Using .NET and the ADO.NET Managed Provider with Caché

Version 2018.1
2020-11-13

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Caché Version 2018.1 2020-11-13

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About This Book

This book is a guide to the Caché .NET Object Binding and the Caché implementation of the ADO.NET Managed Provider.

This book contains the following sections:

- Introduction — provides information on installation, project configuration, binding architecture, and sample programs.
- Connecting to the Caché Database — provides detailed information about database connections (including connection pooling) relevant to both native Caché object access and ADO.NET Managed Provider relational access.
- Using the Caché Object Binding for .NET — provides instructions for creating proxy classes, and gives concrete examples of how to use proxy objects in your code.
- Using ADO.NET Managed Provider Classes — gives concrete examples using the Caché implementation of the ADO.NET Managed Provider API.
- Using the Caché Entity Framework Provider—describes how to setup and get started using the Caché implementation of Entity Framework Provider.
- Using the Caché Dynamic Binding — describes an alternate version of Caché native object access that allows an application to access Caché objects on the server without first generating proxy classes.

Web Services (SOAP) can also be used to exchange data between Caché and .NET client applications. For more information, refer to the following online documents:

- Creating Web Services and Web Clients in Caché in the Caché Language Bindings section.
- Caché Managed Provider for .NET Tutorial in the Caché Tutorials section.

There is also a detailed Table of Contents.

For general information, see *Using InterSystems Documentation*.

1

Introduction

This book describes how to use the CacheClient .NET assembly, which provides two different but complimentary ways to access Caché from a .NET application:

- *The Caché .NET Object Binding* — provides high-performance native object access to data using auto-generated proxy classes. These proxy classes correspond to persistent objects stored within the Caché database and provide object persistence, retrieval, data caching, and life-cycle management (see "Using the Caché Object Binding for .NET").
- *The Caché implementation of the ADO.NET Managed Provider* — provides easy relational access to data using the standard ADO.NET Managed Provider classes (see "Using ADO.NET Managed Provider Classes").

This combination is unique in that it provides a .NET application with simultaneous relational and object access to data, using a common API and without requiring any object-to-relational mapping. The CacheClient assembly is implemented using .NET managed code throughout, making it easy to deploy within a .NET environment. It is thread-safe and can be used within multithreaded .NET applications.

1.1 Installation and Configuration

This section provides specifies requirements and provides instructions for installing Caché and configuring Visual Studio.

1.1.1 Requirements

- The .NET Framework, versions 2.0, 3.0, 4.0, or 4.5.
- Caché 5.1 or higher
- Visual Studio 2008 or 2010. Visual Studio 2010 is required when using .NET 4.0 or 4.5.

Caché is not required on computers that run your Caché .NET client applications, but they must have a TCP/IP connection to the Caché Server and must be running a supported version of the .NET Framework.

1.1.2 Installation

The CacheClient assembly (InterSystems.Data.CacheClient.dll) is installed along with the rest of Caché, and requires no special preparation.

- When installing Caché in Windows, select the `Setup Type: Development` option.

- If Caché has been installed with security level 2, open the Management Portal and go to System Administration > Security > Services, select %Service_CallIn, and make sure the Service Enabled box is checked. If you installed Caché with security level 1 (minimal) it should already be checked.

To use the CacheClient assembly in a .NET project, you must add a reference to the assembly, and add the corresponding Using statements to your code (as described in the following section, "Configuring Visual Studio").

There is a separate version of InterSystems.Data.CacheClient.dll for each supported version of .NET. In the current release of Caché, these files are located in the following subdirectories of <Cache-install-dir>\dev\dotnet\bin:

- .NET version 2.0: \bin\v2.0.50727
- .NET version 3.0: \bin\v3.0
- .NET version 4.0: \bin\v4.0.30319
- .NET version 4.5: \bin\v4.5

See "Caché Installation Directory" in the *Caché Installation Guide* for the location of <Cache-install-dir> on your system.

All Caché assemblies for .NET are installed to the .NET GAC (Global Assembly Cache) when Caché is installed.

