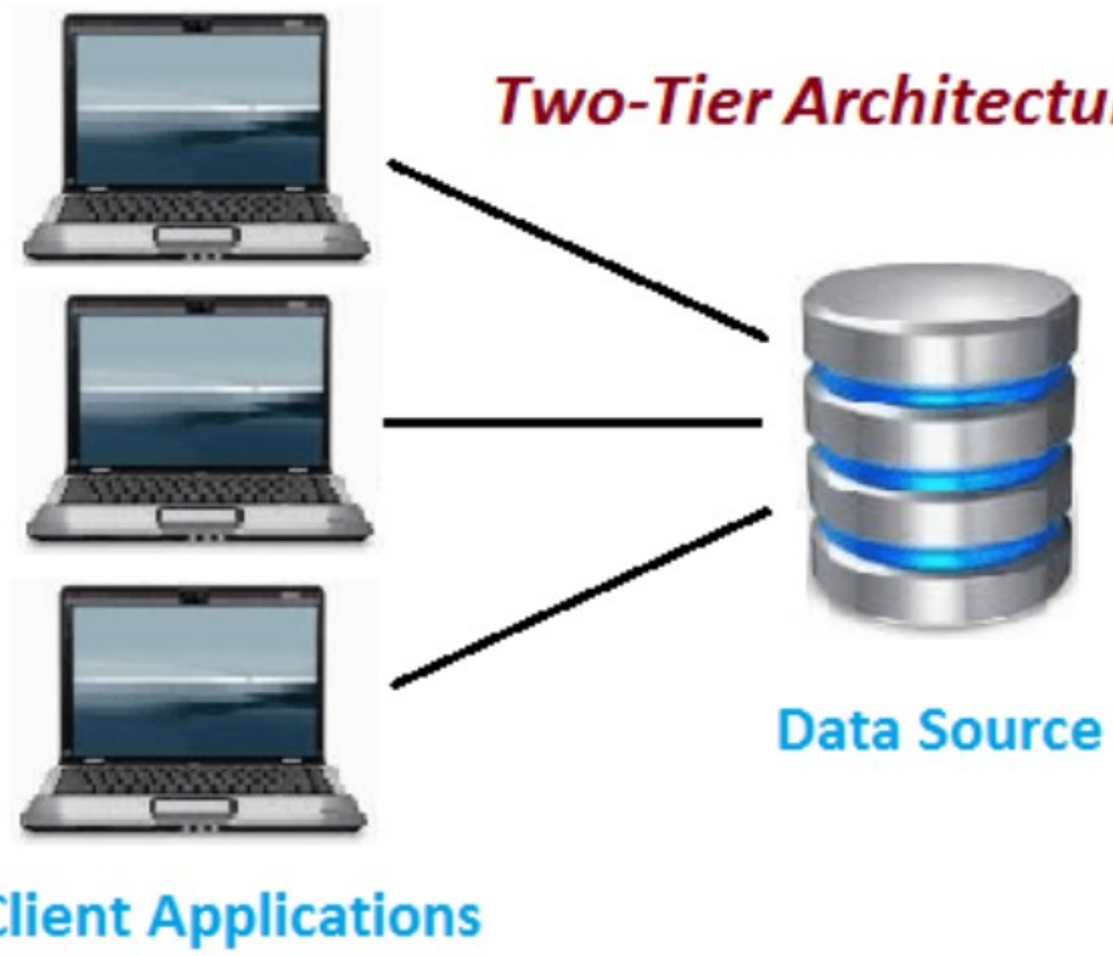
Two-Tier Database Design

- The two-tier is based on **Client-Server** architecture.
- The direct communication takes place between client and server.
- There is no mediator between client and server.
- Because of **tight coupling** a 2 tiered application will run faster.



- Example, Railway reservation application software.
- In this application, both **Database** and **Server** are incorporated with each other, so this technology is called as "**Client-Server Technology**".
- The Two-tier architecture is divided into two parts:
  - **1) Client Application** (Client Tier / presentation layer)
  - **2) Database** (Data Tier / data layer)
- On client application side the code is written for saving the data in the SQL server database. Client sends the request to server and it process the request & send back with data.

