ADO.NET

SoftUni Team

Technical Trainers

Software University

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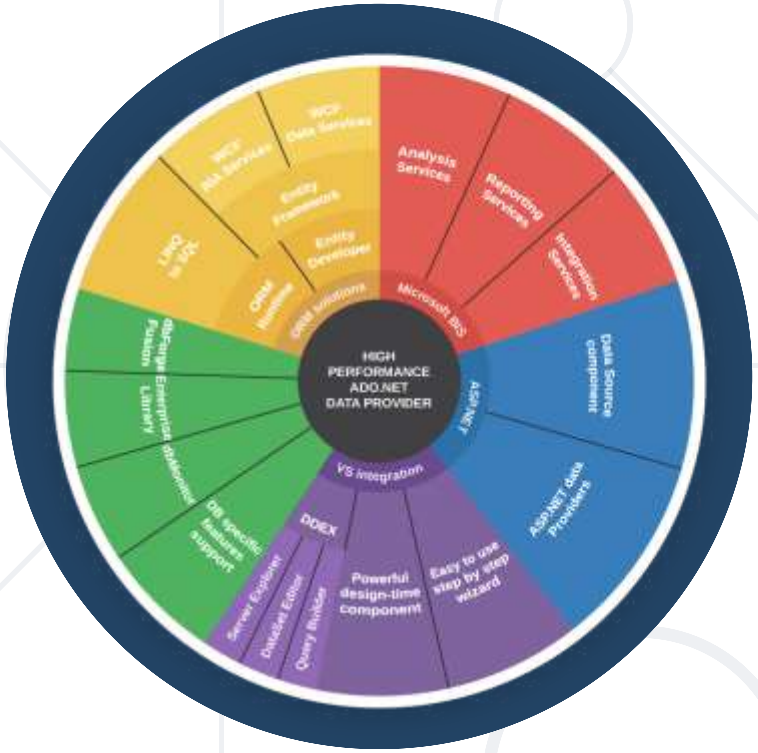
#csharp-db


HIGH PERFORMANCE ADO.NET DATA PROVIDER
Microsoft BIS
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ADO.NET

What is ADO.NET?

- **ADO.NET** is a standard **.NET class library** for accessing databases, processing data and XML
  - NuGet package for SQL Server: **`Microsoft.Data.SqlClient`**
  - https://github.com/dotnet/SqlClient
- Supports connected, disconnected and ORM data access models
  - Excellent integration with **LINQ**
  - Allows executing SQL in **RDBMS** systems
  - Allows accessing data in the **ORM** approach