1.1.3 Configuring Visual Studio

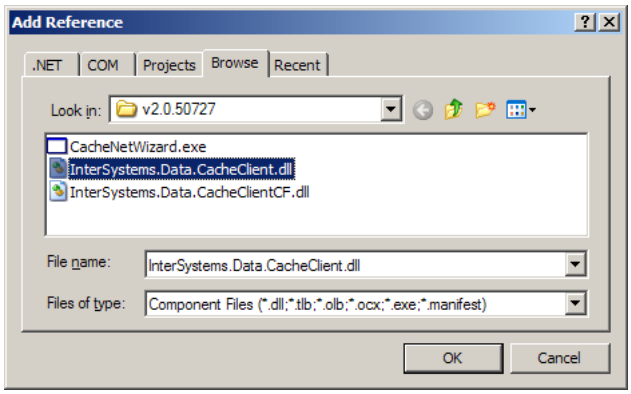
This chapter describes how to set up a Visual Studio project using the CacheClient assembly, and how to add the Caché Object Binding Wizard to Visual Studio. The following topics are covered:

- Configuring a Visual Studio Project — describes how to add a CacheClient assembly reference and Using statements.
- Adding the Caché Object Binding Wizard to Visual Studio — describes how to add the Caché proxy class creation wizard to the Visual Studio Tools menu.

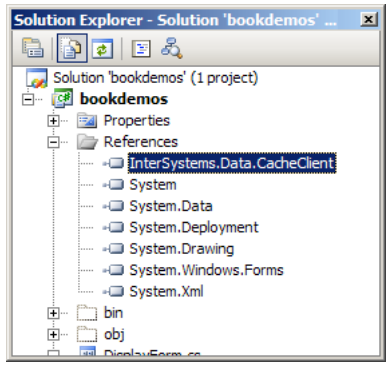
1.1.3.1 Configuring a Visual Studio Project

To add a CacheClient assembly reference to a project:

1. From the Visual Studio main menu, select Project > Add Reference
2. In the Add Reference window, click on Browse...
3. Browse to the subdirectory of <Cache-install-dir>\dev\dotnet\bin that contains the assembly for the version of .NET used in your project (see "Installation"), select InterSystems.Data.CacheClient.dll, and click OK.



4. In the Visual Studio Solution Explorer, the InterSystems.Data.CacheClient assembly should now be listed under References:



Add Using Statements to the Application

Add `Using` statements for the two main namespaces in the InterSystems.Data.CacheClient.dll assembly before the beginning of your application's namespace.

```
using InterSystems.Data.CacheClient;
using InterSystems.Data.CacheTypes;

namespace DotNetSample {
  ...
}
```

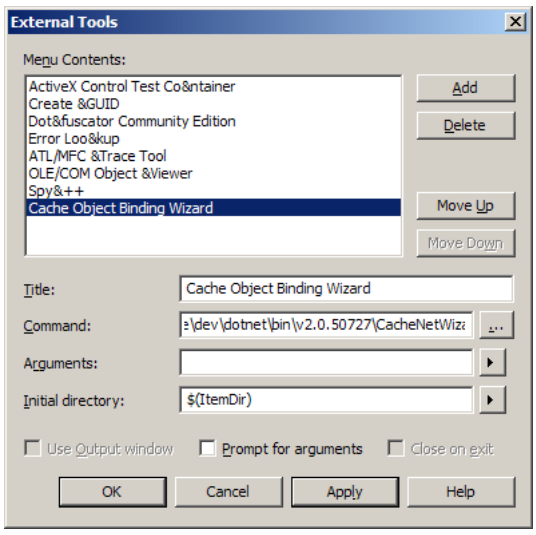
Both the CacheClient and CacheTypes namespaces are included in the InterSystems.Data.CacheClient.dll assembly.

1.1.3.2 Adding the Object Binding Wizard to Visual Studio

The Caché Object Binding Wizard is a program to generate Caché proxy objects (see "Using the Caché Object Binding Wizard"). It can be run from the command line, but will be more readily available if you integrate it into Visual Studio by adding it to the `External Tools` menu.

