Oracle® TimesTen In-Memory Database

Open Source Languages Support Guide

Release 18.1

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This document discusses TimesTen In-Memory Database Release 18.1 support for open source languages. This support applies to both TimesTen Classic and TimesTen Scaleout. In the current release, the languages supported are Python and Node.js.

These topics are covered in this document:

Sample programs for the open source languages are available on GitHub. For an overview of what is available, refer to `README.md` at:

`https://github.com/oracle/oracle-timesten-samples/tree/master/languages`

There are additional `README.md` files with more information for each language, referenced later in this document.

Getting Started

This section discusses basic concepts and initial considerations in using open source languages supported by TimesTen (Python and Node.js).

The following topics are covered here:

- ODPI-C and language-specific packages
- Platform support for open source languages
- Requirements for open source languages
- Restrictions for open source languages

ODPI-C and language-specific packages

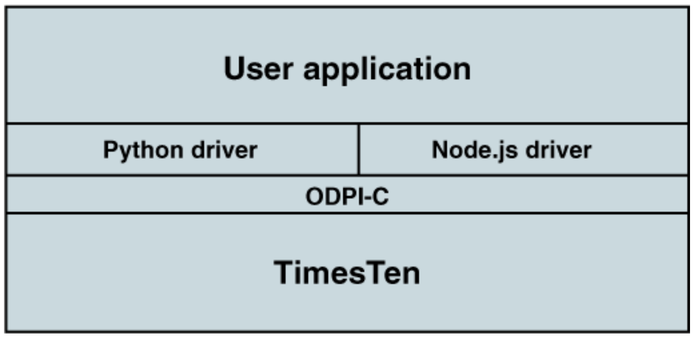
TimesTen support of open source languages is through the Oracle Database Programming Interface for C (ODPI-C). ODPI-C is an open source library from Oracle Corporation designed to simplify access to Oracle databases from a variety of programming languages. You can refer to `https://oracle.github.io/odpi/` for information.

For each language, there is an open source package, or driver, available through GitHub and maintained by Oracle. Terminology for these packages varies from language to language: for example, *extension module* for Python or *add-on* for Node.js.

See the section for each supported language below for information about the corresponding package. ODPI-C is included when you download the driver for each language.

ODPI-C is a layer on top of the Oracle Call Interface (referred to in this document as OCI, but not to be confused with Oracle Cloud Infrastructure). Figure 1 shows the architecture.

Figure 1 TimesTen architecture for open source languages



Platform support for open source languages

Platform support for open source languages is of course limited to the platforms, or a subset of the platforms, supported by TimesTen, and may vary between languages.

TimesTen supports client/server access from Linux, macOS, or Windows, or direct access on Linux, for both Python and Node.js.

For the latest information about platform support for each language, refer to the applicable `README.md` file at:

`https://github.com/oracle/oracle-timesten-samples/tree/master/languages/python`

Or:

`https://github.com/oracle/oracle-timesten-samples/tree/master/languages/nodejs`

For more information about TimesTen platform support, including specific versions supported, refer to "Platforms and configurations" in *Oracle TimesTen In-Memory Database Release Notes*.

Requirements for open source languages

Using open source languages through ODPI-C for access to TimesTen databases requires use of the special OCI client library that is included with the Oracle Instant Client shipped with TimesTen software. Because you must use the Instant Client that is supplied with TimesTen, your library path must be set so that the TimesTen Instant Client directory (*`installation_dir`*`/ttoracle_home/instantclient_12_1`) precedes the path to any Oracle Database libraries. The path is set appropriately when you use the TimesTen `ttenv` script (`ttenv.sh` or `ttenv.csh`), described in "Install TimesTen" on page 3.

Restrictions for open source languages

Because ODPI-C is a layer on top of OCI, TimesTen restrictions for OCI also apply to ODPI-C. These restrictions are documented in "TimesTen restrictions and differences" in *Oracle TimesTen In-Memory Database C Developer's Guide*.

In addition, these features are not supported:

- Application continuity
- Continuous query notification
- Call timeouts
- Session tagging
- Database management, including startup and shutdown

TimesTen setup

This section discusses the following actions to set up TimesTen.

