. Do not explicitly override these settings.

Table 14-18  Oracle Thin Client Settings Not to Override

<table>
<thead>
<tr>
<th>Display Name</th>
<th>Tag Name</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of returned result sets:</td>
<td>handle-stmt-results</td>
<td>single</td>
</tr>
</tbody>
</table>

Connection Properties

The following table lists important connection properties for this driver.

Table 14-19  Oracle Thin Client: Connection Properties

<table>
<thead>
<tr>
<th>Property</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>includeSynonyms</td>
<td>If the value of this property is true, synonym column metadata is available.</td>
</tr>
<tr>
<td>ORACLE.NET.ENCRYPTION_CLIENT</td>
<td>Defines the level of security that the client wants to negotiate with the server.</td>
</tr>
<tr>
<td>ORACLE.NET.ENCRYPTION_TYPES_CLIENT</td>
<td>Defines the encryption algorithm to be used.</td>
</tr>
<tr>
<td>ORACLE.NET.CRYPTO_CHECKSUM_CLIENT</td>
<td>Defines the level of security that it wants to negotiate with the server for data integrity.</td>
</tr>
<tr>
<td>ORACLE.NET.CRYPTO_CHEKSUM_TYPES_CLIENT</td>
<td>Defines the data integrity algorithm to be used.</td>
</tr>
</tbody>
</table>

Known Issues

â†’ High CPU utilization triggered by execution of embedded SQL statements:

The most common problem experienced with this driver is high CPU utilization. As a result, this driver always indicates that more results are available from calls to method java.sql.Statement.execute(String stmt), which can lead to an infinite loop condition. This condition occurs only if all the following happen:

â†’ A value other than single, no, or one in the driver compatibility parameter “Number of Returned Result Sets” on page 71 is being executed.
• An embedded SQL statement is being executed.
• The type of statement is not explicitly specified.

To avoid the conditions that produce high CPU utilization:
• Do not explicitly set this parameter. Defer to the dynamic default value.
• Always place a jdbc:type attribute on embedded <jdbc:statement> elements.

NOTE: The jdbc namespace prefix must map to urn:dirxml:jdbc.

• Can’t retrieve synonym column metadata.
The connection property includeSynonyms must be set to true.
• Can’t see synonym table primary key constraint.
The only known solution to this problem is to use a view.

Oracle OCI JDBC Driver

<table>
<thead>
<tr>
<th>Supported Database Versions</th>
<th>11g (Release 2 (11.2) or later), 12c</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class Name</td>
<td>oracle.jdbc.driver.OracleDriver</td>
</tr>
<tr>
<td>Type</td>
<td>2</td>
</tr>
<tr>
<td>URL Syntax</td>
<td>jdbc:oracle:oci8:@tns-name</td>
</tr>
<tr>
<td>Download Instructions</td>
<td>The SQLNet infrastructure is the main requirement for OCI. SQLNet can run on any platform that Oracle supports, not just Linux. For Linux, register for free and download the following:</td>
</tr>
<tr>
<td></td>
<td>• The Oracle Instant Client (instantclient-basic-linux.x64-12.1.0.2.0.zip) from Instant Client Downloads.</td>
</tr>
<tr>
<td></td>
<td>• The Oracle SQLPlus binary (instantclient-sqlplus-linux.x64-12.1.0.2.0.zip) from Instant Client Downloads.</td>
</tr>
<tr>
<td>Filenames</td>
<td>For 11g, see the file names from Oracle Technology Network.</td>
</tr>
<tr>
<td></td>
<td>For 12c, see the file names from Oracle Technology Network.</td>
</tr>
<tr>
<td>Documentation URLs</td>
<td>Oracle Call Interface (<a href="http://www.oracle.com/technology/">http://www.oracle.com/technology/</a>)</td>
</tr>
<tr>
<td></td>
<td>OCI FAQ (<a href="http://www.oracle.com/technology/">http://www.oracle.com/technology/</a>)</td>
</tr>
<tr>
<td></td>
<td>Oracle Advanced Security (<a href="http://www.stanford.edu/">http://www.stanford.edu/</a>)</td>
</tr>
<tr>
<td></td>
<td>Instant Client (<a href="https://docs.oracle.com/cd/B19306_01/server.102/b14357/ape.htm">https://docs.oracle.com/cd/B19306_01/server.102/b14357/ape.htm</a>)</td>
</tr>
</tbody>
</table>
You can install SQLNet by doing either of the following:

- Use the Instant Client, which bypasses unneeded components of the full version.
- Download the full package from Oracle.

If the database is running on the same server as Identity Manager, you don’t need to install SQLNet because SQLNet comes as standard on the database server.

The Oracle OCI driver is essentially the same as the Thin Client driver. See “Oracle Thin Client JDBC Driver” on page 179. The OCI client differs in the following ways:

- The OCI Client supports clustering, failover, and high availability.
- The OCI Client has additional security options.

For information on setting up the Oracle OCI Client, see Appendix M, “Setting Up an OCI Client on Linux,” on page 229.

### PostgreSQL JDBC Driver

- “Driver Information” on page 182
- “Compatibility” on page 182
- “Security” on page 182

### Driver Information

#### Table 14-21  PostgreSQL JDBC Driver Settings

<table>
<thead>
<tr>
<th>Supported Database Versions</th>
<th>8.4.3 or later, 9.0.4 or later</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class Name</td>
<td>org.postgresql.Driver</td>
</tr>
<tr>
<td>Type</td>
<td>4</td>
</tr>
<tr>
<td>URL Syntax</td>
<td>jdbc:postgresql://ip-address:5432/database-name</td>
</tr>
<tr>
<td>Download Instructions</td>
<td>JDBC Driver Download (<a href="http://jdbc.postgresql.org/download.html">http://jdbc.postgresql.org/download.html</a>)</td>
</tr>
<tr>
<td>Documentation URLs</td>
<td>JDBC Driver Documentation (<a href="http://jdbc.postgresql.org/">http://jdbc.postgresql.org/</a>)</td>
</tr>
<tr>
<td></td>
<td>Using SSL (<a href="http://jdbc.postgresql.org/documentation/80/ssl.html">http://jdbc.postgresql.org/documentation/80/ssl.html</a>)</td>
</tr>
</tbody>
</table>

The filename of the PostgreSQL varies by database version.

### Compatibility

The latest builds of the PostgreSQL driver are backward compatible through server version 8.4.3. Database server updates and driver updates are frequent.

### Security

The PostgreSQL driver supports SSL-encrypted transport for JDBC 3 driver versions.
Sybase Adaptive Server Enterprise JConnect JDBC Driver

- “Driver Information” on page 183
- “Compatibility” on page 183
- “Security” on page 183
- “Connection Properties” on page 183

Driver Information

Table 14-22  Sybase Adaptive Server Enterprise Driver Settings

<table>
<thead>
<tr>
<th>Supported Database Versions</th>
<th>Adaptive Server Enterprise 15.0 or later</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class Name</td>
<td>com.sybase.jdbc3.jdbc.SybDriver (for jconn3.jar)</td>
</tr>
<tr>
<td></td>
<td>com.sybase.jdbc4.jdbc.SybDriver (for jconn4.jar)</td>
</tr>
<tr>
<td>Type</td>
<td>4</td>
</tr>
<tr>
<td>URL Syntax</td>
<td>jdbc:sybase:Tds:ip-address:2048/database-name</td>
</tr>
<tr>
<td>Download Instructions</td>
<td>Sybase Downloads (<a href="http://www.sybase.com/downloads">http://www.sybase.com/downloads</a>)</td>
</tr>
<tr>
<td>Filenames</td>
<td>jconn3.jar or jconn4.jar</td>
</tr>
<tr>
<td>Documentation URLs</td>
<td>For more information on jConnect Documentation, see Sybase inforcenter page.</td>
</tr>
</tbody>
</table>

For JDBC 3 (Java 1.4) versions and later.

Compatibility

The Adaptive Server driver is backward compatible. Database server updates and driver updates are infrequent.

Security

The Adaptive Server driver supports SSL-encrypted transport. To enable SSL encryption, you must specify a custom socket implementation via the SYBSOCKET_FACTORY connection property. For additional information on how to set connection properties, see “Connection Properties” on page 66.

Connection Properties

The SYBSOCKET_FACTORY property can be used to specify the class name of a custom socket implementation that supports encrypted transport.

MariaDB Connector/J JDBC Driver

- “Driver Information” on page 184
- “Security” on page 184
- “Required Parameter Settings for MyISAM Tables” on page 184
Driver Information

Table 14-23  MariaDB Connector/J JDBC Driver Settings

| Supported Database Versions | 10.2.13 |
| Class Name                  | org.mariadb.jdbc.Driver |
| Type                        | 4 |
| URL Syntax                  | jdbc:mysql://ip-address:3306/database-name |
| Download Instructions       | Download and extract. The jar file is located in the extract-dir/mysql-connector-java-version directory. |
| Documentation URLs          | For more information on MariaDB Connector/J Documentation, see MariaDB Connector/J Referral manual (https://mariadb.com/kb/en/library/about-mariadb-connector-j/) |

Also see “Generation/Retrieval Method (Table-Global)” on page 81.

Security

The Connector/J driver supports JSSE (Java Secure Sockets Extension) SSL-encrypted transport.

Required Parameter Settings for MyISAM Tables

The following table lists driver parameters that you must set so that the JDBC driver can interoperate with the Connector/J driver against MyISAM tables.

Table 14-24  Settings for MyISAM Tables

<table>
<thead>
<tr>
<th>Display Name</th>
<th>Tag Name</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Use manual transactions?</td>
<td>use-manual-transactions</td>
<td>false</td>
</tr>
</tbody>
</table>

Supported Third-Party JDBC Drivers (Not Recommended)

This section identifies third-party JDBC drivers that are supported but whose use with the Identity Manager JDBC driver is not recommended:

- “Third-Party JDBC Driver Features” on page 185
- “JDBC URL Syntaxes” on page 185
- “JDBC Driver Class Names” on page 185
- “IBM DB2 Universal Database JDBC Driver” on page 186
Third-Party JDBC Driver Features

The following table summarizes third-party JDBC driver features:

<table>
<thead>
<tr>
<th>Driver</th>
<th>Supports Encrypted Transport?</th>
<th>Supports Retrieval of Auto-Generated Keys?</th>
</tr>
</thead>
<tbody>
<tr>
<td>IBM DB2 UDB Type 3</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Microsoft 2008</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Microsoft 2008 R2</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>

JDBC URL Syntaxes

The following table lists URL syntaxes for supported third-party JDBC drivers:

<table>
<thead>
<tr>
<th>Third-Party JDBC Driver</th>
<th>JDBC URL Syntax</th>
</tr>
</thead>
<tbody>
<tr>
<td>IBM DB2 UDB Type 3</td>
<td>jdbc:db2://ip-address:6789/database-name</td>
</tr>
<tr>
<td>Microsoft SQL Server 2008</td>
<td>jdbc:sqlserver://ip-address-or-dns-name:1433;databaseName=database-name</td>
</tr>
<tr>
<td>Microsoft SQL Server 2008 R2</td>
<td>jdbc:sqlserver://ip-address-or-dns-name:1433;databaseName=database-name</td>
</tr>
</tbody>
</table>

This information is used in conjunction with the Authentication Context parameter. For information on this parameter, see “Authentication Context” on page 54.

JDBC Driver Class Names

The following table lists the fully-qualified Java class names of supported third-party JDBC drivers:

<table>
<thead>
<tr>
<th>Third-Party JDBC Driver</th>
<th>Class Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>IBM DB2 UDB Type 3</td>
<td>COM.ibm.db2.jdbc.net.DB2Driver</td>
</tr>
<tr>
<td>Microsoft 2008</td>
<td>com.microsoft.sqlserver.jdbc.SQLServerDriver</td>
</tr>
<tr>
<td>Microsoft 2008 R2</td>
<td>com.microsoft.sqlserver.jdbc.SQLServerDriver</td>
</tr>
</tbody>
</table>
This information is used in conjunction with the JDBC Driver Class Name parameter. For information on this parameter, see “Third-Party JDBC Driver Class Name” on page 57.

IBM DB2 Universal Database JDBC Driver

- “Driver Information” on page 186
- “Compatibility” on page 186
- “Security” on page 186
- “Known Issues” on page 186

Driver Information

Table 14-28  IBM DB2 Driver Settings

<table>
<thead>
<tr>
<th>Supported Database Versions</th>
<th>9.x</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class Name</td>
<td>com.ibm.db2.jcc.DB2Driver</td>
</tr>
<tr>
<td>URL Syntax</td>
<td>jdbc:db2://ip-address:50000/database-name</td>
</tr>
<tr>
<td>Download Instructions</td>
<td>Copy the file from the database server. file:///database-installation-directory/java</td>
</tr>
<tr>
<td>File Name</td>
<td>db2jcc.jar</td>
</tr>
<tr>
<td>Documentation URLs</td>
<td>DB2 Information Center (<a href="http://publib.boulder.ibm.com/infocenter/db2v7luw">http://publib.boulder.ibm.com/infocenter/db2v7luw</a>)</td>
</tr>
<tr>
<td></td>
<td>JDBC Programming (<a href="http://publib.boulder.ibm.com/infocenter/db2v7luw/index.jsp?topic=/com.ibm.db2v7.doc/db2a0/db2a0159.htm">http://publib.boulder.ibm.com/infocenter/db2v7luw/index.jsp?topic=/com.ibm.db2v7.doc/db2a0/db2a0159.htm</a>)</td>
</tr>
</tbody>
</table>

Compatibility

The IBM DB2 driver can best be characterized as version-hypersensitive. It is not compatible across major or minor versions of DB2, including Fix Packs. For this reason, we recommend that you use the file installed on the database server.