To add the Caché Object Binding Wizard to the `Tools` menu:

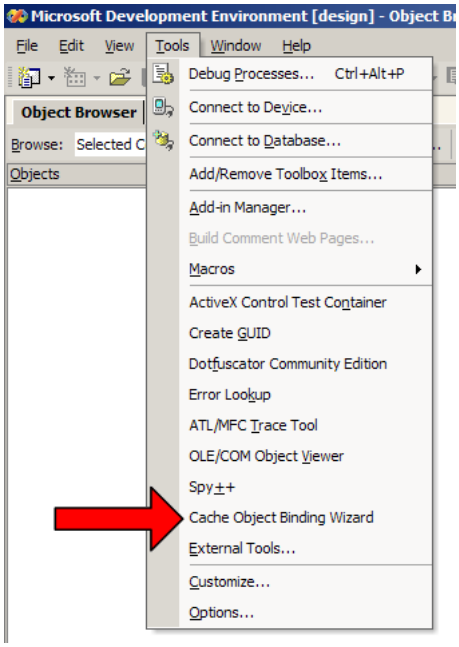
1. From the Visual Studio main menu, select `Tools > External Tools...`



2. In the `External Tools` window:
   - Click `Add`
   - In the `Title` field, enter : `Cache Object Binding Wizard`

- In the Command field, browse to the <Cache-install-dir>\dev\dotnet\bin\v2.0.50727 directory and select CacheNetWizard.exe. (Although this executable is located in the .NET 2.0 directory, it provides the Binding Wizard for all supported versions of .NET. For the location of <Cache-install-dir> on your system, see "Caché Installation Directory" in the *Caché Installation Guide*).
- Click OK

The Caché Object Binding Wizard now will be displayed as an option on the Visual Studio Tools menu.



1.2 Caché .NET Binding Architecture

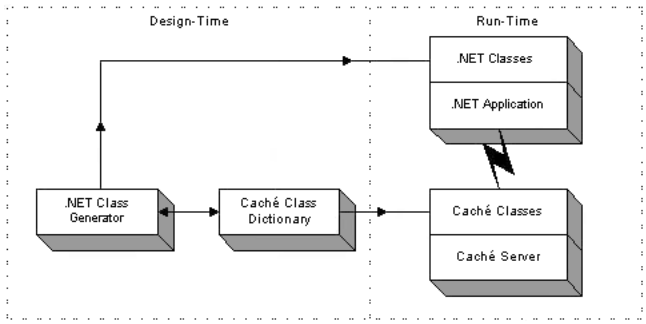
The Caché .NET binding gives .NET applications a way to interoperate with objects contained within a Caché server. These objects can be persistent objects stored within the Caché object database or they can be transient objects that perform operations within a Caché server.

The Caché .NET Binding consists of the following components:

- *The Caché Object Server* — a high performance server process that manages communication between .NET objects and a Caché database server using standard networking protocols (TCP/IP). Caché uses a common server for .NET, C++, Java, Perl, Python, ODBC, and JDBC access.
- *The InterSystems.Data.CacheClient assembly* — a set of .NET classes that implement all the functionality of the .NET classes created by the Caché Proxy Generator. It also provides a set of proxy classes for a few Object Server classes that are projected differently to make them fit into the framework of the .NET standard library.
- *The Caché Proxy Generator* — a set of methods that generate .NET classes from classes defined in the Caché Class Dictionary. Several different interfaces are available (see "Generating Caché Proxy Classes").

The Proxy Generator can create .NET proxy classes for any class in the Caché Class Dictionary. The proxy classes contain only managed .NET code, which the Proxy Generator creates by inspecting the class definitions found in the Caché Class Dictionary. Instances of the .NET proxy classes on the client communicate at runtime (using TCP/IP sockets) with their corresponding Caché objects on a Caché server. This is illustrated in the following diagram:

Figure 1–1: Caché .NET Binding Client/Server Architecture



The basic mechanism works as follows:

- You define one or more classes within Caché. These can be persistent objects stored within the Caché database or transient objects that run within a Caché server.
- The Caché Proxy Generator creates .NET proxy classes that correspond to your Caché classes. These classes contain stub methods and properties that correspond to Caché object methods and properties on the server.
- At runtime, your .NET application connects to a Caché server. It can then create instances of .NET proxy objects that correspond to objects within the Caché server. You can use these proxy objects as you would any other .NET objects. Caché automatically manages all communications as well as client-side data caching.

The runtime architecture consists of the following:

- A Caché database server (or servers).
- A .NET client application into which your generated and compiled .NET proxy classes have been linked.

At runtime, the .NET application connects to Caché using an object connection interface (provided by the CacheConnection class). All communication between the .NET application and the Caché server uses the standard TCP/IP protocol.