- Install TimesTen
- Set the TimesTen environment
- Define and manage the TimesTen database
- Configure connections for TimesTen

Install TimesTen

If you do not already have TimesTen, you can download it from
`https://www.oracle.com/technetwork/database/database-technologies/timesten/downloads/index.html`

> **Important:** Full support for open source languages requires a TimesTen release of 18.1.4.1.0 or higher.

There is a single ZIP file distribution for both TimesTen Classic and TimesTen Scaleout, but setup instructions differ from there:

- For prerequisites, environment setup, and installation for TimesTen Classic, refer to "Overview of the Installation Process in TimesTen Classic" and the applicable installation chapter in *Oracle TimesTen In-Memory Database Installation, Migration, and Upgrade Guide*.

  The installation chapters also describe how to create a TimesTen instance.

- For prerequisites, environment setup, and installation for TimesTen Scaleout, refer to "Prerequisites and Installation of TimesTen Scaleout" in *Oracle TimesTen In-Memory Database Scaleout User's Guide*.

  "Setting Up a Grid" in that document includes information about creating the initial management instance.

Set the TimesTen environment

After you have installed TimesTen and created a TimesTen instance, use the appropriate `ttenv` script (`ttenv.sh` or `ttenv.csh`) under *`timesten_home`*`/bin` to finish setting up the environment.

Define and manage the TimesTen database

For defining and managing a database for TimesTen Classic, refer to "Managing TimesTen Databases" in *Oracle TimesTen In-Memory Database Operations Guide*.

For defining and managing a TimesTen grid and database for TimesTen Scaleout, refer to "Setting Up the Membership Service", "Setting Up a Grid", and "Managing a Database" in *Oracle TimesTen In-Memory Database Scaleout User's Guide*.

Configure connections for TimesTen

Because TimesTen support of open source languages goes through OCI, you can connect to TimesTen from Python or Node.js using either the `tnsnames` or the easy connect naming method. For details on these methods, see "Connecting to a TimesTen database from OCI" in *Oracle TimesTen In-Memory Database C Developer's Guide*.

You may have a `tnsnames.ora` entry such as the following, for example, for connecting to database `sampledb`. Then you would reference the TNS name, `sampledbconn`, for the connection string in your code.

```
sampledbconn =(DESCRIPTION=(CONNECT_DATA = (SERVICE_NAME = sampledb)(SERVER =
timesten_direct)))
```

Or, to avoid using `tnsnames.ora`, you can use an easy connect string, such as `myhost/sampledb:timesten_direct`, directly in your code for the connection string.

Use `timesten_direct` for a direct connection to TimesTen or `timesten_client` for a client/server connection.

See "Configure connections to TimesTen in Python" on page 6 and "Configure connections to TimesTen in Node.js" on page 10 for examples using TNS names and easy connect strings in your code.

You will need a TimesTen database user in order to connect to a TimesTen database. For information about creating users in TimesTen, see "CREATE USER" in *Oracle TimesTen In-Memory Database SQL Reference*.

The following example creates a TimesTen internal user `appuser` with password `appuser` and grants `CREATE SESSION` and `CREATE TABLE` privileges so `appuser` can create a user session in connecting to the database and then create a database table.

```
CREATE USER appuser IDENTIFIED BY "appuser";

GRANT CREATE SESSION TO appuser;
GRANT CREATE TABLE TO appuser;
```

Support for Python

Python is an interpreted, high-level, general purpose language that includes support for object-oriented programming and a robust standard library. Simple syntax rules make Python code easy to read and support.

Many platforms come with Python installed. Enter "python" at the command prompt to confirm. If it is installed, its response will include the version number.

You can find information about Python and download it from
`https://www.python.org`

For information about Python versions supported by TimesTen, refer to the `README.md` file at
`https://github.com/oracle/oracle-timesten-samples/tree/master/languages/python`

The Python extension module for access to Oracle or TimesTen databases from Python applications is `cx_Oracle`. This module conforms to the Python database API 2.0 specification. There is general information about the module at
`https://github.com/oracle/python-cx_Oracle`.

For information about versions of the Python extension module supported by TimesTen, refer to the `README.md` file.

The rest of this section covers these topics:

- Setup for Python
- Additional information for Python

Setup for Python

This section covers these setup actions to use Python with TimesTen.