Advantages:

- High **portability**.
- Systems are accessible by **multiple users** from any part of the world
- Easy to **maintain** and **modification** is bit easy as compare to 3 - tier.
- Communication is **faster**.
- Due to their **less complexity**, easy to build and thereby less **expensive**.

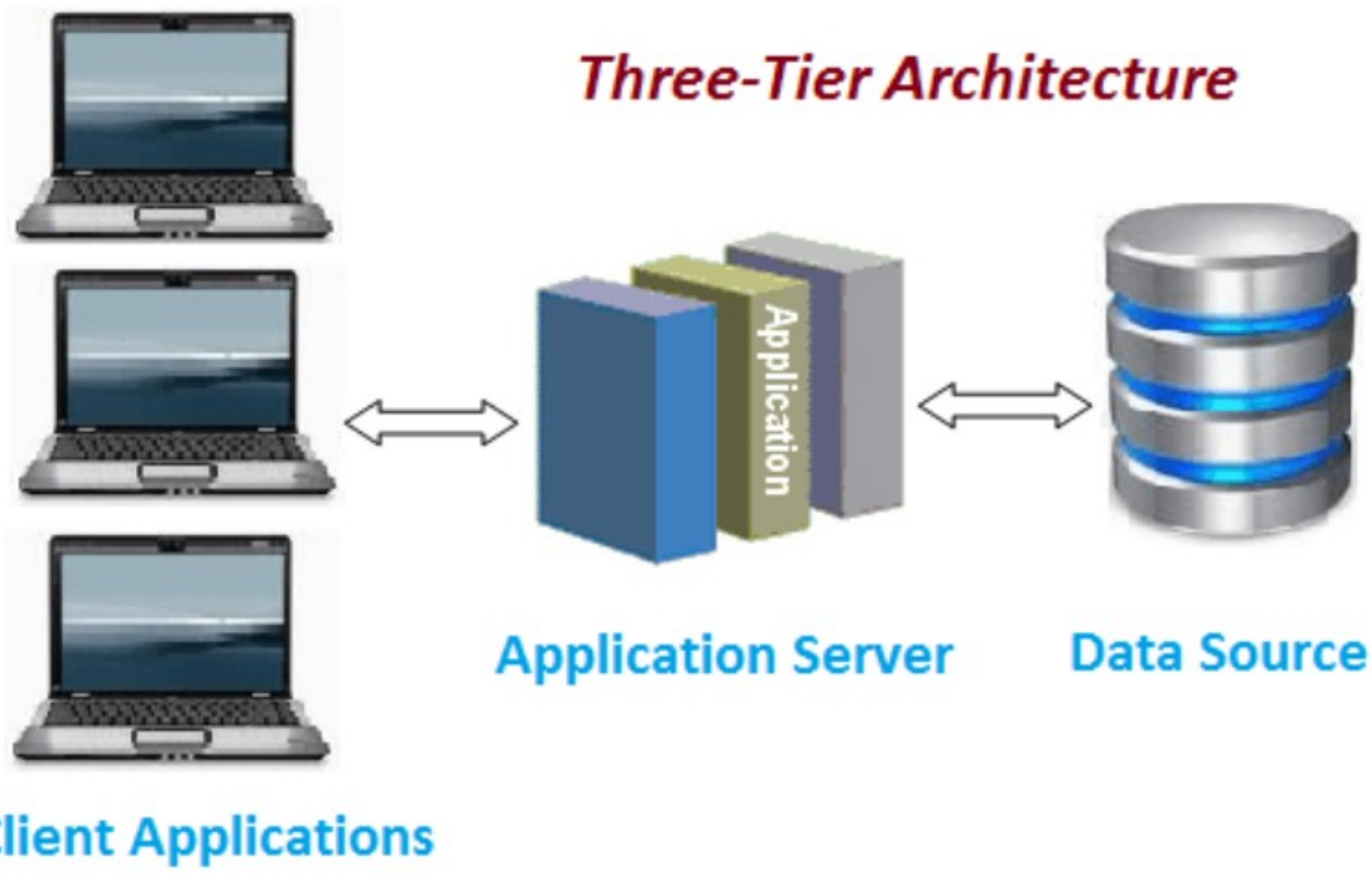
Disadvantages:

- Performance is reduced when **clients increase**. But generally faster with **less number of users** due to **tight coupling** between client and server.

- More suitable to **departmental applications** with small scale groupware and simple for Web-based.