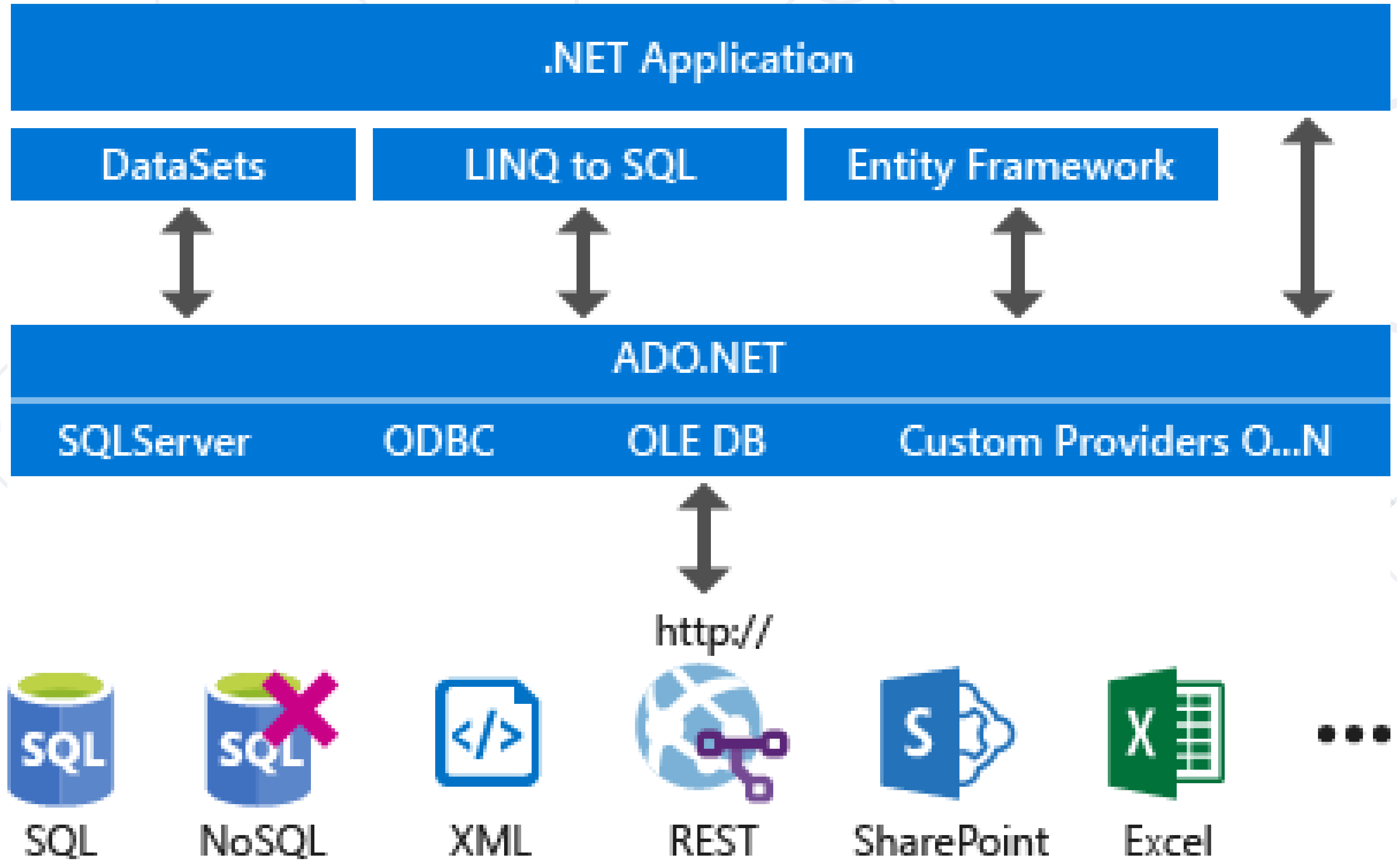
Data Providers in ADO.NET (1)

- Data Providers are collections of classes that provide access to various databases
  - For different RDBMS systems different **Data Providers** are available
- Several common objects are defined
  - **`Connection`** – to connect to the database
  - **`Command`** – to run an SQL command
  - **`DataReader`** – to retrieve data

Data Providers in ADO.NET (2)