The IBM DB2 driver must be updated on the Identity Manager or Remote Loader server every time the target database is updated, even if only at the Fix Pack level.

Security

The IBM DB2 driver does not support encrypted transport.

Known Issues

- A version mismatch usually results in connectivity-related failures.
The most common problem experienced with the IBM DB2 driver is because of a driver/database version mismatch. The symptom of a version mismatch is connectivity-related failures such as CLI0601E Invalid statement handle or statement is closed. To remedy the problem, overwrite the db2java.zip file on the Identity Manager or Remote Loader server with the version installed on the database server.

- It’s very difficult to diagnose and remedy Java-related errors on the database server. Numerous error conditions and error-codes can arise when you attempt to install and execute user-defined stored procedures and functions written in Java. Diagnosing them can be time consuming and frustrating. A log file (db2diag.log on the database server) can often provide additional debugging information. In addition, all error codes are documented and available online.

**Microsoft SQL Server 2008 JDBC Driver**

- “Driver Information” on page 187
- “Compatibility” on page 187
- “Security” on page 187
- “URL Properties” on page 188

**Driver Information**

<table>
<thead>
<tr>
<th>Supported Database Versions</th>
<th>2008</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class Name</td>
<td>com.microsoft.sqlserver.jdbc.SQLServerDriver</td>
</tr>
<tr>
<td>Type</td>
<td>4 (2 if integrated security is enabled)</td>
</tr>
<tr>
<td>URL Syntax</td>
<td>jdbc:sqlserver://ip-address-or-dns-name:1433;databaseName=database-name</td>
</tr>
<tr>
<td>Filenames</td>
<td>sqljdbc.jar</td>
</tr>
</tbody>
</table>

The filename, URL syntax, and classname differ (often subtly) from those of the 2000 driver.

**Compatibility**

The SQL Server 2008 driver works only with SQL Server 2005. Database server and driver updates are infrequent.

**Security**

The SQL Server 2008 driver supports encrypted transport.
**URL Properties**

Delimit URL properties by using a semicolon (;).

The following table lists values for the integratedSecurity URL property for the SQL Server 2005 driver.

*Table 14-30  Values for the integratedSecurity URL Property*

<table>
<thead>
<tr>
<th>Legal Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>false</td>
<td>The default value. JDBC authentication is used.</td>
</tr>
<tr>
<td>true</td>
<td>Windows process-level authentication is used.</td>
</tr>
</tbody>
</table>

**Microsoft SQL Server 2008 R2 JDBC Driver**

- “Driver Information” on page 188
- “Compatibility” on page 188
- “Security” on page 188
- “URL Properties” on page 189

**Driver Information**

*Table 14-31  Microsoft SQL Server 2008 Driver Settings*

<table>
<thead>
<tr>
<th>Supported Database Versions:</th>
<th>2008 R2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class Name</td>
<td>com.microsoft.sqlserver.jdbc.SQLServerDriver</td>
</tr>
<tr>
<td>Type</td>
<td>4 (2 if integrated security is enabled)</td>
</tr>
<tr>
<td>URL Syntax</td>
<td>jdbc:sqlserver://ip-address-or-dns-name:1433;databaseName=database-name</td>
</tr>
<tr>
<td>Filenames</td>
<td>sqljdbc.jar</td>
</tr>
</tbody>
</table>

The filename, URL syntax, and classname differ (often subtly) from those of the 2000 driver.

**Compatibility**

The SQL Server 2008 R2 driver works only with SQL Server 2008. Database server and driver updates are infrequent.

**Security**

The SQL Server 2008 driver supports encrypted transport.
URL Properties

Delimit URL properties by using a semicolon (;).

The following table lists values for the integratedSecurity URL property for the SQL Server 2008 driver.

<table>
<thead>
<tr>
<th>Legal Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>false</td>
<td>The default value. JDBC authentication is used.</td>
</tr>
<tr>
<td>true</td>
<td>Windows process-level authentication is used.</td>
</tr>
</tbody>
</table>

Table 14-32 Values for the integratedSecurity URL Property

Deprecated Third-Party JDBC Drivers

The BEA WebLogic jDriver for Microsoft SQL Server is no longer supported.

Other Third-Party JDBC Drivers

This section lists an unsupported driver of interest (IBM Toolbox for Java/JTOpen) and discusses how to assess the feasibility of using unsupported third-party JDBC drivers with this product.

- “IBM Toolbox for Java/JTOpen” on page 189
- “Minimum Third-Party JDBC Driver Requirements” on page 190
- “Considerations When Using Other Third-Party JDBC Drivers” on page 190

IBM Toolbox for Java/JTOpen

Table 14-33 Settings for IBM Toolbox for Java/JTOpen

<table>
<thead>
<tr>
<th>Database</th>
<th>IBM Toolbox for Java/JTOpen</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>iSeries Toolbox for Java (alias)</td>
</tr>
<tr>
<td></td>
<td>AS/400 Toolbox for Java (alias)</td>
</tr>
<tr>
<td>Class Name</td>
<td>com.ibm.as400.access.AS400JDBCDriver</td>
</tr>
<tr>
<td>Type</td>
<td>4</td>
</tr>
<tr>
<td>URL Syntax</td>
<td>jdbc:as400://ip-address/database-name</td>
</tr>
<tr>
<td>Download Instructions</td>
<td>Download URLs for JTOpen</td>
</tr>
<tr>
<td></td>
<td>JTOpen (<a href="http://jt400.sourceforge.net">http://jt400.sourceforge.net</a>)</td>
</tr>
<tr>
<td></td>
<td>Toolbox for Java/JTOpen (<a href="http://www-03.ibm.com/">http://www-03.ibm.com/</a> servers/eserver/iseries/toolbox/downloads.html)</td>
</tr>
<tr>
<td>Filenames</td>
<td>jt400.jar</td>
</tr>
<tr>
<td>Documentation URLs</td>
<td>Toolbox for Java/JTOpen (<a href="http://www-03.ibm.com/servers/">http://www-03.ibm.com/servers/</a> eserver/iseries/toolbox/)</td>
</tr>
</tbody>
</table>
If you use the IBM Toolbox for Java/JTOpen driver, you must manually enter values for the JDBC Driver Class Name and Authentication Context parameters. The settings are not automatically populated. See “Third-Party JDBC Driver Class Name” on page 57 and “Authentication Context” on page 54.

**Minimum Third-Party JDBC Driver Requirements**

The JDBC driver might not interoperate with all third-party JDBC drivers. If you use an unsupported third-party JDBC driver, it must meet the following requirements:

- **Support required metadata methods**
  
  For a current list of the required and optional java.sql.DatabaseMetaData method calls that the JDBC driver makes, see Appendix F, “java.sql.DatabaseMetaData Methods,” on page 211.

- **Support other required JDBC methods**
  
  For a list of required JDBC methods that the JDBC driver uses, refer to Appendix G, “JDBC Interface Methods,” on page 213. You can use this list in collaboration with third-party driver documentation to identify potential incompatibilities.

**Considerations When Using Other Third-Party JDBC Drivers**

- **Because the JDBC driver is directly dependent upon third-party JDBC driver implementations, bugs in those implementations might cause this product to malfunction.**

  To assist you in debugging third-party JDBC drivers, the JDBC driver supports the following:
  
  - Tracing at the JDBC API level (level 6)
  - Third-party JDBC driver (level 7) tracing
  
- **Stored procedure or function support is a likely point of failure.**

- **You probably need to write a custom driver descriptor file.**

  Specifically, you need to categorize error codes and SQL states for the third-party driver that you are using.

**Security Issues**

To ensure that a secure connection exists between the Identity Manager JDBC driver and a third-party driver, we recommend the following:

- **Run the JDBC driver remotely on the database server.**

- **Use SSL to encrypt communications between the Identity Manager server and the database server.**

If you cannot run the JDBC driver remotely, you might want to use a type 2 or type 3 JDBC driver. These driver types often facilitate a greater degree of security through middleware servers or client APIs unavailable to other JDBC driver types. Some type 4 drivers support encrypted transport, but encryption is the exception rather than the rule.
**15 Troubleshooting the JDBC Driver**

- “DirXML-Accounts Attribute Shows Incorrect Value When a User is Enabled or Disabled in the Identity Vault on DB2 and Oracle Database Drivers” on page 191
- “Password Changes for Users Are Not Synchronized from the Identity Vault for the Oracle Database Driver” on page 191
- “Modifying the Default Configuration for the Sybase Driver in Direct Mode” on page 192
- “Driver Shim Is Irresponsive When a Connected Database Server Does Not Respond” on page 192
- “Recognizing Publication Events” on page 192
- “Executing Test Scripts” on page 192
- “Applying the Latest Driver Package Does Not Change the Default Setting of Enable Service Channel ECV” on page 193
- “Troubleshooting Driver Processes” on page 193

**DirXML-Accounts Attribute Shows Incorrect Value When a User is Enabled or Disabled in the Identity Vault on DB2 and Oracle Database Drivers**

This issue is observed with certain settings on the driver:

**DB2 driver:** When the Allow Loopback option is set to Yes on the Publisher channel in the Indirect Triggered mode.

Workaround: Disable the Allow Loopback option.

**Oracle Driver:** In the Direct Triggerless mode.

There is no workaround.

**Password Changes for Users Are Not Synchronized from the Identity Vault for the Oracle Database Driver**

The Oracle Database driver created with an Indirect/Direct Synchronization sample package used an incorrect query to create or change the name and password of the users. The driver patch 2 fixed this issue, but after upgrading to patch 2, if the password is reset for an existing user, it fails with an error and displays the following message:

**User does not exist.**

To workaround this issue, after upgrading the driver, delete the existing user from the Oracle database and synchronize it from the Identity Vault.
Modifying the Default Configuration for the Sybase Driver in Direct Mode

When you add users using the default configuration on the subscriber channel for the Sybase driver in direct mode, an error is displayed. Change the driver settings as follows:

- Set the Generation/retrieval method (table-global) to Subscriber-generated.
- Set the Retrieval timing (table-global) to after row insertion.
- Leave the Method and timing (table-local) as blank.

When you change the value for the Method and timing option, you need to edit the sample procedures appropriately. For example, if you set it to `view_usr("indirect.proc_idu(pk_idu)"); view_grp("indirect.proc_idg(pk_idg)")`, you must edit the `indirect.proc_idu` and `indirect.proc_idg` procedures so that unique values are returned for the `idg` and `idu` columns respectively.

Driver Shim Is Irresponsive When a Connected Database Server Does Not Respond

This issue is observed in the following cases:

- **Case 1**: The driver tries to update a record that is currently being modified through another database connection.
  
  If you instruct the driver to update this record, the driver will wait to operate on it until the updated record is committed to the database.
  
  This is an expected behavior. The driver is designed to wait to eliminate the chances of inconsistent results in such situations.

- **Case 2**: When the transaction log in a database is filled. For example, Sybase database.
  
  The database does not allow any operations until the transaction log is cleared.
  
  It is the responsibility of the database administrator to clear the transactions log. When the log is cleared, the database is unlocked for operations and the driver resumes processing without issues.

Recognizing Publication Events

Publication events might not be recognized by the Publisher channel unless you explicitly commit changes. For the commit keywords of supported databases, see “Commit Keywords” on page 162.

Executing Test Scripts

The test scripts should be executed by a user other than the driver’s `idm` database user account. If you execute them as the `idm` user, events are ignored by the driver’s Publisher channel, unless publication loopback is allowed. For additional information on allowing or disallowing publication loopback, refer to “Allow Loopback?” on page 90.
Applying the Latest Driver Package Does Not Change the Default Setting of Enable Service Channel ECV

**Issue:** If you upgraded to Identity Manager 4.7 and updated the base packages for your driver, the package update process does not overwrite the default setting (False) of Enable Service Channel ECV.

This issue does not occur when you create a new driver.

**Workaround:** Manually change the ECV for the driver.

To change the ECV in Designer:

1. In Modeler, right-click the driver line.
2. Select **Properties > Engine Control Values**.
3. Click the tooltip icon to the right of **Engine Controls for Server**.
   - If a server is associated with the Identity Vault, and if you are authenticated, the engine control values display in the large pane.
4. Change the value for **Enable Subscriber Service Channel**.
5. Click OK.
6. For the change to take effect, deploy the driver to the live Identity Vault.

To change the ECV in iManager:

1. Log in to the instance of iManager that manages your Identity Vault.
2. In the navigation frame, select **Identity Manager**.
3. Select **Identity Manager Overview**.
4. Use the search page to display the Identity Manager Overview for the driver set that contains your driver.
5. Click the round status indicator in the upper right corner of the driver icon.
6. Select **Edit Properties > Engine Control Values**.
7. Change the value for **Enable Subscriber Service Channel**.
8. Click OK, then click **Apply**.
9. For the change to take effect, restart the driver.

**Troubleshooting Driver Processes**

Viewing driver processes is necessary to analyze unexpected behavior. To view the driver processing events, use DSTrace. You should only use it during testing and troubleshooting the driver. Running DSTrace while the drivers are in production increases the utilization on the Identity Manager server and can cause events to process very slowly. For more information, see “Viewing Identity Manager Processes” in the *NetIQ Identity Manager Driver Administration Guide*. 
Uninstalling the Driver

- “Deleting Identity Manager Driver Objects” on page 195
- “Running the Product Uninstaller” on page 195
- “Executing Database Uninstallation Scripts” on page 195

NetIQ Corporation recommends that you install and uninstall preconfigured drivers and database scripts as a unit. To prevent unintentional mismatching, database scripts and preconfigured drivers contain headers with a version number, the target database name, and the database version.