Three-Tier Database Design

- Three-tier architecture typically comprises **Presentation tier**, **Business tier** or **data access tier**, and **Data tier**.
- Three layers in the three tier architecture are as follows:
  1) Client layer (Presentation Layer)
  2) Business layer (Application Layer / Middle Tier)
  3) Data layer



1) Client Layer :

- It is also called as **Presentation Layer** which contains **UI** part of our application.
- This layer is used for the **design** purpose where data is presented to the user or input is taken from the user.
- For this, in web communication **HTML** is used.

2) Business Layer :

- In this layer all **business logic** written like validation of data, calculations, data insertion etc.
- It acts as an **interface** between **Client Layer and Data Layer**.
- It is also called the **mediator**, helps to make **communication faster** between client and data layer.

3) Data Layer :

- In this layer **actual database** is comes in the picture.
- It contains **methods to connect with database** and to perform insert, update, delete, get data from database based on our input data.

Advantages:

- **Improved Security** – Client is not direct access to database.
- **Scalability** – Each layer is run on different systems.
- **Performance** is higher than 2-tier.
- **High degree of flexibility** as an additional tier for integration logic.
- It is **fast in communication** than 2-tier.
- Improve **Data Integrity**.
- Easy to **maintain** and **modification** is bit easy, won't affect other modules.
- Proved the possibility of **integration** of servers where one server can communicate with other servers.

Disadvantages:

- Increase **Complexity/Effort**

JDBC Drivers

- JDBC Driver is a **software component** that enables java application to interact with the database.
- There are **four types of JDBC drivers** :

1) **Type - 1 :** JDBC-ODBC Bridge driver (Bridge)
2) **Type - 2 :** Native-API/partly Java driver (Native)
3) **Type - 3 :** All Java/Net-protocol driver (Middleware)
4) **Type - 4 :** All Java/Native-protocol driver (Pure)

1) JDBC-ODBC Bridge driver

- In Type - 1 driver, a JDBC bridge is used to access ODBC drivers installed on each client machine.
- Using ODBC, requires configuring on your system a Data Source Name (DSN) that represents the target database.
- The Type 1 driver translates all **JDBC calls** into **ODBC calls** and sends them to the **ODBC driver**.
- **ODBC** is a generic **API**.
- The JDBC-ODBC Bridge driver is recommended only for experimental use or when no other alternative is available.