- Install the Python extension module
- Configure connections to TimesTen in Python

Install the Python extension module

You must have internet access to install the Python extension module. You may have to set the `http_proxy` and `https_proxy` environment variables to indicate your proxy server(s) in order to access the internet outside of a firewall.

There are several approaches for downloading the Python extension module. Choose the approach that is most suitable for your setup and environment.

- Download source files from GitHub, using `git clone`. This requires `git` to be installed on your system. Refer to the instructions at
`https://cx-oracle.readthedocs.io/en/latest/user_guide/installation.html#install-using-github`

  Important:

  - Because the setup process requires access to the system `lib` directory, administrative privilege is required.
  - In addition to Python itself, your system must have the Python header files, which requires that the corresponding `python[3]-devel` development package is installed.

- Download prebuilt packages using the Python Pip package manager. Refer to the instructions at `https://cx-oracle.readthedocs.io/en/latest/user_guide/installation.html#quick-start-cx-oracle-installation` as well as to platform-specific sections of that document, as appropriate.

This approach provides prebuilt binaries but downloads and compiles source code as necessary.

Important: In the event that source code must be compiled, you must have package `python[3]-devel` installed.

- Download prebuilt binaries through a platform-specific package manager such as RPM.

  You can use the RPM package manager through a utility such as yum.

  The `cx_Oracle` RPM packages are available from the Oracle Linux yum server (`http://yum.oracle.com/`). This is discussed at `https://cx-oracle.readthedocs.io/en/latest/user_guide/installation.html#installing-cx-oracle-rpms-on-oracle-linux`

Important: Using this approach requires Oracle Instant Client for successful installation. If you do not yet have Instant Client on your system, it will be provided. But for runtime operations, the Instant Client version that comes with TimesTen is required, as discussed in "Requirements for open source languages" on page 2.

Information for all scenarios is available at `https://cx-oracle.readthedocs.io/en/latest/user_guide/installation.html`

Note: In all three cases, ODPI-C is included. For the `git clone` approach, any dependencies, including ODPI-C, are automatically cloned and built.

Configure connections to TimesTen in Python

See "Configure connections for TimesTen" on page 4 for information about using the Oracle `tnsnames.ora` or easy connect mechanisms to set up connections to your database.

This example uses a TNS name for a Python connection string:

```
connection = cx_Oracle.connect("appuser", "appuser", "sampledbconn")
```

This example uses an easy connect string that specifies a direct connection to TimesTen:

```
connection = cx_Oracle.connect("appuser", "appuser", "myhost/sampledb:timesten_
direct")
```

Additional information for Python

This section covers these topics:

- Type mappings for Python applications
- Failure modes for Python
- Python samples

Type mappings for Python applications

Table 1 documents mappings between `cx_Oracle` types (as available through the language extension module) and TimesTen SQL types.

Note: Additional TimesTen SQL types can be mapped to these `cx_Oracle` types as a result of TimesTen implicit data type conversions. See "Data type conversion" in *Oracle TimesTen In-Memory Database SQL Reference*.

For the latest information about data type support in the current release, refer to the `README.md` file at
https://github.com/oracle/oracle-timesten-samples/tree/master/languages/python

Table 1 Type mappings for cx_Oracle

cx_Oracle type	TimesTen type
`cx_Oracle.BINARY`	`BINARY`, `VARBINARY`
`cx_Oracle.BLOB`	`BLOB`
`cx_Oracle.CLOB`	`CLOB`
`cx_oracle.CURSOR`	`REF CURSOR`
`cx_Oracle.DATETIME`	`DATE`
`cx_Oracle.FIXED_CHAR`	`CHAR`
`cx_Oracle.FIXED_NCHAR`	`NCHAR` (In TimesTen, this type is UTF-16 only.)
`cx_Oracle.NATIVE_FLOAT`	`BINARY_DOUBLE`, `BINARY_FLOAT`
`cx_Oracle.NCHAR`	`NVARCHAR2` (In TimesTen, this type is UTF-16 only.)
`cx_Oracle.NCLOB`	`NCLOB`
`cx_Oracle.NUMBER`	`NUMBER`, `TT_BIGINT`, `TT_INTEGER`, `TT_SMALLINT`, `TT_TINYINT`
`cx_Oracle.ROWID`	`ROWID`
`cx_Oracle.STRING`	`VARCHAR2`
`cx_Oracle.TIMESTAMP`	`TIMESTAMP`, `TT_TIMESTAMP`