Deleting Identity Manager Driver Objects

When you are deleting NetIQ Identity Vault objects, you must delete all child objects before you can delete a parent object. For example, you must delete all rules and style sheets on the Publisher channel before you can delete the Publisher object. Similarly, you must delete both the Publisher and Subscriber objects before you can delete the Driver object.

To remove a driver object from an Identity Vault:

1. In NetIQ iManager, click Identity Manager > Identity Manager Overview.
2. Select a driver set.
3. On the Identity Manager Overview page, click Delete Driver.
4. Select the driver that you want to delete, then click OK.

Running the Product Uninstaller

Uninstallation procedures vary by platform.

To uninstall the Identity Manager JDBC driver on Windows, use Add or Remove Programs in the Control Panel.

Executing Database Uninstallation Scripts

This section provides helps you execute database uninstallation SQL scripts.

- “IBM DB2 Universal Database (UDB) Uninstallation” on page 196
- “Informix Dynamic Server (IDS) Uninstallation” on page 196
- “Microsoft SQL Server Uninstallation” on page 196
- “MySQL Uninstallation” on page 197
- “Oracle Uninstallation” on page 197
- “PostgreSQL Uninstallation” on page 197
- “Sybase Adaptive Server Enterprise (ASE) Uninstallation” on page 198
IBM DB2 Universal Database (UDB) Uninstallation

The directory context for DB2 is `install-dir\DirXMLUtilities\jdbc\sql\db2_udbl\install`.

1. Drop the `idm`, `indirect`, and `direct` operating system user accounts.
2. If you haven’t already done so, change the name of the administrator account name and password in the installation scripts.
3. Using the Command Line Processor (CLP), execute the `uninstall.sql` script.
   For example: `db2 -f uninstall.sql`
   This script won’t execute in the Command Center interface beyond version 7 because the script uses the `\` line continuation character. Later versions of the Command Center don’t recognize this character.
4. Delete the `idm_db2.jar` file.

Informix Dynamic Server (IDS) Uninstallation

The directory context for Informix SQL scripts is `install-dir\DirXMLUtilities\jdbc\sql\informix_ids\install`.

1. Drop the `idm` operating system user account.
2. Start a client such as SQL Editor.
3. Log on to your server as user `informix` or another user with DBA (database administrator) privileges.
   By default, the password for `informix` is `informix`.
   If you execute scripts as a user other than `informix`, change all references to `informix` in the install scripts prior to execution.
4. If you aren’t using the `informix` account with the default password, change the name of the DBA account name and password in the installation scripts.
5. Open and execute `uninstall.sql` from the `ansi` (transactional, ANSI-compliant), `log` (transactional, non-ANSI-compliant), or `no_log` (non-transactional, non-ANSI-compliant) subdirectory, depending upon which type of database you installed.

Microsoft SQL Server Uninstallation

The directory context for Microsoft SQL Server scripts is `install-dir\DirXMLUtilities\jdbc\sql\mssql\install`.

1. Start a client such as Query Analyzer.
2. Log on to your database server as user `sa`.
   By default, the `sa` user has no password.
3. Open and execute the first installation script, `uninstall.sql`.
   The execute hotkey in Query Analyzer is F5.
MySQL Uninstallation

The directory context for MySQL SQL scripts is `install-dir\DirXMLUtilities\jdbc\sql\mysql\install`.

1. From a MySQL client, such as mysql, log on as user root or another user with administrative privileges.
   - For example, from the command line execute `mysql -u root -p`
   - By default, the root user has no password.
2. Execute the `uninstall.sql` uninstallation script.
   - For example: `mysql> \c c:\uninstall.sql`
   - Don’t use a semicolon to terminate this statement.

Oracle Uninstallation

The directory context for Oracle SQL scripts is `install-dir\DirXMLUtilities\jdbc\sql\oracle\install`.

1. From an Oracle client, such as SQL Plus, log on as user SYSTEM.
   - By default, the password for SYSTEM is MANAGER.
   - If you execute scripts as a user other than SYSTEM with password MANAGER, change all references to SYSTEM in the scripts prior to execution.
2. Execute the uninstallation script `uninstall.sql`.
   - For example: `SQL> @c:\uninstall.sql`

PostgreSQL Uninstallation

The directory context for PostgreSQL scripts is `install-dir\DirXMLUtilities\jdbc\sql\postgres\install`. The directory context for executing Postgres commands is `postgres-install-dir\pgsql\bin`.

1. From a Postgres client such as psql, log on as user `postgres` to the `idm` database.
   - For example, from the UNIX command line, execute `./psql -d idm postgres`
   - By default, the Postgres user has no password.
2. From inside psql, execute the script `uninstall.sql`.
   - For example: `idm=# \i uninstall.sql`
3. Drop the database `idm`.
   - For example, from the UNIX command line, execute `./dropdb idm`
4. Remove or comment out entries for the `idm` user in the `pg_hba.conf` file.
   - For example:
     ```
     #host    idm         idm    255.255.255.255   255.255.255.0
     ```
5. Restart the Postgres server to effect changes made to the `pg_hba.conf` file.
Sybase Adaptive Server Enterprise (ASE) Uninstallation

The directory context for Sybase SQL scripts is `install-dir\DirXMLUtilities\jdbc\sql\sybase_ase\install`.

1. From a Sybase client, such as isql, log on as user `sa`.
2. Execute the installation script `uninstall.sql`.
   - For example, from the command line, execute `isql -U sa -P -i uninstall.sql`
   - By default, the `sa` account has no password.
Known Issues and Limitations

NetIQ Corporation strives to ensure that our products provide quality solutions for your enterprise software needs. The following issues are currently being researched. If you need further assistance with any issue, please contact Technical Support.

For information about known issues in previous versions of Identity Manager, see the Release Notes for each version on the corresponding documentation page.

- “Known Issues” on page 199
- “Limitations” on page 200

Known Issues

JDBC Driver

- Identity Vault Time and Timestamp syntaxes are inadequate for expressing the range and granularity of their database counterparts. This is a publication problem because database time-related types typically have a wider range and greater degree of granularity (typically nanoseconds). The converse is not true. For more information, see “Time Syntax” on page 57.

- The JDBC driver is unable to parse proprietary database time stamp formats. Some databases, such as Sybase and DB2, have proprietary time stamp formats that the java.sql.Timestamp (http://java.sun.com/j2se/1.5.0/docs/api/java/sql/Timestamp.html) class can’t parse. When synchronizing time stamp columns from these databases, the JDBC driver, by default, assumes that time stamp values placed in the event log table are in ODBC canonical format (that is, yyyy-mm-dd hh:mm:ss.fffffffff). The recommended method for enabling the JDBC driver to handle proprietary database time stamp formats is to implement a custom DBTimestampTranslator class. This interface is documented in the JavaDoc Tool that ships with the JDBC driver. Using this approach avoids the problem of reformatting time stamps in the database before they are inserted into the event log table or reformatted in style sheets. The JDBC driver ships with default implementations for the native DB2 time stamp format and the Sybase style 109 time stamp format.

- Statements executed against the database server might block indefinitely. Typically, blocking is caused by a database resource being exclusively locked. Because the locking mechanisms and locking SQL vary by database, the general solution to this problem is to implement a custom DBLockStatementGenerator class. For additional information, see “Lock Statement Generator Class” on page 72. The JDBC driver ships with a default implementation for Oracle.

Many factors can cause blocking. To mitigate the likelihood of blocking, we recommend that you do not set the Transaction Isolation Level parameter to a level greater than read committed. The JDBC interface defines a method java.sql.Statement.setQueryTimeout(int):void (http://java.sun.com/j2se/1.5.0/docs/api/java/sql/Statement.html) that allows a statement to time out after a specified number of seconds. Unfortunately, implementations of this method between third-party JDBC drivers range from not being implemented to having bugs. For this reason, this method was deemed unsuitable as a general-purpose solution.
• The JDBC displays an exception error "User is unassociated" when performing a Modify and/or Delete event with dest-dn. This is because the JDBC driver does not support CRUD operation.
• In MSSQL database you can only add new values to the view only if the view is created from a single base table. If multiple base tables are used to create the view, you cannot update the view.

JDBC Fan-Out Driver
• If the Cached Priority Synchronisation event is a modify of the Referential Attribute, the driver sends a Success status. However, the modified change is not updated in the target database.

Limitations
• The JDBC driver does not support the use of delimited (quoted) database identifiers (for example, "names with spaces").
• JDBC 2 data types are not supported, with the exception of Large Object data types (LOBs) such as CLOB and BLOB.
• JDBC 3 data types are not supported.
• PostgreSQL does not support <check-object-password> events. Authentication is controlled by manually inserting entries into the pg_hba.conf file.
Best Practices

The following section lists important best practices for using the JDBC driver. You can find additional information in Chapter 6, “Configuring the JDBC Driver,” on page 51.

Tips for Synchronizing Millions of User Records on the Publisher Channel

For successfully synchronizing millions of user records, change the following settings using Designer or iManager:

1. Click the driver set that contains this driver and change the Java Maximum heap size to 256 MB. This change will be applicable to all the drivers under this driver set.
2. Under the Driver Settings, change the Show the compatibility parameters? option to show to display the Show backward compatibility parameters? option. Change it to show, then change the Enable the Table Referential attribute support? to No.
3. Under the Publisher Settings, change the Show polling-related parameters? option to show to display the Batch Size, then change it to 128.

Schema Name Use Cases

In the Schema Name under schema-aware mode the driver qualifies the tables according to the following rules:

- Every table that contains a primary key constraint is considered as an object class. For example, the following `usr` table created by the SQL code is considered as an object class by the driver shim if the Schema Name is set to `indirect`.

```sql
CREATE TABLE indirect.usr
(
    idu INTEGER NOT NULL,
    fname VARCHAR2(64),
    lname CHAR(64),
    CONSTRAINT pk_usr_idu PRIMARY KEY (idu),
)
```

The above table will contain two single-valued attributes; `fname` and `lname`. The driver will build its associations based on the value of the column referenced in the primary key constraint, which in this case is column `idu`.

- Every table that only has a Foreign Key constraint is considered as a multi-valued attribute of the class that holds the primary key pointed by the said foreign key constraint. In the following example, if the driver parameter, Schema Name is set to `indirect`, then the `usr_phone.phoneno` table is considered a multi-valued attribute belonging to the class `usr`.

**NOTE:** The child table `usr_phone` only has a foreign key constraint to the parent table `usr`. The table `usr` is considered an object class since it has a primary key constraint.
CREATE TABLE indirect.usr
(
  idu INTEGER NOT NULL,
  fname VARCHAR2(64),
  lname CHAR(64),
  CONSTRAINT pk_usr_idu PRIMARY KEY (idu),
)

CREATE TABLE indirect.usr_phone
(
  idu INTEGER NOT NULL,
  phoneno VARCHAR2(64) NOT NULL,
  CONSTRAINT fk_phone_idu FOREIGN KEY (idu)
    REFERENCES indirect.usr(idu) ON DELETE CASCADE
)

DN-type references between the two objects will have different requirements based on whether
the reference points back to the same object class or to a different object class. DN-type
references also change depending on whether the DN attribute is single valued or multi-valued.

- If the attribute is single-valued and points back to the same object class, then the table that
  contains that class will have a foreign key constraint to itself and uses a local column to store the
  value. An example is the manager attribute in eDirectory. In the example below, if the driver
  parameter Schema Name is set to indirect, then the attribute manager will be a DN-type
  attribute that points to another row inside the usr table.

CREATE TABLE indirect.usr
(
  idu INTEGER NOT NULL,
  fname VARCHAR2(64),
  lname CHAR(64),
  manager INTEGER,
  CONSTRAINT pk_usr_idu PRIMARY KEY (idu),
  CONSTRAINT fk_usr_manager FOREIGN KEY (manager)
    REFERENCES indirect.usr(idu) ON DELETE SET NULL
)

- If the attribute is multi-valued and points back to the same object class, then we need a child
  table with columns, each having its own foreign key constraint to the same parent table. An
  example is the directReports attribute in eDirectory. In the following example, if the driver
  parameter Schema Name is set to indirect, then the attribute usr_directReports.repname will
  be a DN-type attribute that points to one or more rows inside the usr table.