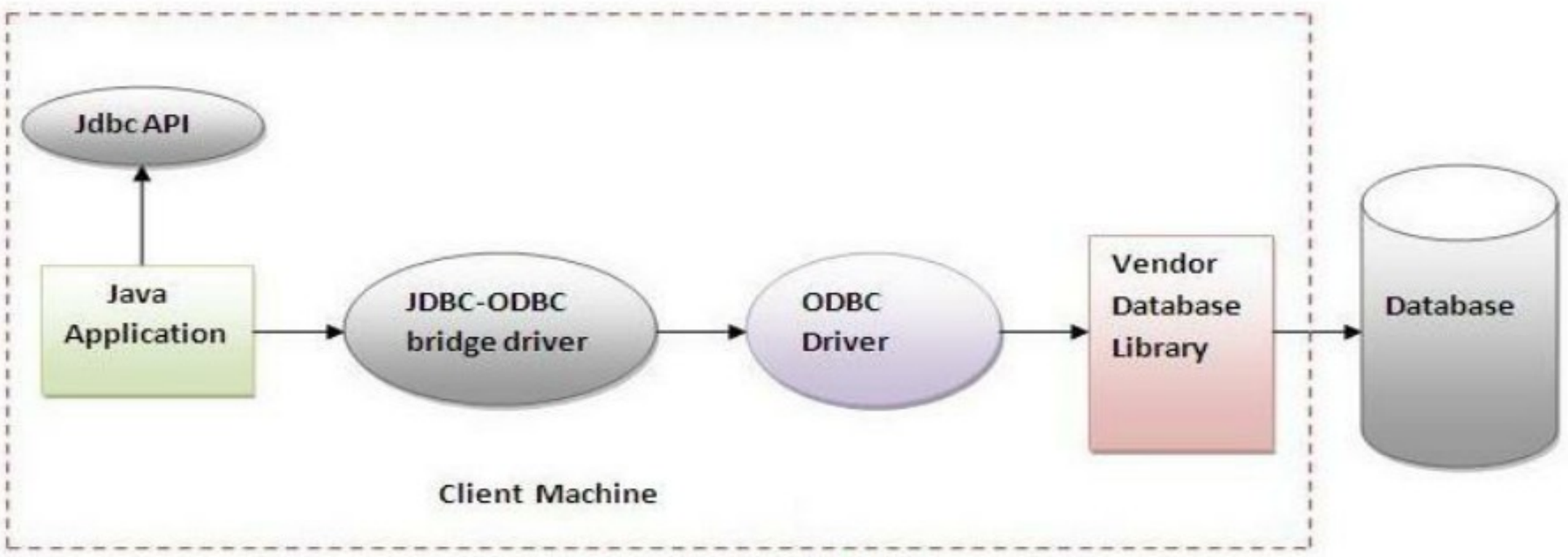


Figure- JDBC-ODBC Bridge Driver

Advantages:

- Easy to use.
- Can be easily **connected to any database**.

Disadvantages:

- The Bridge driver is not written fully in Java, Type 1 drivers are **not portable.**
- **Performance** degraded because JDBC method call is converted into the ODBC function calls.
- The ODBC driver needs to be **installed** on the **client machine**.
- **Not good** for the **Web**.
- It is the **slowest** of all driver types.

2) Native-API/partly Java driver

- Type 2 drivers convert **JDBC calls into database-specific calls**.
- This driver is specific to a particular database.
- The vendor-specific driver must be installed on each client machine.
- If we change the Database, we have to change the native API because it is database specific.
- It is not written entirely in java.