Failure modes for Python

Be aware of the following:

- Error messages may differ slightly from those produced by Oracle under the same conditions.
- For the Python method `Cursor.executemany()`, TimesTen ignores the `batcherrors` option and therefore supports only the default `batcherrors=false` setting. An error is always returned if any row in the batch encounters an error. (By contrast, Oracle Database supports `batcherrors=true`, in which case success is always returned if any row in the batch is successful.) Also, against a TimesTen database, if multiple errors are encountered in a batch, TimesTen makes no attempt to order the errors as they would be ordered if encountered against an Oracle database.

Python samples

This section provides a simple Python example and a URL to TimesTen Python sample applications.

Python example: Connect to TimesTen and execute SQL This simple sample program connects to a TimesTen database, creates a table named `employees`, inserts three rows into the table, selects and displays the rows, drops the table, and disconnects from the database.

```
##
## simple.py
##
from __future__ import print_function
import cx_Oracle
import AccessControl

def run():
  try:
    credentials = AccessControl.getCredentials("simple.py")
    connection = cx_Oracle.connect(credentials.user, credentials.password,
                 credentials.connstr)

    cursor = connection.cursor()
    cursor.execute("""
      CREATE TABLE employees(first_name VARCHAR2(20), last_name VARCHAR2(20))""")
    print("Table has been created")
    values = [["ROBERT", "ROBERTSON"], ["ANDY", "ANDREWS"], ["MICHAEL",
             "MICHAELSON"]]
    cursor.executemany("INSERT INTO employees VALUES (:1, :2)", values)
    print("Inserted ", len(values), "employees into the table")
    cursor.execute("""
      SELECT first_name, last_name FROM employees""")
    for fname, lname in cursor:
      print("Selected employee:", fname, lname)
    cursor.execute("DROP TABLE employees")
    print("Table has been dropped")
    cursor.close()
    connection.close()
    print("Connection has been released")

  except Exception as e:
    # Something went wrong
    print("An error occurred", str(e))

run()
```

Here are the results:

```
% python3 simple.py -u username -p password
Table has been created
Inserted  3 employees into the table
Selected employee: ROBERT ROBERTSON
Selected employee: ANDY ANDREWS
Selected employee: MICHAEL MICHAELSON
Table has been dropped
Connection has been released
```

Download and run TimesTen Python sample programs TimesTen sample programs for Python through `cx_Oracle` are available at https://github.com/oracle/oracle-timesten-samples/tree/master/languages/python

Refer to `README.md` at that location for information.

Support for Node.js

Node.js is an open source Javascript runtime environment you can use to build scalable network applications and tools, such as web servers. It includes "modules" to reduce the complexity of writing server applications by handling basic functions such as file system I/O, networking, data streams, and cryptography.

You can find information about Node.js and download it from https://nodejs.org.

For information about Node.js versions supported by TimesTen, refer to the `README.md` file at
https://github.com/oracle/oracle-timesten-samples/tree/master/languages/nodejs

The Node.js installation includes the package manager `npm`. Use this to install the Node.js add-on, as described below in the section about that add-on.

The Node.js add-on for access to Oracle or TimesTen databases from Node.js applications is `node-oracledb`. There is general information about the add-on at https://oracle.github.io/node-oracledb/.

For information about versions of the Node.js add-on supported by TimesTen, refer to the `README.md` file.

The rest of this section covers these topics:

- Setup for Node.js
- Additional information for Node.js

Setup for Node.js

This section covers these setup actions to use Node.js with TimesTen.

- Install the Node.js add-on
- Configure connections to TimesTen in Node.js

Install the Node.js add-on

You must have internet access to install the Node.js ad-on. You may have to set the `http_proxy` and `https_proxy` environment variables to indicate your proxy server(s) in order to access the internet outside of a firewall.

There are several approaches for downloading the Node.js add-on. Choose the approach that is most suitable for your setup and environment.

- Download source files from GitHub, using `git clone` (requiring `git` to be installed on your system), then install the driver using the NPM package manager.