1.3 The Caché .NET Help File

The Caché .NET help file provides the most current and detailed documentation for both object and relational APIs. Although the file is named CacheProvider.chm, it covers both ADO.NET Managed Provider classes (InterSystems.Data.CacheClient) and Object Binding classes (InterSystems.Data.CacheClient.ObjBind), as well as classes used by both bindings. CacheProvider.chm is available as a stand-alone help file in <Cache-install-dir>\dev\dotnet\help.

1.4 The Caché .NET Sample Programs

Caché comes with a set of sample projects that demonstrate the use of the Caché .NET binding. These samples are located in the <Cache-install-dir>/dev/dotnet/samples/ subdirectory of the Caché installation (see "Caché Installation Directory" in the *Caché Installation Guide* for the location of <Cache-install-dir> on your system).

- adoform — A simple program to access and manipulate the Sample.Person database. The same program is presented in three different Visual Studio languages: C#, Basic, and C++.
- bookdemos — Contains complete, working versions of the examples in this document. The project is a small, easily modified test bed for short sample routines. All of the relevant sample code is in one file: SampleCode.cs. You may

need to regenerate the ..\bookdemos\WizardCode.cs file, which contains proxy classes for the Sample package (see "Generating Caché Proxy Classes" for detailed instructions).

- console — A console program that demonstrates the bare minimum requirements for a Caché .NET project.
- mobiledevice — Similar to adoform, but demonstrates how the mobile version of the CacheClient assembly deals with transient connections.
- objbind — Similar to adoform, but demonstrates how to write code that uses both ADO.NET Managed Provider classes and Caché Object Binding classes in a complementary fashion.

All of these projects use classes from the Sample package in the SAMPLES namespace. You can use Studio to examine the ObjectScript code for these classes.

Note: Most of these samples are written only in C#. If you decide to convert a sample to Visual Basic, bear in mind that a new Visual Basic .NET project will have a default namespace that contains every class defined by the project. If this is ignored, code such as:

```
Dim p As New Sample.Person
p = p.OpenId(CacheConnection, "1")
```

will fail because the root namespace has not been referenced. This can be easily corrected by disabling the "Root namespace" option in the Visual Studio project preferences.

2

Connecting to the Caché Database

This chapter describes how to create a connection between your client application and the Caché Server using a CacheConnection object. Such connections are used by both Caché Object Binding classes and ADO.NET Managed Provider classes

2.1 Creating a Connection

The code below establishes a connection to the SAMPLES namespace used by most Caché sample programs (see "The Caché .NET Sample Programs" for details). The connection object is usable by any class that requires a Caché connection, regardless of whether you are using Caché Object Binding classes, ADO.NET Managed Provider classes, or both. See "Connection Parameters" for a complete list of parameters that can be set when instantiating a connection object.

Add Code to Instantiate the Caché Connection

The following simple method could be called to start a connection:

```
public CacheConnection CacheConnect;
private void CreateConnection(){
  try {
    CacheConnect = new CacheConnection();
    CacheConnect.ConnectionString =
      "Server=localhost; Port=1972; Namespace=SAMPLES;"
      + "Password=SYS; User ID=_SYSTEM;";
    CacheConnect.Open();
  }
  catch (Exception eConn){
    MessageBox.Show("CreateConnection error: " + eConn.Message);
  }
}
```

This example defines the CacheConnection object as a global that can be used anywhere in the program. Once the object has been created, it can be shared among all the classes that need it. The connection object can be opened and closed as necessary. You can do this explicitly by using **CacheConnect.Open()** and **CacheConnect.Close()**. If you are using an ADO.NET Dataset, instances of DataAdapter will open and close the connection automatically, as needed.

Use the CacheConnection.ConnectDlg() Method

You can also prompt the user for a connection string. The previous example could be rewritten as follows:

```
private void CreateConnection(){
  try {
    CacheConnect = new CacheConnection();
    CacheConnect.ConnectionString = CacheConnection.ConnectDlg();
    CacheConnect.Open();
  }
...
```

The **ConnectDlg()** method displays the standard Caché connection dialog and returns the user's input as a connection string.

2.2 Connection Pooling

Connection pooling is on by default. The following connection string parameters can be used to control various aspects of connection pooling:

- `Pooling` — Defaults to `true`. Set `Pooling` to `false` to create a connection with no connection pooling.
- `Max Pool Size` and `Min Pool Size` — Default values are `0` and `100`. Set these parameters to specify the maximum and minimum (initial) size of the connection pool for this specific connection string.
- `Connection Reset` and `Connection Lifetime` — Set `Connection Reset` to `true` to turn on the pooled connection reset mechanism. `Connection Lifetime` specifies the number of seconds to wait before resetting an idle pooled connection. The default value is `0`.