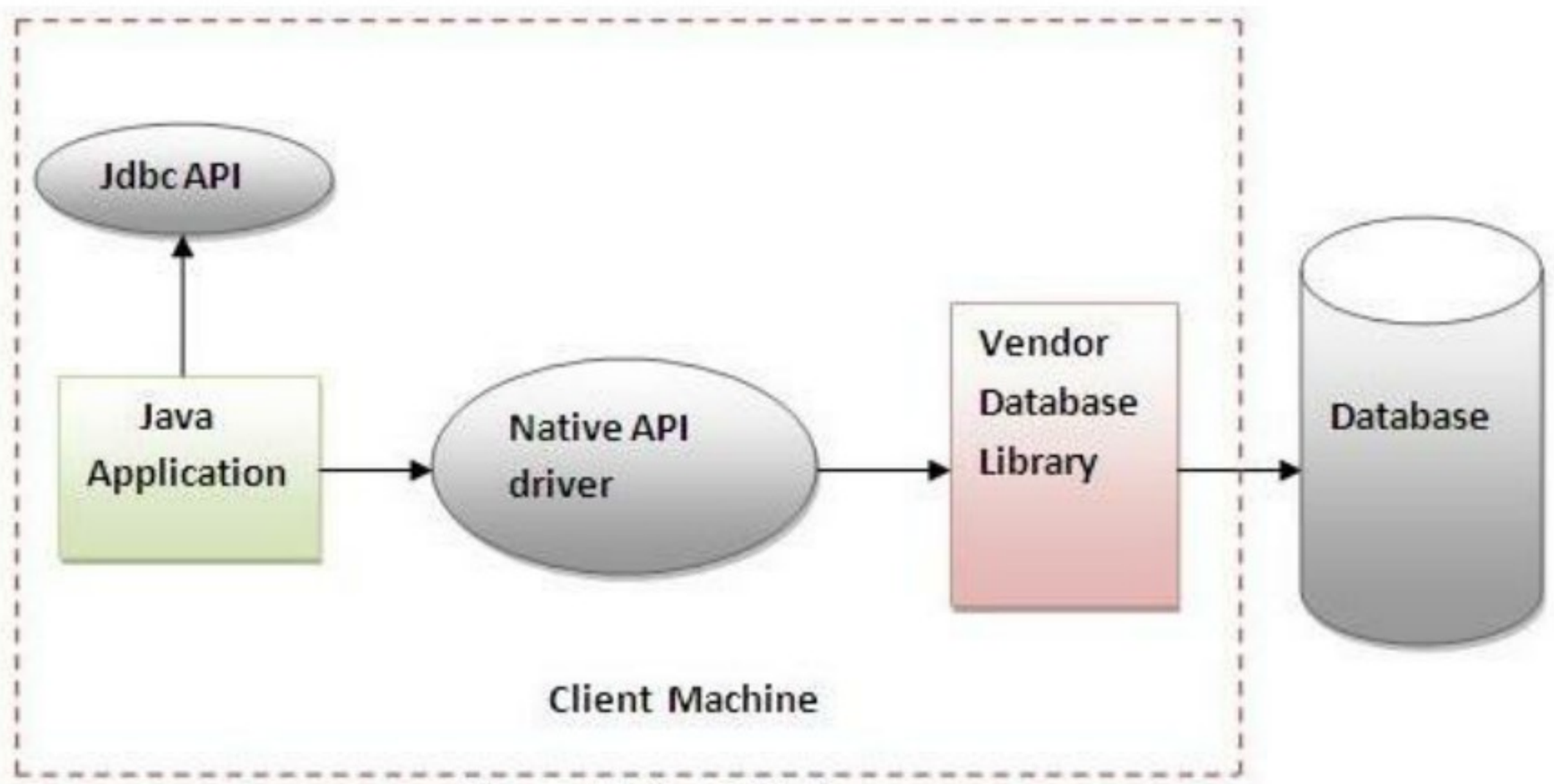


Figure- Native API Driver

Advantages:

- **Performance increases** with a Type 2 driver as compare to Type 1 driver, because it eliminates ODBC's overhead.

Disadvantages:

- The **Native driver** needs to be installed on the each client machine.
- The **Vendor client library** needs to be installed on client machine.
- If we change the Database we have **to change the native API** as it is specific to a database.
- It is **platform dependent**.

3) Pure Java/Network-protocol/Middleware driver

- Type 3 driver is used **three-tier** approach to access databases.
- It uses **middleware** (application server) that converts **JDBC calls** directly or indirectly into the **vendor-specific** database protocol.
- It is fully written in **java**.