CREATE TABLE indirect.usr_directReports
(
  idu INTEGER NOT NULL,
  repname VARCHAR2(64) NOT NULL,
  CONSTRAINT fk_directReports_idu FOREIGN KEY (idu)
    REFERENCES indirect.usr(idu) ON DELETE CASCADE,
  CONSTRAINT fk_directReports_repname FOREIGN KEY (idu)
    REFERENCES indirect.usr(idu) ON DELETE CASCADE
)
- If the attribute is single-valued and points to a different object class, then the table that contains that class will have a foreign key constraint to the table for the other object class, and a local column to store that value. An example is the Host Server attribute in eDirectory. In the following example, if the driver parameter Schema Name is set to indirect, then the attribute hostsrv will be a DN-type attribute that points to a row inside the server table. In this example, both the volume table and the server table represent object classes.

```sql
CREATE TABLE indirect.volume
(
    idv         INTEGER  NOT NULL,
    vname       VARCHAR2(64),
    hostsrv     INTEGER,
    CONSTRAINT pk_volume_idv PRIMARY KEY (idv),
    CONSTRAINT fk_volume_hostsrv FOREIGN KEY (ids)
    REFERENCES indirect.server(ids) ON DELETE SET NULL
)
CREATE TABLE indirect.server
(
    ids         INTEGER  NOT NULL,
    srvname     VARCHAR2(64),
    CONSTRAINT pk_server_ids PRIMARY KEY (ids)
)
```

- If the attribute is multi-valued and points to a different object class, then we need a child table with two columns, each having a foreign key constraint to a different parent table. An example is the Group Membership attribute in eDirectory. In the following example, if the driver parameter Schema Name is set to indirect, then the attribute usr_mbr_of.idu will be a DN-type attribute that points to a row inside the grp table. In this example, both the usr table and the grp table represent object classes.

```sql
CREATE TABLE indirect.usr
(
    idu         INTEGER  NOT NULL,
    fname       VARCHAR2(64),
    lname       CHAR(64),
    CONSTRAINT pk_usr_idu PRIMARY KEY (idu),
)
CREATE TABLE indirect.grp
(
    idg         INTEGER  NOT NULL,
    for_insert  INTEGER,
    CONSTRAINT pk_grp_idg PRIMARY KEY (idg)
)
CREATE TABLE indirect.usr_mbr_of
(
    idu  INTEGER  NOT NULL,
    idg  INTEGER  NOT NULL,
    CONSTRAINT fk_mbr_of_idu FOREIGN KEY (idu)
    REFERENCES indirect.usr(idu) ON DELETE CASCADE,
    CONSTRAINT fk_mbr_of_idg FOREIGN KEY (idg)
    REFERENCES indirect.grp(idg) ON DELETE CASCADE
)
```

Security/Performance:

- For performance and security reasons, run the driver remotely on the database server whenever possible. Be sure to enable SSL encryption between the Identity Vault and the Remote Loader service.
 You should enable SSL encryption for third-party drivers whenever the JDBC driver is not running remotely on the database server. For information on the security capabilities of supported third-party drivers, see Chapter 14, “Third-Party JDBC Drivers,” on page 169.

 In a production environment, turn off tracing.

Other:

 For direct synchronization, prefix one or more view column names with “pk_” (case-insensitive).
 For both direct and indirect synchronization, use different primary key column names between logical database classes.
 Delimit (double-quote) primary key values placed in the event log table_key field if they contain the following characters: , ; ' + = \ < > This caution is usually an issue only if the primary key column is a binary type.
 When an Identity Vault is the authoritative source of primary key values, GUID rather than CN is recommended for use as a primary key. Unlike CN, GUID is single-valued and does not change.
 From publication triggers, omit foreign key columns that link child and parent tables.
 If primary key columns are static (they do not change), do not include them in publication triggers.
 Place the jdbc:type="query" attribute value on all embedded SELECT statements. Place the jdbc:type="update" attribute value on all embedded INSERT, UPDATE and DELETE statements.
 To avoid issues that arise when you run a sql query that has a reserved word as a column name, specify a fully qualified name for the column.
   For example, when you use group as a column name under usr table, group being is a sql keyword, your query might not be properly executed. To avoid this, specify a fully qualified name such as usr.group (<Tablename>.<Columnname>) for the column.
 By design, the driver doesn’t allow primary keys on child tables in the Synch Schema mode. To comply with standard database best practices, if you add a primary key on all tables including the child tables containing multi-valued attributes, the driver doesn’t work properly in this mode. You must operate the driver in the Synch Tables/Views mode to allow primary keys on child tables. The Synch Tables/Views mode prevents the driver from adding the child tables to the list of synchronized tables.
**FAQ**

- “Can’t See Tables or Views” on page 205
- “Synchronizing with Tables” on page 205
- “Processing Rows in the Event Log Table” on page 206
- “Managing Database User Accounts” on page 206
- “Synchronizing Large Data Types” on page 206
- “Slow Publication” on page 206
- “Synchronizing Multiple Classes” on page 207
- “Encrypted Transport” on page 207
- “Mapping Multivalue Attributes” on page 207
- “Synchronizing Garbage Strings” on page 207
- “Running Multiple JDBC Driver Instances” on page 207

---

### Can’t See Tables or Views

**Question:** Why can’t the driver see my tables or views?

**Answer:** The driver is capable of synchronizing only tables that have explicit primary key constraints and views that contain one or more columns prefixed with “pk_” (case-insensitive). The driver uses these constraints to determine which fields to use when constructing associations. As such, the driver ignores any unconstrained tables. If you are trying to synchronize with tables or views that lack the necessary constraints, either add them or synchronize to intermediate tables with the required constraints.

Another possibility is that the driver lacks the necessary database privileges to see the tables. Usually, visibility is determined by the presence or absence of the `SELECT` privilege.

---

### Synchronizing with Tables

**Question:** How do I synchronize with tables located in multiple schemas?

**Answer:** Do one of the following:

- Alias the tables into the synchronization schema.
- Synchronize to intermediate tables in the synchronization schema and move the data across schema boundaries.
- Use a view.
- Create a virtual schema by using the Table/View Names parameter.

See “Table/View Names” on page 64.
Processing Rows in the Event Log Table

**Question:** Why isn't the driver processing rows in the Event Log Table?

**Answer:** Do the following:

1. Check the perpetrator field of the rows in question and make sure that the value is set to something other than the driver's database username.
   
   The Publisher channel checks the perpetrator field to detect loopback events if the Publisher channel Allow Loopback parameter is set to Boolean False (the default). See “Allow Loopback?” on page 90.
   
   When the Allow Loopback parameter is set to Boolean False, the Publisher channel ignores all records where the perpetrator field value is equal to the driver's database username. The driver's database username is specified by using the Authentication ID parameter. See “Authentication ID” on page 54.

2. Ensure that the record's status field is set to N (new).
   
   Records with status fields set to something other than N will not be processed.

3. Make sure to explicitly commit changes.
   
   Changes are often tentative until explicitly committed.

Managing Database User Accounts

**Question:** Can the driver manage database user accounts?

**Answer:** Yes. You can manage database accounts by using embedded SQL. For more information, see Chapter 12, “Embedded SQL Statements in XDS Events,” on page 133.

Synchronizing Large Data Types

**Question:** Can the driver synchronize large binary and string data types?

**Answer:** Yes. Large binary and string data types can be subscribed and published. Publish large binary and string data types by using query-back event types. For additional information, see “Event Types” on page 124.

Slow Publication

**Question:** Why is publication slow?

**Answer:** If the event log table contains a large number of rows, index the table. Example indexes are provided in all database installation scripts. By using trace level 3, you can view the statements that the driver uses to maintain the event log.

You can further refine indexes in the installation scripts to enhance publication performance. Placing indexes in a different tablespace or physical disk than the event log table also enhances publication performance.

Furthermore, in a production environment, set the Delete Processed Rows parameter to Boolean False, unless processed rows are being periodically moved to another table. See “Delete Processed Rows?” on page 89.
Synchronizing Multiple Classes

**Question:** Can the driver synchronize multiple classes?

**Answer:** Yes. However, primary key column names must be unique between logical database classes. For example, if `class1` is mapped to `table1` with primary key column name `key1`, and `class2` is mapped to `table2` with primary key column name `key2`, then the name of `key1` cannot equal `key2`. This requirement can always be satisfied, no matter which synchronization model is employed.

Encrypted Transport

**Question:** Does the driver support encrypted transport?

**Answer:** No. How the driver communicates with a given database depends upon the third-party driver being used. Some third-party drivers support encrypted transport, but others do not. Even if encrypted transport is supported, no standardized way exists to enable encryption between third-party JDBC drivers.

The general solution for this problem is to remotely run the JDBC driver and your third-party driver. This method allows both the JDBC driver and the third-party driver to run locally on the database server. Then all data traveling across the network between the Identity Manager engine and the JDBC driver are SSL encrypted.

Another possibility is to use a type 3 or type 2 third-party JDBC driver. Database middleware and client APIs usually provide encrypted transport mechanisms.

Mapping Multivalue Attributes

**Question:** How do I map multivalue attributes to single-value database fields?

**Answer:** See “Mapping Multivalue Attributes to Single-Value Database Fields” on page 116.

Synchronizing Garbage Strings

**Question:** Why is the driver synchronizing garbage strings?

**Answer:** The database and the third-party driver are probably using incompatible character encoding. Adjust the character encoding that your third-party driver uses.

For more information, refer to Character Encoding Values (http://java.sun.com/j2se/1.5.0/docs/guide/intl/encoding.doc.html), defined by Sun.

Running Multiple JDBC Driver Instances

**Question:** How do I run multiple JDBC driver instances in the same driver set? The instances require different versions of the same third-party JDBC driver (for example, the Oracle JDBC driver or the IBM DB2 Type 3 JDBC driver).

**Answer:** Use the Remote Loader to load each JDBC driver instance in a separate Java Virtual Machine (JVM). When run locally in the same JVM, different versions of the same third-party classes collide.
Supported Data Types

The JDBC driver can synchronize all JDBC 1 data types and a small subset of JDBC 2 data types. How JDBC data types map to a database's native data types depends on the third-party driver.

The following list includes the supported JDBC 1 java.sql.Types (http://java.sun.com/j2se/1.5.0/docs/api/java/sql/Types.html).

**Numeric Types:**

- java.sql.Types.BIGINT
- java.sql.Types.BIT
- java.sql.Types.DECIMAL
- java.sql.Types.DOUBLE
- java.sql.Types.NUMERIC
- java.sql.Types.REAL
- java.sql.Types.FLOAT
- java.sql.Types.INTEGER
- java.sql.Types.SMALLINT
- java.sql.Types.TINYINT

**String Types:**

- java.sql.Types.CHAR
- java.sql.Types.LONGCHAR
- java.sql.Types.VARCHAR

**Time Types:**

- java.sql.Types.DATE
- java.sql.Types.TIME
- java.sql.Types.TIMESTAMP

**Binary Types:**

- java.sql.Types.BINARY
- java.sql.Types.VARBINARY
- java.sql.Types.LONGVARBINARY

The following list includes the supported JDBC 2 java.sql.Types (http://java.sun.com/j2se/1.5.0/docs/api/java/sql/Types.html).

**Large Object (LOB) Types:**

- java.sql.Types.CLOB
- java.sql.Types.BLOB
This section lists the required and optional `java.sql.DatabaseMetaData` methods.

The following JDBC 1 methods are required only if the Synchronization Filter parameter is set to something other than Exclude all tables/views:

- `storesLowerCaseIdentifiers():boolean`
- `storesMixedCaseIdentifiers():boolean`
- `storesUpperCaseIdentifiers():boolean`

Optional JDBC 1 methods:

- `dataDefinitionCausesTransactionCommit():boolean`
- `dataDefinitionIgnoredInTransactions():boolean`
- `getColumnPrivileges(String catalog, String schema, String table, String columnNamePattern):java.sql.ResultSet`
- `getDatabaseProductName():java.lang.String`
- `getDatabaseProductVersion():java.lang.String`
- `getDriverMajorVersion():int`
- `getDriverMinorVersion():int`
- `getDriverName():java.lang.String`
- `getDriverVersion():java.lang.String`
- `getMaxStatements():int`
- `getMaxConnections():int`
- `getMaxColumnsInSelect():int`
- `getProcedureColumns(String catalog, String schemaPattern, String procedureNamePattern, String columnNamePattern):java.sql.ResultSet`
- `getSchemas():java.sql.ResultSet`
- `getTableTypes():java.sql.ResultSet`
- `getUserName():java.lang.String`
- `supportsColumnAliasing():boolean`
• `supportsDataDefinitionAndDataManipulationTransactions()`: boolean
• `supportsDataManipulationTransactionsOnly()`: boolean
• `supportsLimitedOuterJoins()`: boolean
• `supportsMultipleTransactions()`: boolean
• `supportsSchemasInDataManipulation()`: boolean
• `supportsSchemasInProcedureCalls()`: boolean
• `supportsTransactionIsolationLevel(int level)`: boolean
• `supportsTransactions()`: boolean

Optional JDBC 2 methods:
• `supportsBatchUpdates()`: boolean

Optional JDBC 3 methods:
• `supportsGetGeneratedKeys()`: boolean
JDBC Interface Methods

This section lists the JDBC interface methods (other than java.sql.DatabaseMetaData (http://java.sun.com/j2se/1.5.0/docs/api/java/sql/DatabaseMetaData.html) methods) that the JDBC driver uses. Methods are organized by class.

Often, third-party JDBC driver vendors list defects or known issues by method. You can use the following methods in collaboration with third-party JDBC driver documentation to troubleshoot or anticipate potential interoperability problems.

- java.sql.DriverManager (http://java.sun.com/j2se/1.5.0/docs/api/java/sql/DriverManager.html)
- java.sql.CallableStatement (http://java.sun.com/j2se/1.5.0/docs/api/java/sql/CallableStatement.html)
- java.sql.Connection (http://java.sun.com/j2se/1.5.0/docs/api/java/sql/Connection.html)
- java.sql.PreparedStatement (http://java.sun.com/j2se/1.5.0/docs/api/java/sql/PreparedStatement.html)
- java.sql.ResultSet (http://java.sun.com/j2se/1.5.0/docs/api/java/sql/ResultSet.html)
- java.sql.ResultSetMetaData (http://java.sun.com/j2se/1.5.0/docs/api/java/sql/ResultSetMetaData.html)
- java.sql.Statement (http://java.sun.com/j2se/1.5.0/docs/api/java/sql/Statement.html)
- java.sql.Timestamp (http://java.sun.com/j2se/1.5.0/docs/api/java/sql/Timestamp.html)

The following table lists java.sql.DriverManager (http://java.sun.com/j2se/1.5.0/docs/api/java/sql/DriverManager.html) methods that the JDBC driver uses:

<table>
<thead>
<tr>
<th>Method Signature</th>
<th>JDBC Version</th>
<th>Required?</th>
</tr>
</thead>
<tbody>
<tr>
<td>getConnection(String url, java.util.Properties info):java.sql.Connection</td>
<td>1</td>
<td>yes¹</td>
</tr>
<tr>
<td>setLogStream(java.io.PrintStream out):void</td>
<td>1</td>
<td>no</td>
</tr>
</tbody>
</table>

¹Use one method or the other.