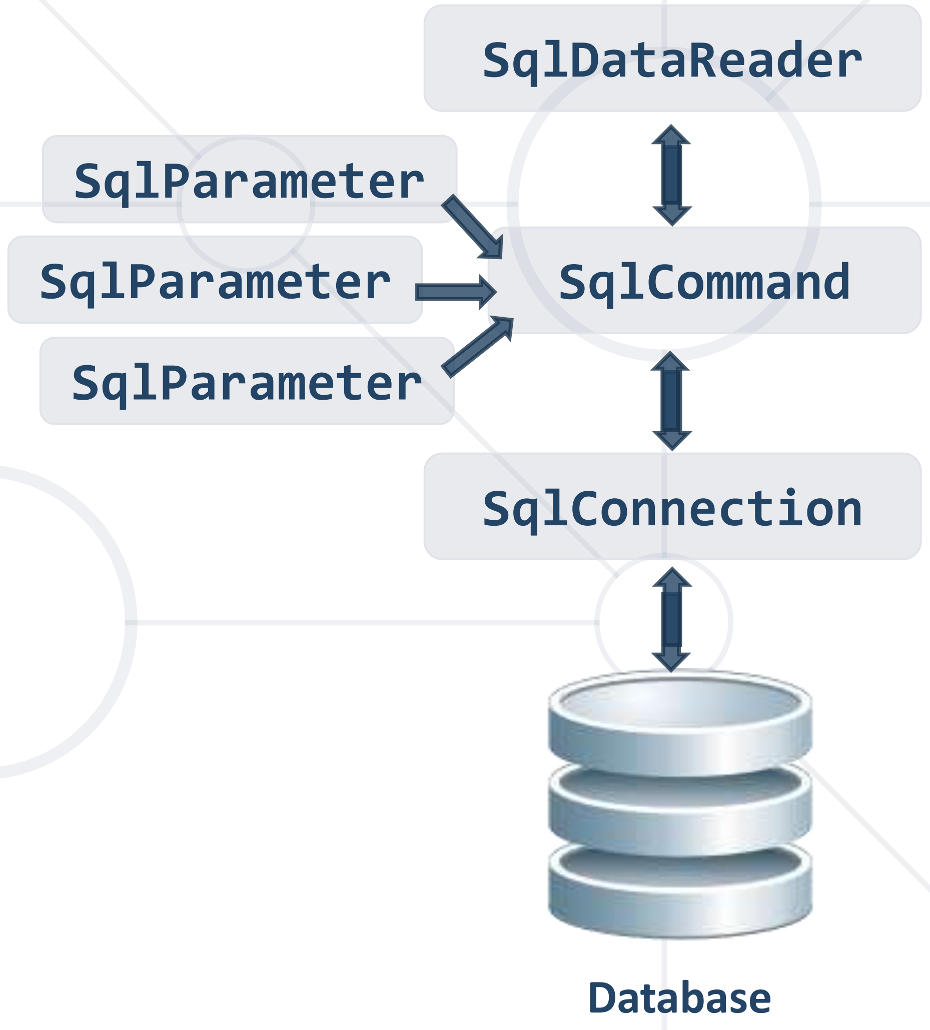
- Several standard ADO.NET Data Providers come as part of .NET Framework
  - **SqlClient** – accessing **SQL Server**
  - **OleDB** – accessing standard **OLE DB** data sources
  - **Odbc** – accessing standard **ODBC** data sources
  - **Oracle** – accessing **Oracle** databases
- Third party Data Providers are available for:
  - **MySQL**, **PostgreSQL**, **Interbase**, **DB2**, **SQLite**
  - Other RDBMS systems and data sources
    - SQL Azure, Salesforce CRM, Amazon SimpleDB, …

.NET, EF, ADO.NET and Data Providers



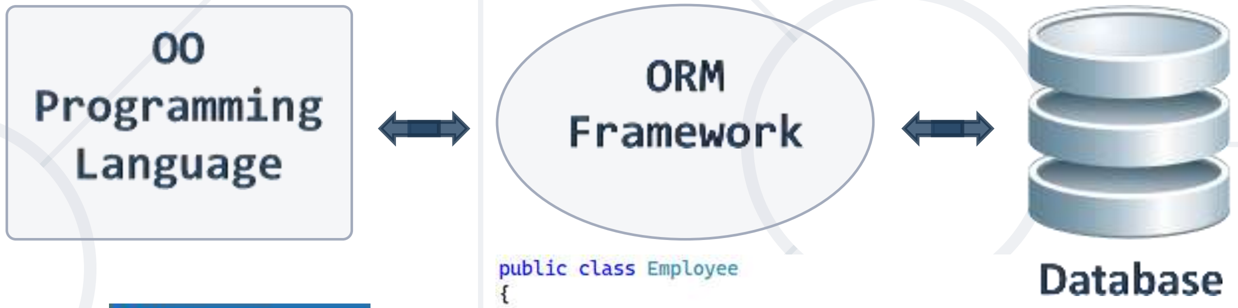
SqlClient and ADO.NET Connected Model

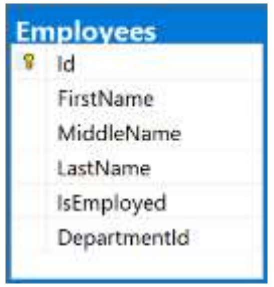
- Retrieving data in connected model
  - Open a connection (**SqlConnection**)
  - Execute command (**SqlCommand**)
  - Process the result set of the query by using a reader (**SqlDataReader**)
  - Close the reader
  - Close the connection