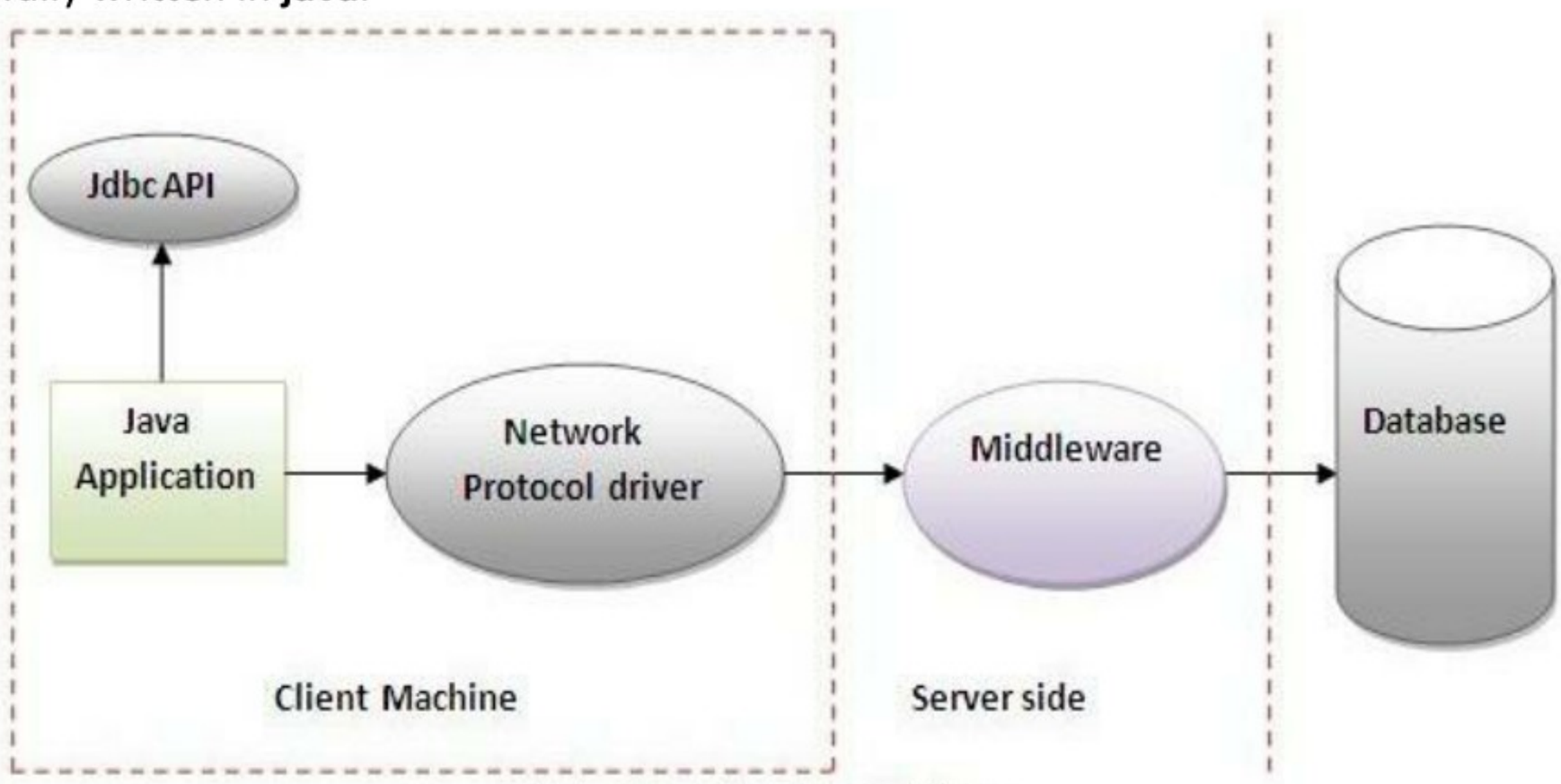


Figure- Network Protocol Driver

Advantages:

- This driver is **server-based**, so there is no need for any **vendor database library** to be present on client machines.
- It is **portable** because it is fully written in java.
- It is very **flexible** allows access to multiple databases using one driver.
- They are **the most efficient** amongst all driver types.
- The middleware server can provide typical middleware services like **caching**, **load balancing**, **logging** and **auditing**.

Disadvantages:

- **Network support** is required on client machine.
- **Maintenance** of Network Protocol driver becomes **costly** because it requires **database-specific coding** to be done in the middle tier.
- It requires another server application to **install** and **maintain**.

4) Database-protocol/Pure Java driver

- Type 4 driver is an all Java driver which connects **directly to the database**. It is also known as **Thin Driver**.
- It is a database driver implementation that **converts JDBC calls** directly into a **vendor-specific database protocol**.
- The database protocol is vendor specific, the JDBC client requires separate drivers, usually vendor supplied, to connect to different types of databases.

- It is fully written in **Java** language.