  You can install `node-oracledb` by downloading source files from GitHub. Once you have downloaded and extracted Node.js, you can optionally use the NPM package manager, located in the Node.js `bin` directory, to install a prebuilt `node-oracledb` binary. (Add the Node.js `bin` directory to your path.)

Refer to the installation instructions at https://oracle.github.io/node-oracledb/INSTALL.html#-3-node-oracledb-installation-instructions under "Source code from GitHub".

- Download prebuilt packages using the NPM package manager.

  Refer to the installation instructions.

  This approach provides prebuilt binaries only. If prebuilt binaries are not available, you must compile the source code. In order to do this, you must have an Oracle Instant Client installed. The one provided with TimesTen will suffice for this.

- Download prebuilt binaries through a platform-specific package manager such as RPM.

  The `node-oracledb` RPM packages are available from the Oracle Linux yum server (http://yum.oracle.com/).

  Refer to the installation instructions.

> **Important:** Using this approach requires Oracle Instant Client for successful installation. If you do not yet have Instant Client on your system, it will be provided. But for runtime operations, the Instant Client version that comes with TimesTen is required, as discussed in "Requirements for open source languages" on page 2.

Information for all scenarios is available at https://oracle.github.io/node-oracledb/INSTALL.html.

> **Note:** In all three cases, ODPI-C is included. For the `git clone` approach, any dependencies, including ODPI-C, are automatically cloned and built.

Configure connections to TimesTen in Node.js

See "Configure connections for TimesTen" on page 4 for information about using the Oracle `tnsnames.ora` or easy connect mechanisms to set up connections to your database.

This example uses a TNS name for a Node.js connection string:

```
// Get connection
function connect(cb) {
    oracledb.getConnection({
      user          :  "appuser",
      password      :  "appuser",
      connectString :  "sampledbconn"
    } ,
    cb);
}
```

This example uses an easy connect string that specifies a direct connection to TimesTen:

```
// Get connection
function connect(cb) {
    oracledb.getConnection({
      user          : "appuser",
      password      : "appuser",
      connectString : "myhost/sampledb:timesten_direct"
    } ,
    cb);
}
```

Additional information for Node.js

This section covers these topics:

- Type mappings for Node.js applications
- Failure modes for Node.js
- Node.js samples

Type mappings for Node.js applications

Table 2 documents mappings between `node-oracledb` types as available through the language add-on and TimesTen SQL types.

Note: Additional TimesTen SQL types can be mapped to these Oracle Database types and `node-oracledb` alias types as a result of TimesTen implicit data type conversions. See "Data type conversion" in *Oracle TimesTen In-Memory Database SQL Reference*.

For the latest information about data type support in the current release, refer to the `README.md` file at `https://github.com/oracle/oracle-timesten-samples/tree/master/languages/nodejs`

Table 2 Type mappings for node-oracledb

Node.js type	Oracle Database type	node-oracledb alias type	TimesTen type
`Number`	`oracledb.DB_TYPE_BINARY_DOUBLE`	n/a	`BINARY_DOUBLE`
`Number`	`oracledb.DB_TYPE_BINARY_FLOAT`	n/a	`BINARY_FLOAT`
`Lob`	`oracledb.DB_TYPE_BLOB`	`oracledb.BLOB`	`BLOB`
`String`	`oracledb.DB_TYPE_CHAR`	n/a	`CHAR`
`Lob`	`oracledb.DB_TYPE_CLOB`	`oracledb.CLOB`	`CLOB`
`ResultSet`	`oracledb.DB_TYPE_CURSOR`	`oracledb.CURSOR`	`REF CURSOR`
`Date`	`oracledb.DB_TYPE_DATE`	`oracledb.DATE`	`DATE`
`Number`	`oracledb.DB_TYPE_INTEGER`	n/a	`NUMBER`, `TT_BIGINT`, `TT_INTEGER`, `TT_SMALLINT`, `TT_TINYINT`
`String`	`oracledb.DB_TYPE_NCHAR`	n/a	`NCHAR` (In TimesTen, this type is UTF-16 only.)
`Lob`	`oracledb.DB_TYPE_NCLOB`	`oracledb.NCLOB`	`NCLOB`