The following table lists java.sql.CallableStatement (http://java.sun.com/j2se/1.5.0/docs/api/java/sql/CallableStatement.html) methods that the JDBC driver uses:

<table>
<thead>
<tr>
<th>Method Signature</th>
<th>JDBC Version</th>
<th>Required?</th>
</tr>
</thead>
<tbody>
<tr>
<td>getBigDecimal(int parameterIndex, int scale):java.math.BigDecimal</td>
<td>1</td>
<td>yes</td>
</tr>
<tr>
<td>Method Signature</td>
<td>JDBC Version</td>
<td>Required?</td>
</tr>
<tr>
<td>------------------</td>
<td>--------------</td>
<td>-----------</td>
</tr>
<tr>
<td><code>getBoolean(int parameterIndex):boolean</code></td>
<td>1</td>
<td>yes</td>
</tr>
<tr>
<td><code>getBoolean(String parameterName):boolean</code></td>
<td>3</td>
<td>no</td>
</tr>
<tr>
<td><code>getByte(int parameterIndex):byte</code></td>
<td>1</td>
<td>yes</td>
</tr>
<tr>
<td><code>getByte(String parameterName):byte</code></td>
<td>3</td>
<td>no</td>
</tr>
<tr>
<td><code>getBytes(int parameterIndex):byte[]</code></td>
<td>1</td>
<td>yes</td>
</tr>
<tr>
<td><code>getBytes(String parameterName):byte[]</code></td>
<td>3</td>
<td>no</td>
</tr>
<tr>
<td><code>getDate(int parameterIndex):java.sql.Date</code></td>
<td>1</td>
<td>yes</td>
</tr>
<tr>
<td><code>getDate(String parameterName):java.sql.Date</code></td>
<td>3</td>
<td>no</td>
</tr>
<tr>
<td><code>getDouble(int parameterIndex):double</code></td>
<td>1</td>
<td>no</td>
</tr>
<tr>
<td><code>getDouble(String parameterName):double</code></td>
<td>3</td>
<td>no</td>
</tr>
<tr>
<td><code>getFloat(int parameterIndex):float</code></td>
<td>1</td>
<td>yes</td>
</tr>
<tr>
<td><code>getFloat(String parameterName):float</code></td>
<td>3</td>
<td>no</td>
</tr>
<tr>
<td><code>getInt(int parameterIndex):int</code></td>
<td>1</td>
<td>yes</td>
</tr>
<tr>
<td><code>getInt(String parameterName)</code></td>
<td>3</td>
<td>no</td>
</tr>
<tr>
<td><code>getLong(int parameterIndex):long</code></td>
<td>1</td>
<td>yes</td>
</tr>
<tr>
<td><code>getLong(String parameterName):long</code></td>
<td>3</td>
<td>no</td>
</tr>
<tr>
<td><code>getShort(int parameterIndex):short</code></td>
<td>1</td>
<td>yes</td>
</tr>
<tr>
<td><code>getShort(String parameterName):short</code></td>
<td>3</td>
<td>no</td>
</tr>
<tr>
<td><code>getString(int parameterIndex):String</code></td>
<td>1</td>
<td>yes</td>
</tr>
<tr>
<td><code>getString(String parameterName):String</code></td>
<td>3</td>
<td>no</td>
</tr>
<tr>
<td><code>getTime(int parameterIndex):java.sql.Time</code></td>
<td>1</td>
<td>yes</td>
</tr>
<tr>
<td><code>getTime(String parameterName):java.sql.Time</code></td>
<td>3</td>
<td>no</td>
</tr>
<tr>
<td><code>getTimestamp(int parameterIndex):java.sql.Timestamp</code></td>
<td>1</td>
<td>yes</td>
</tr>
<tr>
<td><code>getTimestamp(String parameterName):java.sql.Timestamp</code></td>
<td>3</td>
<td>no</td>
</tr>
<tr>
<td><code>registerOutParameter(int parameterIndex, int sqlType):void</code></td>
<td>1</td>
<td>yes</td>
</tr>
<tr>
<td><code>wasNull():boolean</code></td>
<td>1</td>
<td>yes</td>
</tr>
</tbody>
</table>

The following table lists java.sql.Connection (http://java.sun.com/j2se/1.5.0/docs/api/java/sql/Connection.html) methods that the JDBC driver uses:
### Table G-3  java.sql.Connection Methods

<table>
<thead>
<tr>
<th>Method Signature</th>
<th>JDBC Version</th>
<th>Required?</th>
</tr>
</thead>
<tbody>
<tr>
<td>close():void</td>
<td>1</td>
<td>yes</td>
</tr>
<tr>
<td>commit():void</td>
<td>1</td>
<td>no</td>
</tr>
<tr>
<td>createStatement():java.sql.Statement</td>
<td>1</td>
<td>yes</td>
</tr>
<tr>
<td>getAutoCommit():boolean</td>
<td>1</td>
<td>no</td>
</tr>
<tr>
<td>getMetaData():java.sql.DatabaseMetaData</td>
<td>1</td>
<td>yes</td>
</tr>
<tr>
<td>getTransactionIsolation():int</td>
<td>1</td>
<td>no</td>
</tr>
<tr>
<td>getWarnings():java.sql.SQLWarning</td>
<td>1</td>
<td>no</td>
</tr>
<tr>
<td>isClosed():boolean</td>
<td>1</td>
<td>no</td>
</tr>
<tr>
<td>prepareCall(String sql):java.sql.CallableStatement</td>
<td>1</td>
<td>no</td>
</tr>
<tr>
<td>prepareStatement(String sql):java.sql.PreparedStatement</td>
<td>1</td>
<td>yes</td>
</tr>
<tr>
<td>rollback():void</td>
<td>1</td>
<td>no</td>
</tr>
<tr>
<td>setAutoCommit(boolean autoCommit):void</td>
<td>1</td>
<td>no</td>
</tr>
<tr>
<td>setTransactionIsolation(int level):void</td>
<td>1</td>
<td>no</td>
</tr>
</tbody>
</table>

The following table lists [java.sql.PreparedStatement](http://java.sun.com/j2se/1.5.0/docs/api/java/sql/PreparedStatement.html) methods that the JDBC driver uses:

### Table G-4  java.sql.PreparedStatement Methods

<table>
<thead>
<tr>
<th>Method Signature</th>
<th>JDBC Version</th>
<th>Required?</th>
</tr>
</thead>
<tbody>
<tr>
<td>clearParameters() :void</td>
<td>1</td>
<td>no</td>
</tr>
<tr>
<td>execute():boolean</td>
<td>1</td>
<td>yes</td>
</tr>
<tr>
<td>executeQuery():java.sql.ResultSet</td>
<td>1</td>
<td>yes</td>
</tr>
<tr>
<td>executeUpdate():int</td>
<td>1</td>
<td>yes</td>
</tr>
<tr>
<td>setBigDecimal(int parameterIndex, java.math.BigDecimal x):void</td>
<td>1</td>
<td>yes</td>
</tr>
<tr>
<td>setBoolean(int parameterIndex, boolean x):void</td>
<td>1</td>
<td>yes</td>
</tr>
<tr>
<td>setByte(int parameterIndex, byte x):void</td>
<td>1</td>
<td>yes</td>
</tr>
<tr>
<td>setBytes(int parameterIndex, byte x[]):void</td>
<td>1</td>
<td>yes</td>
</tr>
<tr>
<td>setDate(int parameterIndex, java.sql.Date x):void</td>
<td>1</td>
<td>yes</td>
</tr>
<tr>
<td>setDouble(int parameterIndex, double x):void</td>
<td>1</td>
<td>yes</td>
</tr>
<tr>
<td>setFloat(int parameterIndex, float x):void</td>
<td>1</td>
<td>yes</td>
</tr>
<tr>
<td>setInt(int parameterIndex, int x):void</td>
<td>1</td>
<td>yes</td>
</tr>
<tr>
<td>setLong(int parameterIndex, long x):void</td>
<td>1</td>
<td>yes</td>
</tr>
</tbody>
</table>
The following table lists `java.sql.ResultSet` (http://java.sun.com/j2se/1.5.0/docs/api/java/sql/ResultSet.html) methods that the JDBC driver uses:

<table>
<thead>
<tr>
<th>Method Signature</th>
<th>JDBC Version</th>
<th>Required?</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>setNull(int parameterIndex, int sqlType):void</code></td>
<td>1</td>
<td>yes</td>
</tr>
<tr>
<td><code>setShort(int parameterIndex, short x):void</code></td>
<td>1</td>
<td>yes</td>
</tr>
<tr>
<td><code>setString(int parameterIndex, String x):void</code></td>
<td>1</td>
<td>yes</td>
</tr>
<tr>
<td><code>setTime(int parameterIndex, java.sql.Time x):void</code></td>
<td>1</td>
<td>yes</td>
</tr>
<tr>
<td><code>setTimestamp(int parameterIndex, java.sql.Timestamp x):void</code></td>
<td>1</td>
<td>yes</td>
</tr>
</tbody>
</table>

Table G-5  `java.sql.ResultSet` Methods

<table>
<thead>
<tr>
<th>Method Signature</th>
<th>JDBC Version</th>
<th>Required?</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>close():void</code></td>
<td>1</td>
<td>yes</td>
</tr>
<tr>
<td><code>getBigDecimal(int columnIndex, int scale):java.math.BigDecimal</code></td>
<td>1</td>
<td>yes</td>
</tr>
<tr>
<td><code>getBigDecimal(String columnName, int scale):java.math.BigDecimal</code></td>
<td>1</td>
<td>yes</td>
</tr>
<tr>
<td><code>getBinaryStream(int columnIndex):java.io.InputStream</code></td>
<td>1</td>
<td>yes</td>
</tr>
<tr>
<td><code>getBinaryStream(String columnName):java.io.InputStream</code></td>
<td>1</td>
<td>yes</td>
</tr>
<tr>
<td><code>getBoolean(int columnIndex):boolean</code></td>
<td>1</td>
<td>yes</td>
</tr>
<tr>
<td><code>getBoolean(String columnName):boolean</code></td>
<td>1</td>
<td>yes</td>
</tr>
<tr>
<td><code>getByte(int columnIndex):byte</code></td>
<td>1</td>
<td>yes</td>
</tr>
<tr>
<td><code>getByte(String columnName):byte</code></td>
<td>1</td>
<td>yes</td>
</tr>
<tr>
<td><code>getBytes(int columnIndex):byte[]</code></td>
<td>1</td>
<td>yes</td>
</tr>
<tr>
<td><code>getBytes(String columnName):byte[]</code></td>
<td>1</td>
<td>yes</td>
</tr>
<tr>
<td><code>getDate(int columnIndex):java.sql.Date</code></td>
<td>1</td>
<td>yes</td>
</tr>
<tr>
<td><code>getDate(String columnName):java.sql.Date</code></td>
<td>1</td>
<td>yes</td>
</tr>
<tr>
<td><code>getFloat(int columnIndex):float</code></td>
<td>1</td>
<td>yes</td>
</tr>
<tr>
<td><code>getFloat(String columnName):float</code></td>
<td>1</td>
<td>yes</td>
</tr>
<tr>
<td><code>getInt(int columnIndex):int</code></td>
<td>1</td>
<td>yes</td>
</tr>
<tr>
<td><code>getInt(String columnName):int</code></td>
<td>1</td>
<td>yes</td>
</tr>
<tr>
<td><code>getLong(int columnIndex):long</code></td>
<td>1</td>
<td>yes</td>
</tr>
<tr>
<td><code>getLong(String columnName):long</code></td>
<td>1</td>
<td>yes</td>
</tr>
<tr>
<td><code>getMetaData():java.sql.ResultSetMetaData</code></td>
<td>1</td>
<td>no</td>
</tr>
<tr>
<td><code>getShort(int columnIndex):short</code></td>
<td>1</td>
<td>yes</td>
</tr>
<tr>
<td><code>getShort(String columnName):short</code></td>
<td>1</td>
<td>yes</td>
</tr>
<tr>
<td>Method Signature</td>
<td>JDBC Version</td>
<td>Required?</td>
</tr>
<tr>
<td>----------------------------------</td>
<td>--------------</td>
<td>-----------</td>
</tr>
<tr>
<td>getString(int columnIndex):String</td>
<td>1</td>
<td>yes</td>
</tr>
<tr>
<td>getString(String columnName):String</td>
<td>1</td>
<td>yes</td>
</tr>
<tr>
<td>getTime(int columnIndex):java.sql.Time</td>
<td>1</td>
<td>yes</td>
</tr>
<tr>
<td>getTime(String columnName):java.sql.Time</td>
<td>1</td>
<td>yes</td>
</tr>
<tr>
<td>getTimestamp(int columnIndex):java.sql.Timestamp</td>
<td>1</td>
<td>yes</td>
</tr>
<tr>
<td>getTimestamp(String columnName):java.sql.Timestamp</td>
<td>1</td>
<td>yes</td>
</tr>
<tr>
<td>getWarnings():java.sql.SQLWarning</td>
<td>1</td>
<td>no</td>
</tr>
</tbody>
</table>

The following table lists `java.sql.ResultSetMetaData` methods that the JDBC driver uses:

**Table G-6 java.sql.ResultSetMetaData Methods**

<table>
<thead>
<tr>
<th>Method Signature</th>
<th>JDBC Version</th>
<th>Required?</th>
</tr>
</thead>
<tbody>
<tr>
<td>getColumnCount():int</td>
<td>1</td>
<td>yes</td>
</tr>
<tr>
<td>getColumnName(int column):String</td>
<td>1</td>
<td>no</td>
</tr>
<tr>
<td>getColumnType(int column):int</td>
<td>1</td>
<td>no</td>
</tr>
</tbody>
</table>