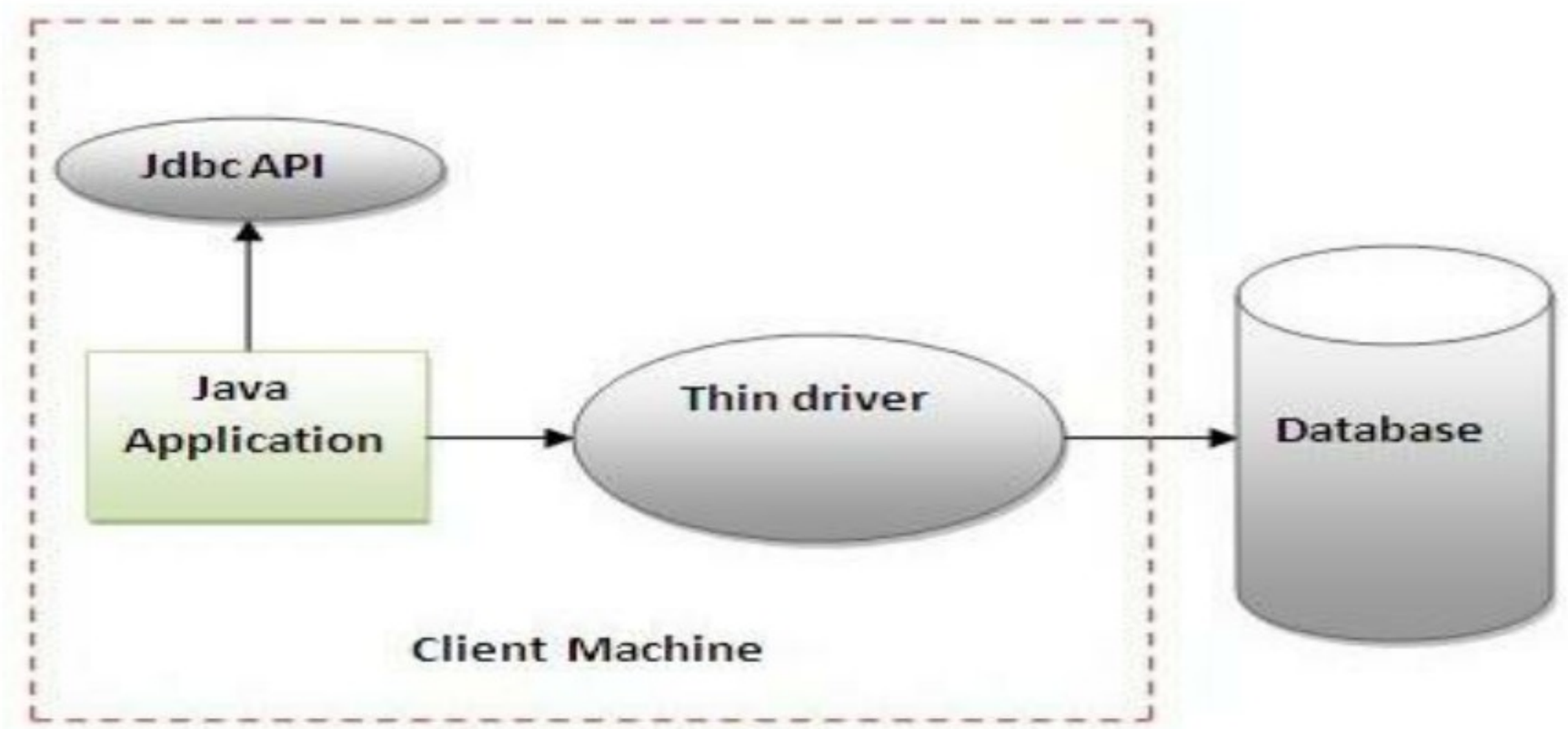


Figure- Thin Driver

Advantages:

- It is **platform dependent**.
- The client application connects directly to the database server. No **translation** or **middleware** layers are used, performance is quite good.
- **No software** is required at client side or server side.

Disadvantages:

- Drivers depend on the Database.

JDBC-ODBC Bridge

- The JDBC-ODBC Bridge is a JDBC driver which implements J**DBC operations by translating them into ODBC operations**.
- To ODBC it appears as a normal **application program**.
- The bridge implements JDBC for any database for which an **ODBC driver is available**.
- The bridge is implemented as the **sun.jdbc.odbc** Java package and contains a native library used to access ODBC.
- The bridge is a joint development of **Intervolve and Java Soft**.
- The bridge is implemented in **Java** and uses **Java native methods** to call ODBC.
- The bridge is installed **automatically** with the JDK as package **sun.jdbc.odbc**.
- **No special configuration** is required for the bridge.
- The bridge is used by opening a **JDBC connection** using a URL with the **odbc** subprotocol.

  Class.forName("sun.jdbc.odbc.JdbcOdbcDriver");
- Before a connection can be established, the bridge driver class, **sun.jdbc.odbc.JdbcOdbcDriver** must be **explicitly loaded** using the **Java class loader**.
- When loaded, the ODBC driver **creates an instance of itself** and **registers** this with the JDBC **driver manager**.

- JDBC used with a **Pure Java JDBC driver** works well with **applets**. The bridge driver does **not work** well with **applets**.
- The bridge driver uses the **odbc subprotocol**. **URLs** for this subprotocol are of the form:

  jdbc:odbc:<data-source-name>[<attribute-name>=<attribute-value>]*

  Example:

  jdbc:odbc:sybase
  jdbc:odbc:mydb;UID=me;PWD=secret

JDBC API

- JDBC API provides **the application to JDBC Manager connection**.
- The JDBC API uses a driver manager and database-specific drivers to provide transparent connectivity to **heterogeneous databases.**
- Some of the important **classes** and **interface** defined in JDBC API are as follows.