ORM (Object-Relational Mapping)

- **ORM data access model** (Entity Framework Core)
  - Maps **database tables** to **classes** and **objects**
  - Objects can be **automatically persisted** in the database
  - Can operate in both connected and disconnected modes





```
public class Employee
{
    public int Id { get; set; }
    public string FirstName { get; set; }
    public string MiddleName { get; set; }
    public string LastName { get; set; }
    public bool IsEmployed { get; set; }
    public Department Department { get; set; }
}
```

ORM – Benefits and Problems

- **ORM benefits**
  - Less code
  - Use objects with **associations** instead of tables and SQL
  - Integrated object query mechanism
- **ORM drawbacks**
  - Less flexibility
    - SQL is automatically generated
  - Performance issues (sometimes)

ADO.NET: Entity Framework Core

- **Entity Framework Core** is a generic **ORM** framework
  - Create entity data model mapping the database
  - Open an object context
  - Retrieve data with LINQ / modify the tables in the object context
  - Persist the object context changes into the DB
  - Connection is automatically managed

Accessing SQL Server from ADO.NET

SqlClient Data Provider

- `SqlConnection`
  - Establishes database connection to SQL Server
- `SqlCommand`
  - Executes SQL commands on the SQL Server through an established connection
  - Could accept parameters (`SQLParameter`)
- `SqlDataReader`
  - Retrieves data (record set) from SQL Server as a result of SQL query execution

The SqlConnection Class

- **SqlConnection** establishes a connection to SQL Server database
  - Requires a valid **connection string**
- Connection string example

```
Server=(local)\SQLEXPRESS;Initial
Catalog=SoftUni;Integrated Security=true;
```

- Connecting to SQL Server

```
SqlConnection con = new SqlConnection(
 @"Server=.;
   Database=SoftUni;
   Integrated Security=true");
con.Open();
```

DB Connection String

- **Database connection string**
  - Defines the parameters needed to establish the connection to the database
- Settings for **SQL Server connections**
  - **Data Source** / **Server** – server name / IP address + database instance name
  - **Database** / **Initial Catalog** – database name
  - **User ID** / **Password** – credentials
  - **Integrated Security** – false if credentials are provided

SqlConnection – Example

- Creating and opening connection to SQL Server (database `SoftUni`)

```
SqlConnection dbCon = new SqlConnection(
    "Server=.\\SQLEXPRESS; " +
    "Database=SoftUni; " +
    "Integrated Security=true");
dbCon.Open();
using (dbCon)
{
 // TODO: Use the connection to execute SQL commands here…
}
```

Working with SqlConnection

- Explicitly opening and closing a connection
  - `Open()` and `Close()` methods
  - Works through the connection pool
- DB connections are `IDisposable` objects
  - Always use the `using` construct in C#!

The SqlCommand Class

- More important methods
  - `ExecuteScalar()`
    - Returns a single value - the value in the first column of the first row of the result set (as `System.Object`)
  - `ExecuteReader()`
    - Returns a `SqlDataReader`
      - It is a cursor over the returned records (result set)
    - `CommandBehavior` – assigns some options
  - `ExecuteNonQuery()`
    - Used for non-query SQL commands, e.g. `INSERT`, `UPDATE`, `DELETE`, `CREATE`
    - Returns the number of affected rows (`int`)

SqlCommand – Example

```
SqlConnection dbCon = new SqlConnection(
  "Server=.; " +
  "Database=SoftUni; " +
  "Integrated Security=true");
dbCon.Open();
using(dbCon)
{
  SqlCommand command = new SqlCommand(
    "SELECT COUNT(*) FROM Employees", dbCon);
  int employeesCount = (int) command.ExecuteScalar();
  Console.WriteLine("Employees count: {0} ", employeesCount);
}
```

The SqlDataReader Class

- `SqlDataReader` retrieves a sequence of records (cursor) returned as result of an SQL command
  - Data is available for reading-only (can't be changed)
  - Forward-only row processing (no move back)
- Important properties and methods
  - `Read()` – moves the cursor forward and returns **`false`**, if there is no next record
  - `Indexer[]` – retrieves the value in the current record by given column name or index
  - `Close()` – closes the cursor and releases resources