The following table lists `java.sql.Statement` methods that the JDBC driver uses:

**Table G-7 java.sql.Statement Methods**

<table>
<thead>
<tr>
<th>Method Signature</th>
<th>JDBC Version</th>
<th>Required?</th>
</tr>
</thead>
<tbody>
<tr>
<td>addBatch(java.lang.String sql):void</td>
<td>2</td>
<td>no</td>
</tr>
<tr>
<td>clearBatch():void</td>
<td>2</td>
<td>no</td>
</tr>
<tr>
<td>clearWarnings():void</td>
<td>1</td>
<td>no</td>
</tr>
<tr>
<td>close():void</td>
<td>1</td>
<td>yes</td>
</tr>
<tr>
<td>execute(java.lang.String sql):boolean</td>
<td>1</td>
<td>yes</td>
</tr>
<tr>
<td>executeBatch():int[]</td>
<td>2</td>
<td>no</td>
</tr>
<tr>
<td>executeUpdate(String sql):int</td>
<td>1</td>
<td>yes</td>
</tr>
<tr>
<td>executeQuery(String sql):java.sql.ResultSet</td>
<td>1</td>
<td>yes</td>
</tr>
<tr>
<td>getGeneratedKeys():java.sql.ResultSet</td>
<td>3</td>
<td>no</td>
</tr>
<tr>
<td>getMoreResults():boolean</td>
<td>1</td>
<td>no</td>
</tr>
<tr>
<td>getResultSet():java.sql.ResultSet</td>
<td>1</td>
<td>yes</td>
</tr>
<tr>
<td>getUpdateCount():int</td>
<td>1</td>
<td>no</td>
</tr>
</tbody>
</table>
The following table lists `java.sql.Timestamp` methods that the JDBC driver uses:

<table>
<thead>
<tr>
<th>Method Signature</th>
<th>JDBC Version</th>
<th>Required?</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>getWarnings()</code>;<code>java.sql.SQLWarning</code></td>
<td>1</td>
<td>no</td>
</tr>
</tbody>
</table>

The following table lists `java.sql.Timestamp` methods that the JDBC driver uses:

<table>
<thead>
<tr>
<th>Method Signature</th>
<th>JDBC Version</th>
<th>Required?</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>getNanos():int</code></td>
<td>1</td>
<td>yes</td>
</tr>
<tr>
<td><code>getTime():long</code></td>
<td>1</td>
<td>yes</td>
</tr>
<tr>
<td><code>setNanos(int n):void</code></td>
<td>1</td>
<td>yes</td>
</tr>
<tr>
<td><code>setTime(long time):void</code></td>
<td>1</td>
<td>yes</td>
</tr>
<tr>
<td><code>toString ():String</code></td>
<td>1</td>
<td>yes</td>
</tr>
</tbody>
</table>
This section contains the DTD for third-party JDBC descriptor files.

```xml
<?xml version="1.0" encoding="UTF-8"?>
<!ELEMENT actions (exec-sql | check-for-closed-connection | fetch metadata | rollback)>*
<!ELEMENT add-default-values-on-view-insert (#PCDATA)>
<!ELEMENT authentication (regular-expression | sql-state | error-code | sql-state-class | error-code-range | actions)>*
<!ELEMENT check-for-closed-connection EMPTY>
<!ELEMENT column-position-comparator (#PCDATA)>
<!ELEMENT connection-properties (property*)>
<!ELEMENT connectivity (regular-expression | sql-state | error-code | sql-state-class | error-code-range | actions)>*
<!ELEMENT current-timestamp-stmt (#PCDATA)>
<!ELEMENT error-code (value)>
<!ATTLIST error-code
description CDATA #IMPLIED>
<!ELEMENT error-code-range (from, to)>
<!ATTLIST error-code-range
description CDATA #IMPLIED>
<!ELEMENT errors (connectivity | authentication | retry | fatal)>*
<!ELEMENT exclude-table-filter (#PCDATA)>
<!ELEMENT exec-sql (#PCDATA)>
<!ELEMENT fatal (regular-expression | sql-state | error-code | sql-state-class | error-code-range | actions)>*
<!ELEMENT fetch-metadata EMPTY>
<!ELEMENT from (#PCDATA)>
<!ELEMENT function-return-method (#PCDATA)>
<!ELEMENT handle-stmt-results (#PCDATA)>
<!ELEMENT identity (name?, target-database?, jdbc-type?, jdbc-class?)>
<!ELEMENT import (#PCDATA)>
<!ELEMENT imports (import*)>
<!ELEMENT include-table-filter (#PCDATA)>
<!ELEMENT jdbc-class (#PCDATA)>
<!ELEMENT jdbc-driver (imports?, identity, (metadata-override | connection-properties | sql-type-map | options | errors)*)>
<!ELEMENT jdbc-type (#PCDATA)>
<!ELEMENT key (#PCDATA)>
<!ELEMENT left-outer-join-operator (#PCDATA)>
<!ELEMENT lock-generator-class (#PCDATA)>
<!ELEMENT metadata-override (supports-schemas-in-procedure-calls?)>
<!ELEMENT minimal-metadata (#PCDATA)>
<!ELEMENT name (#PCDATA)>
<!ELEMENT options (lock-generator-class | supports-schemas-in metadata-retrieval | time-translator-class | column-position comparator | use-manual-transactions | minimal-metadata | transaction isolation-level | use-single-connection | exclude-table-filter | include-table-filter | left-outer-join-operator | current-timestamp stmt | add-default-values-on-view-insert | reuse-statements |
function-return-method | handle-stmt-results)*
<!ELEMENT property (key, value)>
<!ELEMENT regular-expression (value)>
<!ELEMENT retry (regular-expression | sql-state | error-code | sql state-class | error-code-range | actions)*>
<!ELEMENT reuse-statements (#PCDATA)>
<!ELEMENT rollback EMPTY>
<!ELEMENT sql-state (value)>
<!ATTLIST sql-state
description CDATA #IMPLIED>
<!ELEMENT sql-state-class (value)>
<!ATTLIST sql-state-class
description CDATA #IMPLIED>
<!ELEMENT sql-type-map (type*)>
<!ELEMENT supports-schemas-in-metadata-retrieval (#PCDATA)>
<!ELEMENT supports-schemas-in-procedure-calls (#PCDATA)>
<!ELEMENT target-database (#PCDATA)>
<!ELEMENT time-translator-class (#PCDATA)>
<!ELEMENT to (#PCDATA)>
<!ELEMENT transaction-isolation-level (#PCDATA)>
<!ELEMENT type (from, to)>
<!ELEMENT use-manual-transactions (#PCDATA)>
<!ELEMENT use-single-connection (#PCDATA)>
<!ELEMENT value (#PCDATA)>
Third-Party JDBC Driver Descriptor Import DTD

This section contains the DTD for third-party JDBC descriptor import files.

```xml
<?xml version="1.0" encoding="UTF-8"?>
<!ELEMENT actions (exec-sql | check-for-closed-connection | fetch-metadata | rollback)*>
<!ELEMENT add-default-values-on-view-insert (#PCDATA)>
<!ELEMENT authentication (regular-expression | sql-state | error-code | sql-state-class | error-code-range | actions)*>
<!ELEMENT check-for-closed-connection EMPTY>
<!ELEMENT column-position-comparator (#PCDATA)>
<!ELEMENT connection-properties (property*)>
<!ELEMENT connectivity (regular-expression | sql-state | error-code | sql-state-class | error-code-range | actions)*>
<!ELEMENT current-timestamp-stmt (#PCDATA)>
<!ELEMENT error-code (value)>
<!ATTLIST error-code
description CDATA #IMPLIED>
<!ELEMENT error-code-range (from, to)>
<!ATTLIST error-code-range
description CDATA #IMPLIED>
<!ELEMENT errors (connectivity | authentication | retry | fatal)*>
<!ELEMENT exclude-table-filter (#PCDATA)>
<!ELEMENT exec-sql (#PCDATA)>
<!ELEMENT fatal (regular-expression | sql-state | error-code | sql-state-class | error-code-range | actions)*>
<!ELEMENT fetch-metadata EMPTY>
<!ELEMENT from (#PCDATA)>
<!ELEMENT function-return-method (#PCDATA)>
<!ELEMENT handle-stmt-results (#PCDATA)>
<!ELEMENT jdbc-driver (metadata-override | connection-properties | sql-type-map | options | errors)*>
<!ELEMENT key (#PCDATA)>
<!ELEMENT left-outer-join-operator (#PCDATA)>
<!ELEMENT lock-generator-class (#PCDATA)>
<!ELEMENT metadata-override (supports-schemas-in-procedure-calls?)>
<!ELEMENT minimal-metadata (#PCDATA)>
<!ELEMENT property (key, value)>
<!ELEMENT retry (regular-expression | sql-state | error-code | sql-state-class | error-code-range | actions)*>
<!ELEMENT reuse-statements (#PCDATA)>
<!ELEMENT rollback EMPTY>
```
<!ELEMENT sql-state (value)>
<!ATTLIST sql-state
    description CDATA #IMPLIED>
>
<!ELEMENT sql-state-class (value)>
<!ATTLIST sql-state-class
    description CDATA #IMPLIED>
>
<!ELEMENT sql-type-map (type*)>
<!ELEMENT supports-schemas-in-metadata-retrieval (#PCDATA)>
<!ELEMENT supports-schemas-in-procedure-calls (#PCDATA)>
<!ELEMENT time-translator-class (#PCDATA)>
<!ELEMENT to (#PCDATA)>
<!ELEMENT transaction-isolation-level (#PCDATA)>
<!ELEMENT type (from, to)>
<!ELEMENT use-manual-transactions (#PCDATA)>
<!ELEMENT use-single-connection (#PCDATA)>
<!ELEMENT value (#PCDATA)>
Database Descriptor DTD

This section contains the DTD for database descriptor files.

```xml
<?xml version="1.0" encoding="UTF-8"?>
<!ELEMENT add-default-values-on-view-insert (#PCDATA)>
<!ELEMENT column-position-comparator (#PCDATA)>
<!ELEMENT current-timestamp-stmt (#PCDATA)>
<!ELEMENT database (imports?, identity, options?)>
<!ELEMENT exclude-table-filter (#PCDATA)>
<!ELEMENT function-return-method (#PCDATA)>
<!ELEMENT handle-stmt-results (#PCDATA)>
<!ELEMENT include-table-filter (#PCDATA)>
<!ELEMENT identity (name?, regex-name?, regex-version?)>
<!ELEMENT import (#PCDATA)>
<!ELEMENT imports (import*)>
<!ELEMENT left-outer-join-operator (#PCDATA)>
<!ELEMENT lock-generator-class (#PCDATA)>
<!ELEMENT minimal-metadata (#PCDATA)>
<!ELEMENT name (#PCDATA)>
<!ELEMENT regex-name (#PCDATA)>
<!ELEMENT regex-version (#PCDATA)>
<!ELEMENT reuse-statements (#PCDATA)>
<!ELEMENT supports-schemas-in-metadata-retrieval (#PCDATA)>
<!ELEMENT time-translator-class (#PCDATA)>
<!ELEMENT transaction-isolation-level (#PCDATA)>
<!ELEMENT use-manual-transactions (#PCDATA)>
<!ELEMENT use-single-connection (#PCDATA)>
```
This section contains the DTD for database descriptor import files.

```xml
<?xml version="1.0" encoding="UTF-8"?>
<!ELEMENT add-default-values-on-view-insert (#PCDATA)>  
<!ELEMENT column-position-comparator (#PCDATA)>   
<!ELEMENT current-timestamp-stmt (#PCDATA)>        
<!ELEMENT exclude-table-filter (#PCDATA)>          
<!ELEMENT function-return-method (#PCDATA)>        
<!ELEMENT handle-stmt-results (#PCDATA)>           
<!ELEMENT include-table-filter (#PCDATA)>          
<!ELEMENT database (options?)>                      
<!ELEMENT left-outer-join-operator (#PCDATA)>      
<!ELEMENT lock-generator-class (#PCDATA)>          
<!ELEMENT minimal-metadata (#PCDATA)>              
<!ELEMENT reuse-statements (#PCDATA)>              
<!ELEMENT supports-schemas-in-metadata-retrieval (#PCDATA)>  
<!ELEMENT time-translator-class (#PCDATA)>        
<!ELEMENT transaction-isolation-level (#PCDATA)>  
<!ELEMENT use-manual-transactions (#PCDATA)>       
<!ELEMENT use-single-connection (#PCDATA)>        
```
Policy Example: Triggerless Future Event Processing

The following example assumes that a “commence” attribute exists and does the following:

- Holds the time stamp value indicating when an event should be processed
- Contains an integer or Java string time stamp value. See “Time Syntax” on page 57.