For example, the following connect string sets the initial size of the connection pool to 2 and the maximum number of connections to 5, and activates connection reset with a maximum connection idle time of 3 seconds:

```
CacheConnect.ConnectionString =
  "Server = localhost;"
  + " Port = 1972;"
  + " Namespace = SAMPLES;"
  + " Password = SYS;"
  + " User ID = _SYSTEM;"
  + " Min Pool Size = 2;"
  + " Max Pool Size = 5;"
  + " Connection Reset = true;"
  + " Connection Lifetime = 3;";
```

The CacheConnection class also includes the following static methods that can be used to control pooling:

ClearPool(conn)

```
CacheConnection.ClearPool(conn);
```

Clears the connection pool associated with connection `conn`.

ClearAllPools()

```
CacheConnection.ClearAllPools();
```

Removes all connections in the connection pools and clears the pools.

2.2.1 Using the CachePoolManager Class

The CacheClient.CachePoolManager class can be used to monitor and control connection pooling programmatically. The following static methods are available:

ActiveConnectionCount

```
int count = CachePoolManager.ActiveConnectionCount;
```

Total number of established connections in all pools. Count includes both idle and in-use connections.

IdleCount()

```
int count = CachePoolManager.IdleCount();
```

Total number of idle connections in all the pools.

IdleCount(conn)

```
int count = CachePoolManager.IdleCount(conn);
```

Total number of idle connections in the pool associated with connection object `conn`.

InUseCount()

```
int count = CachePoolManager.InUseCount();
```

Total number of in-use connections in all pools.

InUseCount(conn)

```
int count = CachePoolManager.InUseCount(conn);
```

Total number of in-use connections in the pool associated with connection object `conn`.

RecycleAllConnections(Boolean)

```
CachePoolManager.RecycleAllConnections(bool remove);
```

Recycles connections in all pools

RecycleConnections(conn, Boolean)

```
CachePoolManager.RecycleConnections(conn,bool remove)
```

Recycles connections in the pool associated with connection object `conn`.

RemoveAllIdleConnections()

```
CachePoolManager.RemoveAllIdleConnections();
```

Removes idle connections from all connection pools.

RemoveAllPoolConnections()

```
CachePoolManager.RemoveAllPoolConnections();
```

Deletes all connections and removes all pools, regardless of what state the connections are in.

For a working example that uses most of these methods, see the **Proxy_9_Connection_Pools()** method in the bookdemos sample program (see "The Caché .NET Sample Programs").

2.3 Caché Server Configuration

Very little configuration is required to use a .NET client with a Caché Server process. The sample programs provided with Caché should work with no change following a default Caché installation. This section describes the server settings required for a connection, and some troubleshooting tips.

Every .NET client that wishes to connect to a Caché Server needs the following information:

- A URL that provides the server IP address, port number, and Caché namespace.
- A case-sensitive username and password.

By default, the sample programs use the following connection information:

- connection string: "localhost[1972]:SAMPLES"
- username: "_SYSTEM"
- password: "SYS"

Check the following points if you have any problems:

- Make sure that the Caché Server process is installed and running.
- Make sure that you know the IP address of the machine on which the Caché Server process is running. The sample programs use "localhost". If you want a sample program to default to a different system you will need to change the connection string in the code.
- Make sure that you know the TCP/IP port number on which the Caché Server is listening. The sample programs use "1972". If you want a sample program to default to a different port, you will need change the number in the sample code.
- Make sure that you have a valid username and password to use to establish a connection. (You can manage usernames and passwords using the Management Portal: System Administration > Security > Users). The sample programs use the administrator username "_SYSTEM" and the default password "SYS". Typically, you will change the default password after installing the server. If you want a sample program to default to a different username and password, you will need to change the sample code.
- Make sure that your connection URL includes a valid Caché namespace. This should be the namespace containing the classes and data your program uses. The samples connect to the SAMPLES namespace, which is pre-installed with Caché.

2.4 Connection Parameters

The following tables describe all parameters that can be used in a connection string.