SqlDataReader – Example

```
SqlConnection dbCon = new SqlConnection(…);
dbCon.Open();
using(dbCon)
{
  SqlCommand command = new SqlCommand("SELECT * FROM Employees", dbCon);
  SqlDataReader reader = command.ExecuteReader();
  using (reader)
  {
    while (reader.Read())
    {
      string firstName = (string)reader["FirstName"];
      string lastName = (string)reader["LastName"];
      decimal salary = (decimal)reader["Salary"];
      Console.WriteLine("{0} {1} - {2}", firstName, lastName, salary);
    }
  }
}
```

Fetch more rows until finished

SQL Injection

What is SQL Injection? How to Prevent It?

What is SQL Injection? (1)

```
bool IsPasswordValid(string username, string password)
{
  string sql =
    $"SELECT COUNT(*) FROM Users " +
    $"WHERE UserName = '{username}' AND" +
    $"PasswordHash = '{CalcSHA1(password)}'";
  SqlCommand cmd = new SqlCommand(sql, dbConnection);

  int matchedUsersCount = (int)cmd.ExecuteScalar();
  return matchedUsersCount > 0;
}
```

What is SQL Injection? (2)

```
bool normalLogin =
  IsPasswordValid("peter", "qwerty123"); // true

bool sqlInjectedLogin =
  IsPasswordValid(" ' or 1=1 --", "qwerty123"); // true

bool evilHackerCreatesNewUser =
  IsPasswordValid("' INSERT INTO Users VALUES('hacker','') --",
  "qwerty123");
```

How Does SQL Injection Work?

- The following SQL commands are executed
  - Usual password check (no SQL injection)

```
SELECT COUNT(*) FROM Users WHERE UserName = 'peter'
AND PasswordHash = 'XOwXWxZePV5iyeE86Ejvb+rIG/8='
```

  - SQL-injected password check

```
SELECT COUNT(*) FROM Users WHERE UserName = ' ' or 1=1
-- ' AND PasswordHash = 'XOwXWxZePV5iyeE86Ejvb+rIG/8='
```

  - SQL-injected INSERT command

```
SELECT COUNT(*) FROM Users WHERE UserName = ''
INSERT INTO Users VALUES('hacker','')
--' AND PasswordHash = 'XOwXWxZePV5iyeE86Ejvb+rIG/8='
```

Preventing SQL Injection

- Ways to prevent the SQL injection
  - SQL-escape all data coming from the user

```
string escapedUsername = username.Replace("'", "''");
string sql =
    "SELECT COUNT(*) FROM Users " +
    "WHERE UserName = '" + escapedUsername + "' and " +
    "PasswordHash = '" + CalcSHA1(password) + "'";
```

    - Not recommended: use as last resort only!
  - Preferred approach
    - Use **parameterized queries**
    - Separate the SQL command from its arguments

The SqlParameter Class

- What are `SqlParameters`?
  - SQL queries and stored procedures can have input and output parameters
  - Accessed through the `Parameters` property of the `SqlCommand` class
- Properties of `SqlParameter`
  - `ParameterName` – name of the parameter
  - `DbType` – SQL type (`NVarChar`, `Timestamp`, …)
  - `Size` – size of the type (if applicable)
  - `Direction` – input / output

Parameterized Commands – Example

```
void InsertProject(string name, string description, DateTime startDate)
{
  SqlCommand cmd = new SqlCommand(
    "INSERT INTO Projects " +
    "(Name, Description, StartDate, EndDate) VALUES " +
    "(@name, @desc, @start, @end)", dbCon);

  cmd.Parameters.AddWithValue("@name", name);
  cmd.Parameters.AddWithValue("@desc", description);
  cmd.Parameters.AddWithValue("@start", startDate);

  cmd.ExecuteNonQuery();
}
```

Summary

- **ADO.NET** provides an interface between our apps and the database engine
- Different engines can be used with other data providers
- SQL **commands** must be **parametrized** to prevent malicious behavior

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