Class / Interface	**Description**
Driver Manager	The **DriverManager** class loads and configures a database driver on the client side.
Connection	The **Connection** class performs connection and authentication to a database server. **Syntax:** Connection con = DriverManager.getConnection (url, "username", "password");
Statement	Useful when you are using static SQL statement at runtime and **return** the results by using **ResultSet** object. The Statement interface cannot accept parameter. The object is created using the **createStatement()** method of the Connection interface. **Syntax:** Connection con = DriverManager.getConnection (url, "username", "password"); Statement stmt = con.createStatement();
PreparedStatement	The **PreparedStatement** interface accepts **input parameter at runtime**. It is subclass of the Statement interface. It is **precompiled** query which can be executed **multiple times**. The object is created using the **prepareStatement()** method of Connection interface. **Syntax:** Connection con = DriverManager.getConnection (url, "u_name", "password"); String query = "insert into emp values(? ,?)"; PreparedStatement ps = con.prepareStatement(query); ps.setInt(1,5);

	ps.setString(2, ”New Employee”); int n = ps.executeUpdate();
CallableStatement	The CallableStatement interface can also accept **input parameter at runtime**. It is used to call the stored procedures and functions. The object is created using the **preparecall()** method of connection interface. **Syntax:** Connection cn = DriverManager.getConnection("jdbc:odbc:exm"); CallableStatement cs = cn.prepareCall("{call proc1()}"); ResultSet rs= cs.executeQuery();
ResultSet	The object of ResultSet maintains a cursor pointing to a particular row of data. Initially, cursor points to before the first row. You can use the next()method of ResultSet to move from row to row.
DatabaseMetaData	**DatabaseMetaData** interface provides methods to get meta data of a database such as database product name, database product version, driver name, driver version etc.
ResultSetMetaData	**ResultSetMetaData** interface provides methods to get meta data of a Resultset such as table name, column name, column type, total number of column etc.

JDBC Advantages and Disadvantages

Advantages:

- Can read any database if proper drivers are installed.
- No content conversion required.
- Query and Stored procedure supported.
- Can be used for both Synchronous and Asynchronous processing.
- Zero Configurations for Network Computers.
- Database Connection Identified by URL.

Disadvantages:

- Correct drivers need to be deployed for each type of database.
- Cannot update or insert multiple tables with sequence.

Develop java program using JDBC.

```
import java.sql.*;

public class DemoDatabase
{
        // JDBC driver name and database URL
        static final String JDBC_DRIVER = "com.mysql.jdbc.Driver";
        static final String DB_URL = "jdbc:mysql://localhost:3306/Student";

        //  Database credentials
        static final String USER = "root";
        static final String PASS = "root";

public static void main(String[] args)
{
        Connection  conn = null;
        Statement  stmt = null;
        try
        {
                //STEP 2: Register JDBC driver
                Class.forName("com.mysql.jdbc.Driver").newInstance();

                //STEP 3: Open a connection
                System.out.println("Connecting to database...");
                conn = DriverManager.getConnection(DB_URL,USER,PASS);

                //STEP 4: Execute a query
                System.out.println("Creating statement...");
                stmt = conn.createStatement();
                String sqlQuery;
                sqlQuery = "SELECT  Id, Name, Branch  FROM  demo";
                ResultSet rs = stmt.executeQuery(sqlQuery);

                //STEP 5: Extract data from result set
                while(rs.next())
                {
                        //Retrieve by column name
                        int  id  = rs.getInt("Id");
                        String  Name = rs.getString("Name");
                        String  Branch = rs.getString("Branch");
                        //Display values
                        System.out.print("ID: " + id +"\n");
```

```
                System.out.print("Name: " + Name + "\n");
                System.out.print("Branch: " + Branch +"\n");

            }
            //STEP 6: Clean-up environment
            rs.close();
            stmt.close();
            conn.close();
        }
        catch(SQLException se)
        {
            se.printStackTrace();
        }
        catch(Exception e)
        {
            e.printStackTrace();
        }
        finally
        {
            try
            {
                if(stmt!=null)
                    stmt.close();
            }
            catch(SQLException se2)
            {
            }
            try
            {
                if(conn!=null)
                    conn.close();
            }
            catch(SQLException se)
            {
                se.printStackTrace();
            }
        }
        System.out.println("It's over !!!");
    }
}
```