Table 2 (Cont.) Type mappings for node-oracledb

Node.js type	Oracle Database type	node-oracledb alias type	TimesTen type
`Number`	`oracledb.DB_TYPE_NUMBER`	`oracledb.NUMBER`	`NUMBER`, `TT_BIGINT`, `TT_INTEGER`, `TT_SMALLINT`, `TT_TINYINT`
`String`	`oracledb.DB_TYPE_NVARCHAR`	n/a	`NVARCHAR2` (In TimesTen, this type is UTF-16 only.)
`Buffer`	`oracledb.DB_TYPE_RAW`	`oracledb.BUFFER`	`BINARY`, `VARBINARY`
`String`	`oracledb.DB_TYPE_ROWID`	n/a	`ROWID`
`Date`	`oracledb.DB_TYPE_TIMESTAMP`	n/a	`TIMESTAMP`, `TT_TIMESTAMP`
`String`	`oracledb.DB_TYPE_VARCHAR`	`oracledb.STRING`	`VARCHAR`

Failure modes for Node.js

Be aware of the following:

- Error messages may differ slightly from those produced by Oracle under the same conditions.
- For the Node.js method `connection.executeMany()`, TimesTen ignores the `batcherrors` option and therefore supports only the default `batcherrors=false` setting. An error is always returned if any row in the batch encounters an error. (By contrast, Oracle Database supports `batcherrors=true`, in which case success is always returned if any row in the batch is successful.) Also, against a TimesTen database, if multiple errors are encountered in a batch, TimesTen makes no attempt to order the errors as they would be ordered if encountered against an Oracle database.

Node.js samples

This section provides a simple Node.js example and a URL to TimesTen Node.js sample applications.

Node.js example: Connect to TimesTen This simple sample program connects to a TimesTen database, creates a table named `employees`, inserts three rows into the table, selects and displays the rows, drops the table, and disconnects from the database.

```
//
// simple.js
//
var oracledb      = require('oracledb');
var accessControl = require('./AccessControl');

async function run() {

  let connection;

  try {
    let credentials   = accessControl.getCredentials("simple.js");
    connection = await oracledb.getConnection({
      user: credentials['-u'], password: credentials['-p'], connectString:
            credentials['-c']
    });

    let result;

    await connection.execute("CREATE TABLE employees(first_name VARCHAR2(20),
          last_name VARCHAR2(20))");
    console.log("Table has been created");
    const values = [["ROBERT", "ROBERTSON"], ["ANDY", "ANDREWS"], ["MICHAEL",
                   "MICHAELSON"]];
    await connection.executeMany("INSERT INTO employees VALUES(:1, :2)", values);
    console.log("Inserted", values.length, "employees into the table");
    result = await connection.execute("SELECT first_name, last_name FROM
             employees");
    result.rows.forEach(function(row){
    console.log("Selected employee:", row[0], row[1]);
    });
    await connection.execute("DROP TABLE employees");
    console.log("Table has been dropped");
  }
  catch (err) {
    console.log(err);
  }
  finally {
    if (connection) {
      try {
        connection.close();
        console.log("Connection has been released");
      }
      catch (err) { console.log(err); }
    }
  }
}

run();
```

Here are the results:

```
% node simple.js -u username -p password
Table has been created
Inserted 3 employees into the table
Selected employee: ROBERT ROBERTSON
Selected employee: ANDY ANDREWS
Selected employee: MICHAEL MICHAELSON
Table has been dropped
Connection has been released
```

Download and run TimesTen Node.js sample programs TimesTen sample programs for Node.js through `node-oracledb` are available under `https://github.com/oracle/oracle-timesten-samples/tree/master/languages/nodejs`

Refer to `README.md` at that location for information.

Documentation Accessibility

For information about Oracle's commitment to accessibility, visit the Oracle Accessibility Program website at `http://www.oracle.com/pls/topic/lookup?ctx=acc&id=docacc`.

Access to Oracle Support

Oracle customers that have purchased support have access to electronic support through My Oracle Support. For information, visit `http://www.oracle.com/pls/topic/lookup?ctx=acc&id=info` or visit `http://www.oracle.com/pls/topic/lookup?ctx=acc&id=trs` if you are hearing impaired.

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