```xml
<policy
xmlns:Timestamp="http://www.novell.com/nxsl/java/java.sql.Timestamp"
xmlns:TimestampUtil="http://www.novell.com/nxsl/java/
com.novell.nds.dirxml.driver.jdbc.db.TimestampUtil"
xmlns:jdbc="urn:dirxml:jdbc">
  <rule>
    <description>Get commencement date from datasource.</description>
    <conditions>
      <and>
        <if-xpath op="true">.</if-xpath>
      </and>
    </conditions>
    <actions>
      <do-set-local-variable name="commence">
        <arg-string>
          <token-src-attr class-name="User" name="commence"/>
        </arg-string>
      </do-set-local-variable>
    </actions>
  </rule>
  <rule>
    <description>Break if commencement date unavailable.</description>
    <conditions>
      <and>
        <if-local-variable name="commence" op="equal"/>
      </and>
    </conditions>
    <actions>
      <do-break/>
    </actions>
  </rule>
  <rule>
    <description>Parse times.</description>
    <conditions>
      <and>
        <if-xpath op="true">.</if-xpath>
      </and>
    </conditions>
    <actions>
      <do-set-local-variable name="dbTime">
        <arg-object>
          <token-xpath expression="Timestamp:valueOf(@jdbc:database-local-time)"/>
        </arg-object>
      </do-set-local-variable>
      <do-set-local-variable name="eventTime">
        <!-- event time calculation or manipulation -->
      </do-set-local-variable>
    </actions>
  </rule>
</policy>
```
<arg-object>
    <token-xpath expression="Timestamp:valueOf($commence)="/>
</arg-object>
</do-set-local-variable>
</actions>
</rule>

<rule>
    <description>Is commencement date after database time?</description>
    <conditions>
        <and>
            <if-xpath op="true">.</if-xpath>
        </and>
    </conditions>
    <actions>
        <do-set-local-variable name="after">
            <arg-string>
                <token-xpath expression="TimestampUtil:after($eventTime, $dbTime)="/>
            </arg-string>
        </do-set-local-variable>
    </actions>
</rule>

<rule>
    <description>Retry if future event.</description>
    <conditions>
        <and>
            <if-local-variable name="after" op="equal">true</if-local-variable>
        </and>
    </conditions>
    <actions>
        <do-status level="retry">
            <arg-string>
                <token-text xml:space="preserve">Future event detected.</token-text>
            </arg-string>
        </do-status>
    </actions>
</rule>
</policy>
Setting Up an OCI Client on Linux

- “Downloading the Instant Client” on page 229
- “Setting Up the OCI Client” on page 229
- “Configuring the OCI Driver” on page 230

Downloading the Instant Client

1. Download the Oracle Instant Client (instantclient-basic-linux32-11.1.0.7.zip).
2. Download the Oracle SQL Plus binary (instantclient-sqlplus-linux32-11.1.0.7.zip).

Setting Up the OCI Client

Set up the Oracle Instant Client on the machine where the JDBC driver is running (not on the machine where Oracle is running).

1. Log into Linux as root, and create the following structure:
   /oracle /oracle/client /oracle/client/bin /oracle/client/lib /oracle/client/network/admin
2. Unzip all files from instantclient-basic-linux32-11.1.0.7.zip to /oracle/client/lib.
3. Unzip all files from instantclient-sqlplus-linux32-11.1.0.7.zip to /oracle/client/bin.
4. Copy libsqlplus.so from /oracle/client/bin to /oracle/client/lib.
5. Copy libsqlplusic.so from /oracle/client/bin to /oracle/client/lib.
6. Using chmod, ensure that the file sqlplus in /oracle/client/bin is executable.
7. Copy a valid tnsnames.ora into /oracle/client/network/admin.
   If you don’t have a tnsnames.ora file, use the Oracle configuration tool to create one.
   Make sure that the tnsnames.ora filename is in lowercase.
8. Modify the profile.local file by adding the following lines:
   export LD_LIBRARY_PATH=$LD_LIBRARY_PATH:/oracle/client/lib
   export TNS_ADMIN=/oracle/client/network/admin
   export PATH=$PATH:/oracle/client/lib

   The profile.local file is in the /etc folder. If the file doesn’t exist, create one. The file can consist of only the three export lines.
   The profile.local file extends the LD_LIBRARY_PATH, sets TNS_ADMIN, and extends the PATH. This file is read when the server boots.
9 Ensure that the exports in the `profile.local` file are always valid.

10 Copy the appropriate jar files to the Identity Manager classes directory.
   These `.jar` files are supplied with the Instant Client.
   The Identity Manager classes directory is the directory where your driver is located.

11 Start SQL Plus with the following example command (assuming that the directory is `/oracle/client/bin`):
   ```bash
   ./sqlplus username/password@sid
   ```

## Configuring the OCI Driver

To configure the driver, customize the driver's URL syntax. See Table 14-20 on page 181.

An example URL syntax is `jdbc:oracle:oci8:@ORACLE10`. In this example, `ORACLE10` is the connection string in the `tnsnames.ora` file.

*Figure M-1  Example tnsnames.ora File*
Sybase can execute stored procedures in two distinct modes: chained and unchained. Depending upon the configuration of the Identity Manager JDBC driver and stored procedures in a database, various problems can arise. This section can help you understand and resolve those problems.

- “Error Codes” on page 231
- “Procedures and Modes” on page 232

**Error Codes**

- “Error 226: SET CHAINED command not allowed within multi-statement transaction” on page 231
- “Error 7112: Stored procedure 'x' may be run only in chained transaction mode” on page 231
- “Error 7113: Stored procedure 'x' may be run only in unchained transaction mode” on page 232

**Error 226: SET CHAINED command not allowed within multi-statement transaction**

  Effect: Throws the exception of com.sybase.jdbc2.jdbc.SybSQLException with error code 226 and an SQL state of ZZZZZ.

  Cause: This exception is usually caused by a defect in older versions of jConnect.


**Error 7112: Stored procedure 'x' may be run only in chained transaction mode**

  Effect: Throws the exception of com.sybase.jdbc2.jdbc.SybSQLException with error code 7712 and an SQL state of ZZZZZ.

  Cause: The stored procedure was created in chained mode, or later altered to run in chained mode, but the driver is currently running in unchained mode. The probable cause is that the Use Manual Transactions? parameter is set to False. Another possibility is that the transaction type has been overridden to auto in a policy.

  Solution: Do one of the following:

  - Use stored procedure sp_procxmode to change the stored procedure's mode to unchained or anymode (preferred).
  - Change the driver's Use Manual Transactions? parameter to True, or change the policy transaction type to manual.
Error 7113: Stored procedure 'x' may be run only in unchained transaction mode

Effect: Throws the exception com.sybase.jdbc2.jdbc.SybSQLException with error code 7713 and an SQL state of ZZZZZ.

Cause: The stored procedure was created in unchained mode, or later altered to run in unchained mode, but the driver is currently running in chained mode. The probable cause is that the Use Manual Transactions? parameter is set to True. Another possibility is that the transaction type has been overridden to manual in policy.

Solution: Do one of the following:

- Use stored procedure sp_procxmode to change the stored procedure's mode to chained or anymode (preferred).
- Change the driver's Use Manual Transactions? parameter to False, or change the policy transaction type to auto.

If you set use-manual-transactions to False, all transactions consist of a maximum of one statement.

Procedures and Modes

- “Using Stored Procedure sp_procxmode” on page 232
- “Chained and Unchained Modes” on page 232
- “Managing Transactions in a Policy” on page 233
- “Useful Links” on page 233

Using Stored Procedure sp_procxmode

The preferred way to avoid errors 7112 and 7113 is to alter all stored procedures invoked directly or indirectly by the driver (via triggers, for example) to run in both chained and unchained mode. To alter a procedure, invoke the sp_procxmode procedure with two arguments:

- The procedure name
- The mode

The following example illustrates how to invoke the sp_procxmode procedure from the isql command line:

client:sp_procxmode my_procedure, anymode go

Of course, not all customers are willing to alter stored procedure modes. Altering a procedure's mode might alter its runtime behavior, which could alter the behavior of other applications that invoke the procedure.

Chained and Unchained Modes

Unchained mode is Sybase's native way of executing SQL. A second mode, chained mode, was later added to make the database compatible with SQL standards.
Sybase provides a third-party JDBC driver called jConnect. The default mode of jConnect is unchained. Whenever the method `Connection.setAutoCommit(boolean autoCommit):void` is invoked, jConnect switches modes. See [java.sql Interface Connection](http://java.sun.com/j2se/1.4.2/docs/api/java/sql/Connection.html).

### Table N-1 Modes and Compatibility

<table>
<thead>
<tr>
<th>Mode</th>
<th>Compatibility</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chained</td>
<td>SQL-compatible mode</td>
</tr>
<tr>
<td>Unchained</td>
<td>Sybase native mode</td>
</tr>
</tbody>
</table>

If the Use Manual Transactions? parameter is set to False, the driver invokes `Connection.setAutoCommit(true)`. That is, the driver enters unchained mode. This is the normal processing mode for SELECT statements and SQL embedded in a policy where the transaction type is set to auto. See “Manual vs. Automatic Transactions” on page 139. When the driver is in this state, any chained stored procedures invoked directly or indirectly by the driver yield the 7112 error.

If the Use Manual Transactions? parameter is set to True, the driver invokes `Connection.setAutoCommit(false)`. That is, the driver enters chained mode. This is the normal processing mode for all statements except SELECT statements and SQL embedded in a policy where the transaction type is set to manual. See “Manual vs. Automatic Transactions” on page 139. When the driver is in this state, any unchained stored procedures invoked directly or indirectly by the driver yield the 7113 error.

### Managing Transactions in a Policy

For information on managing transactions in a policy, see “Manual vs. Automatic Transactions” on page 139.

### Useful Links

- Transaction modes and stored procedures ([http://manuals.sybase.com/onlinebooks/group-as/asg1250e/sqlug/@Generic__BookTextView/55096;hf=0;pt=55096#X](http://manuals.sybase.com/onlinebooks/group-as/asg1250e/sqlug/@Generic__BookTextView/55096;hf=0;pt=55096#X)) in the Transact-SQL User’s Guide
- Selecting the transaction mode and isolation level ([http://manuals.sybase.com/onlinebooks/group-as/asg1250e/sqlug/@Generic__BookTextView/53713;pt=53001](http://manuals.sybase.com/onlinebooks/group-as/asg1250e/sqlug/@Generic__BookTextView/53713;pt=53001)) in the Transact-SQL User’s Guide
Driver Properties

This section provides information about the Driver Configuration and Global Configuration Values properties for the JDBC driver and the Fan-out driver. These are the only unique properties for drivers. All other driver properties (Named Password, Engine Control Values, Log Level, and so forth) are common to all drivers. Refer to “Driver Properties” in the NetIQ Identity Manager Driver Administration Guide for information about the common properties.

The information is presented from the viewpoint of iManager. If a field is different in Designer, it is marked with a Designer icon.

- “Driver Configuration” on page 235
- “Global Configuration Values” on page 239

Driver Configuration

In iManager:

1. Click to display the Identity Manager Administration page.
2. Open the driver set that contains the driver whose properties you want to edit:
   2a. In the Administration list, click Identity Manager Overview.
   2b. If the driver set is not listed on the Driver Sets tab, use the Search In field to search for and display the driver set.
   2c. Click the driver set to open the Driver Set Overview page.
3. Locate the driver icon, then click the upper right corner of the driver icon to display the Actions menu.
4. Click Edit Properties to display the driver’s properties page.
   By default, the Driver Configuration page displays.

In Designer:

1. Open a project in the Modeler.
2. Right-click the driver icon or line, then select click Properties > Driver Configuration.

The Driver Configuration options are divided into the following sections:

- “Driver Module” on page 236
- “Authentication” on page 236
- “Startup Option” on page 236
- “Driver Parameters” on page 237
- “ECMAScript” on page 239
- “Global Configuration” on page 239
**Driver Module**

The driver module changes the driver from running locally to running remotely or the reverse.

**Java:** Use this option to specify the name of the Java class that is instantiated for the shim component of the driver. This class can be located in the `classes` directory as a class file, or in the `lib` directory as a `.jar` file. If this option is selected, the driver is running locally. Select this option to run the driver locally.

The Java class name is: `com.netiq.idm.driver.fanoutshim.FanoutDriverShim`.

**Native:** This option is not used with the REST driver.

**Connect to Remote Loader:** This option is not used for JDBC Fan-out driver. Used when the driver is connecting remotely to the connected system.

**Name:** Displays the Java class name.

**Driver Object Password:** Use this option to set a password for the driver object. If you are using the Fan-out Agent, you must enter a password on this page. This password is used by the Fan-out Agent to authenticate itself to the driver shim.

**Authentication**

The authentication section describes the parameters required for authentication to the connected database.

**Authentication ID:** Specify a user application ID. This ID is used to pass Identity Vault subscription information to the application. For example, `Administrator`.

**Connection Information (Designer only):** Specify the IP address or name of the server the application shim should communicate with.

**IMPORTANT:** The Remote Loader options are not applicable for the JDBC Fan-out drivers. The Fan-out drivers use the Fan-out Agent component to create multiple database instances.

**Driver Cache Limit (kilobytes):** Specify the maximum event cache file size (in KB). If it is set to zero, the file size is unlimited. select **Unlimited** option to set the file size to unlimited in Designer.

**Application Password:** Use the **Set Password** option to set the application authentication password.

**Remote loader password:** Use this option to update the remote loader password. This option is not used for the JDBC Fan-out driver.

**Startup Option**

The Startup Option section allows you to set the driver state when the Identity Manager server is started.

**Auto start:** The driver starts every time the Identity Manager server is started.

**Manual:** The driver does not start when the Identity Manager server is started. The driver must be started through Designer or iManager.
**Disabled**: The driver has a cache file that stores all of the events. When the driver is set to Disabled, this file is deleted and no new events are stored in the file until the driver state is changed to Manual or Auto Start.

**Driver Parameters**

The Driver Parameters section lets you configure the driver-specific parameters. When you change driver parameters, you tune driver behavior to align with your network environment.

The parameters are presented by category:

- “Driver Settings” on page 237
- “Normal JDBC Driver Settings” on page 238
- “Subscriber Settings” on page 238
- “Publisher Settings” on page 238

**Driver Settings**

**Fanout transport related parameters**: Select Show to view the transport related parameters for Fan-out drivers.

**Show Subscriber Event Queue parameters**: Select Show to view the subscriber event parameters. The options are:

- **SEND**: The queue for sending the subscriber events to the Fan-out Agent.
- **RECV**: The subscriber event receiving queue for receiving the subscriber events from Fan-out Agent.
- **DELAYED RECV**: The subscriber delayed event receiving queue is used for receiving the delayed subscriber events from FanOut Agent.

**Show Configuration Queue Parameters**: Select Show to view the configuration queue parameters. The options are SEND and RECV.

**Show Query-in Queue Parameters**: Select Show to view the query-in queue parameters. The options are SEND and RECV.

**Show Query-out Queue Parameters**: Select Show to view the query-out queue parameters. The options are SEND and RECV.

**Show Other Parameters**: Select Show to view the additional parameters.

- Configuration batch size: Specify the batch size for the Driver configuration document. The value is from 1 - 99999.

**Show Fanout Parameters**: Select Show to view the fan-out connection related information such as Fan-out Agent password, configuration information, Fan-out Agent shim password.

- **Fanout Shim Password**: Specify the password for the fan-out driver shim. After successful authentication, the FanOut Agent loads/creates the driver instances of the specified shim class name.
- **Fanout Agent Password**: Specify the password of Fan-out Agent you are connecting to. The Fan-out Agent establishes connection only after a valid authentication.
- **Encryption Key**: Specify the key to encrypt/decrypt the sensitive data before sending to the message queue(s).
• AMQ Keystore Key: Specify the full path to the keystore file.
• AMQ Keystore Password: Specify the keystore password.
• AMQ Truststore Path for SSL Certs: Specify the full path to the truststore file.
• AMQ Truststore Password: Specify the truststore.
• Fanout Shim classname: Specify shim classname that the Fan-out Agent loads when you start the any fan-out driver.
• Matching Attributes: Matching attributes that Fan-out Agent uses to match objects in delayed add events. Attribute names must be as per the schema of the connected system. NetIQ recommends that these attributes must be schema-mapped equivalent of the attributes that are used in the object matching policy.

Normal JDBC Driver Settings

For the normal JDBC driver setting, see Driver Parameters.

Subscriber Settings

Disable Subscriber: Select no (default) to allow flow of events from Identity Manager engine to the connected database.

Show primary key parameters: Select Show if you want to configure the primary key parameters.

• Generation/retrieval method (table-global): Select the desired option to generate/retrieve the primary key values. This setting is global for all tables and views. The options are as follows:
  • subscription event (default)
  • subscriber-generated
  • auto-generated / identity column
• Retrieval timing (table-global): Select the desired option to retrieve the primary key value. This setting is global for all tables and views. The options are:
  • before row insertion (default)
  • after row insertion
• Method and timing (table-global): Specify how and when the primary key values are generated or retrieved on a per table or view basis. This parameter overrides global method and timing settings. Use semicolon, comma, or space as the delimiter for multiple values. For example: usr("?=indirect.proc_idu()"); grp("indirect.proc_idg(idg)").

Disable statement-level locking: Select the appropriate option to disable statement locking. This option determines if explicit locking or database resources are disabled on the Subscriber channel. The value is set to no (default) by default.

Check update counts: Select yes (default) to enable the Subscriber channel to check for any updates after any of the insert, update, or delete statements are executed against the tables. This option ensures that the statements are resulting in updating the database. The value is set to yes (default) by default.

Publisher Settings

Disable the Publisher Channel: Select yes (default) to ignore the flow of events from the connected database to Identity Manager engine. The Fan-out driver implementation do not support the Publisher channel. By default, this option is disabled for the Fan-out driver configuration.
**Heartbeat interval (in minutes):** Specify the interval in minutes that the Publisher remain inactive before sending a heartbeat document.

**ECMAScript**

Displays an ordered list of ECMAScript resource files. The files contain extension functions for the driver that Identity Manager loads when the driver starts. You can add additional files, remove existing files, or change the order the files are executed.

**Global Configuration**

Displays an ordered list of Global Configuration objects. The objects contain extension GCV definitions for the driver that Identity Manager loads when the driver is started. You can add or remove the Global Configuration objects, and you can change the order in which the objects are executed.

**Global Configuration Values**

Global configuration values (GCVs) are values that can be used by the driver to control functionality. GCVs are defined on the driver or on the driver set. Driver set GCVs can be used by all drivers in the driver set. Driver GCVs can be used only by the driver on which they are defined.

The REST driver includes several predefined GCVs. You can also add your own if you discover you need additional ones as you implement policies in the driver.

To access the driver’s GCVs in iManager:

1. Click to display the Identity Manager Administration page.
2. Open the driver set that contains the driver whose properties you want to edit:
   1. In the Administration list, click Identity Manager Overview.
   2. If the driver set is not listed on the Driver Sets tab, use the Search In field to search for and display the driver set.
   3. Click the driver set to open the Driver Set Overview page.
3. Locate the driver icon, click the upper right corner of the driver icon to display the Actions menu, then click Edit Properties.
   or
   To add a GCV to the driver set, click Driver Set, then click Edit Driver Set properties.

To access the driver’s GCVs in Designer:

1. Open a project in the Modeler.
2. Right-click the driver icon or line, then select Properties > Global Configuration Values.
   or
   To add a GCV to the driver set, right-click the driver set icon, then click Properties > GCVs.

The global configuration values are organized as follows:
Global Configuration Values

The following global configuration values are used for database options and base configuration options.

**JDBC connection URL format used:** Specify the connection URL format used for the JDBC driver to connect to the databases. Use `<HOST>','<PORT>' and '<DB>' tokens to specify the location of host's IP address, port and database/SID in the connection URL.

**NOTE:** The tokens are case-sensitive and angle-brackets are mandatory since they are used as delimiters.

If you use the same fan-out driver to connect oracle pluggable database and oracle traditional database, the url template of the databases should be separated using a comma. For example: `jdbc:oracle:thin:@<HOST>;<PORT>/<DB>, jdbc:oracle:thin:@<HOST>:<PORT>:<DB>`

**Synchronization model:** Select the synchronization model. The synchronization options are: Direct and Indirect. Direct synchronization uses views to synchronize directly to existing tables of arbitrary structure. Indirect synchronization synchronizes to intermediate staging tables with a particular structure.

**UserName Column:** Specify the exact column name of the `usr` table that store the usernames.

Managed System Information

These settings help Identity Reporting to generate reports. There are different sections in the Managed System Information tab.

- “General Information” on page 240
- “System Ownership” on page 240
- “System Classification” on page 241
- “Connection and Miscellaneous Information” on page 241
- “JDBC FanOut Instances Information” on page 241

**General Information**

**Name:** Specify a descriptive name for the managed system.

**Description:** Specify a brief description of the managed system.

**Location:** Specify the physical location of the managed system.

**Vendor:** Specify Microsoft as the vendor of the managed system.

**Version:** Specify the version of the managed system.

**System Ownership**

**Business Owner:** Browse to and select the business owner in the Identity Vault for the connected application. You must select a user object, not a role, group, or container.

**Application Owner:** Browse to and select the application owner in the Identity Vault for the connected application. You must select a user object, not a role, group, or container.
System Classification

**Classification:** Select the classification of the connected application. This information is displayed in the reports. The options are:

- Mission-Critical
- Vital
- Not-Critical
- Other

If you select *Other*, you must specify a custom classification for the connected application.

**Environment:** Select the type of environment the connected application provides. The options are:

- Development
- Test
- Staging
- Production
- Other

If you select *Other*, you must specify a custom classification for the connected application.

Connection and Miscellaneous Information

**Connection and miscellaneous information:** This set of options is always set to **hide**, so that you don’t make changes to these options. These options are system options that are necessary for reporting to work.

JDBC FanOut Instances Information

These settings help to configure the Managed System Service related details of each JDBC FanOut instance. To create a new instance, click the plus sign and fill in the following information:

- **JDBC FanOut Instance Name:** Specify the descriptive name of the new logical instance of the managed system.
- **Show other configuration values:** Select *Show* to display additional information related to the FanOut instance. For more information, see "Managed System Information" on page 240.
- **Connection and miscellaneous information:** Select *Show* to display the system options. The options are:
  - Instance ID
  - Authentication IP Address
  - Authentication Port
  - Authentication ID
  - Database Schema
  - Type

**NOTE:** The connection information options are auto-generated and always set to **hide**.
Entitlements

There are multiple sections in the Entitlements tab. Depending on which packages you installed, different options are enabled or displayed.

- "Entitlements" on page 242
- "Data Collection" on page 242
- "Role Mapping" on page 242
- "Resource Mapping" on page 243
- "Parameter Format" on page 243
- "Entitlements Extensions" on page 243

Entitlements

Account Entitlement Value: Specify the entitlement value to assign for user account during the account creation. Identity Applications display this value to the user during account provisioning.

Use Entitlements to Control DB Accounts: Select True to enable the driver to manage database accounts based on the driver’s defined entitlements. Select False to disable management of database accounts based on the entitlements.

Use Group Entitlement: Select True to enable the driver to manage group membership based on the driver’s defined entitlements.

Allow Login Disabled in Subscriber Channel: Select True to enable the driver to control the flow of Login Disabled attribute in the Subscriber Channel and only on a regular attribute change.

Advanced Settings: Entitlement options that allow or deny additional functionality like data collection, role mapping, resource mapping, parameter format, and entitlement extensions. Leave these settings as default.

Data Collection

Data collection enables Identity Report to gather information to generate reports. For more information, see the Administrator Guide to NetIQ Identity Reporting.

Enable data collection: Select Yes to enable data collection for the driver through Data Collection Service by the Managed System Gateway driver. If you are not going to run reports on data collected by this driver, select No.

Allow data collection from user accounts: Select Yes to allow data collection by Data Collection Service for the user accounts.

Allow data collection from groups: Select Yes to allow data collection by Data Collection Service for groups.

Role Mapping

The Identity Manager Identity Applications allows you to map business roles with IT roles. For more information, see Identity Applications Administration in the NetIQ Identity Manager - Administrator’s Guide to the Identity Applications.

Enable role mapping: Select Yes to make this driver visible to Identity Applications.
**Allow mapping of user accounts**: Select Yes if you want to allow mapping of user accounts in Identity Applications. An account is required before a role, profile, or license can be granted through Identity Applications.

**Allow mapping of groups**: Select Yes if you want to allow mapping of groups in Identity Applications.

**Resource Mapping**

Identity Applications allow you to map resources to users. For more information, see the NetIQ Identity Manager - User’s Guide to the Identity Applications.

**Enables resource mapping**: Select Yes to make this driver visible to Identity Applications.

**Allow mapping of user accounts**: Select Yes if you want to allow mapping of user accounts in Identity Applications. An account is required before a role, profile, or license can be granted.

**Allow mapping of groups**: Select Yes if you want to allow mapping of groups in Identity Applications.

**Parameter Format**

**Format for Account entitlement**: Specify the parameter format the entitlement agent must use when granting the user account entitlement. The options are Identity Manager 4 and Legacy.

**Format for Group entitlement**: Specify the parameter format the entitlement agent must use when granting the group entitlement. The options are Identity Manager 4 and Legacy.

**Entitlements Extensions**

**User account extension**: Specify the user account extension. The content of this field is added below the entitlement elements in the EntitlementConfiguration resource object.

**Group extensions**: Specify the group extensions. The content of this field is added below the entitlement elements in the EntitlementConfiguration resource object.

**Account Tracking**

The following controls the Account tracking is part of Identity Reporting. For more information, see the Administrator Guide to NetIQ Identity Reporting.

**Enable Account Tracking**: Set this to True to enable account tracking policies for the JDBC Fan-out driver. Set it to False if you do not want to execute account tracking policies.

- Object class
- Realm
- Identifiers for Account
- Status Attribute
- Status active value
- Status inactive value
- Subscription default status
- Publication default status
Password Synchronization

The following GCVs control password synchronization for the Office 365 driver. For more information, see the NetIQ Identity Manager Password Management Guide.

**Application Accepts Passwords from Identity Manager:** If this option is set to True, the driver allows passwords to flow from the Identity Manager data store to the connected Office 365 server.

**Identity Manager Accepts Passwords from the Application:** If this option is set to True, it allows passwords to flow from the connected system to Identity Manager.

**Publish Passwords to NDS Password:** Use the password from the connected system to set the non-reversible NDS password in the Identity Vault.

**Publish Passwords to Distribution Password:** Use the password from the connected system to set the NMAS Distribution Password used for Identity Manager password synchronization.

**Require passwords policy validation before publishing passwords:** Select True to apply NMAS password policies when publishing passwords. Password is not written to the data store if it does not comply.

**Reset user’s external system password to the Identity Manager password on failure:** If this option is set to True, and the Distribution Password fails to distribute, attempt to reset the password in the connected system by using the Distribution Password from the Identity Manager data store.

**Notify the user of password synchronization failure via e-mail:** If this option is set to True, notify the user by e-mail of any password synchronization failures.

**Connected System or Driver Name:** Specifies the name of the connected system, application or Identity Manager driver. This value is used by the e-mail notification templates to identify the source of notification messages.

In Designer, you must click the icon next to a GCV to edit it. This displays the Password Synchronization Options dialog box for a better view of the relationship between the different GCVs.

In iManager, to edit the Password management options go to Driver Properties > Global Configuration Values, and then edit it in your Password synchronization policy tab.

**JDBC Fanout Common**

**Allow ‘Group add’ in Fanout mode:** Select to Disable to prevent the group add/creation events in the Subscriber channel. Group add events are broadcasted to each of the instances configured by the driver. If disabled, group add operations will be vetoed.

**Synchronize the first or the last replica value:** Select the appropriate option to synchronize the first or last replica value of multi-valued attributes mapped to single-valued columns. The options are: First and Last.