2.4.1 Required Parameters

The following five parameters are required for all connection strings (see “Creating a Connection”).

Table 2–1: Required Parameters

Name	Description
SERVER	IP address or host name. For example: `Server = localhost` *alternate names:* ADDR, ADDRESS, DATA SOURCE, NETWORK ADDRESS
PORT	Specifies the TCP/IP port number for the connection. For example: `Port = 1972`
NAMESPACE	Specifies the namespace to connect to. For example: `Namespace = SAMPLES` *alternate names:* INITIAL CATALOG, DATABASE
PASSWORD	User's password. For example: `Password = SYS` *alternate name:* PWD
USER ID	set user login name. For example: `User ID = _SYSTEM` *alternate names:* USER, UID

2.4.2 Connection Pooling Parameters

The following parameters define various aspects of connection pooling (see "Connection Pooling").

Table 2–2: Connection Pooling Parameters

Name	Description
CONNECTION LIFETIME	The length of time in seconds to wait before resetting an idle Pooled connection when the connection reset mechanism is on. Default is `0`.
CONNECTION RESET	Turn on Pooled connection reset mechanism (used with CONNECTION LIFETIME). Default is `false`.
MAX POOL SIZE	Maximum size of connection pool for this specific connection string. Default is `100`.
MIN POOL SIZE	Minimum or initial size of the connection pool, for this specific connection string. Default is `0`.
POOLING	Turn on connection pooling. Default is `true`.

2.4.3 Other Connection Parameters

The following optional parameters can be set if required.

Table 2–3: Other Connection Parameters

Name	Description
APPLICATION NAME	Sets the application name.
CONNECTION TIMEOUT	Sets the length of time in seconds to try and establish a connection before failure. Default is `30`. *alternate name:* CONNECT TIMEOUT
CURRENT LANGUAGE	Sets the language for this process.
LOGFILE	Turns on logging and sets the log file location. *alternate name:* LOG FILE.
PACKET SIZE	Sets the TCP Packet size. Default is `1024`.
PREPARSE CACHE SIZE	Sets an upper limit to the number of SQL commands that will be held in the preparse cache before recycling is applied. Default is `200`.
SO RCVBUF	Sets the TCP receive buffer size. Default is `0` (use system default value). *alternate name:* SO_RCVBUF
SO SNDBUF	Sets the TCP send buffer size. Default is `0` (use system default value) *alternate name:* SO_SNDBUF
SSL	Specifies whether SSL/TLS secures the client-server connection (see "Configuring .NET Clients to Use SSL/TLS with Caché" in the *Caché Security Administration Guide*). Default is `false`.
TCP NODELAY	Sets the TCP nodelay option. Default is `true`. *alternate name:* TCP_NODELAY
TRANSACTION ISOLATION LEVEL	Sets the System.Data.IsolationLevel value for the connection. *alternate name:* TRANSACTIONISOLATIONLEVEL
WORKSTATION ID	Sets the Workstation name for process identification.

3

Using the Caché Object Binding for .NET

One of the most important features of Caché is the ability to access database items as objects rather than rows in relational tables. In Caché .NET Binding applications, this feature is implemented using Caché proxy objects. Proxy objects are instances of .NET classes generated from classes defined in the Caché Class Dictionary. Each proxy object communicates with a corresponding object on the Caché server, and can be manipulated just as if it were the original object. The generated proxy classes are written in fully compliant .NET managed code, and can be used anywhere in your project.

This section gives some concrete examples of code using Caché proxy classes.

- Introduction to Proxy Objects — a simple demonstration of how proxy objects are used.
- Generating Caché Proxy Classes — using various tools to generate proxy classes.
- Using Caché Proxy Objects — using proxy objects to create, open, alter, save, and delete objects on the Caché server.
- Using Caché Queries — using a pre-existing Caché query to generate and manipulate a result set.
- Using Collections and Lists — manipulating Caché lists and arrays.
- Using Relationships — using Caché relationship objects to access and manipulate data sets.
- Using I/O Redirection — redirecting Caché Read and Write statements.

Although the examples in this chapter use only proxy objects to access Caché data, it is also possible to access database instances via ADO.NET classes and SQL statements (as described in "Using Caché ADO.NET Managed Provider Classes"). Both types of access can be used in the same program.

Note: The examples presented in this chapter are fragments from samples provided in the bookdemos project (see "The Caché .NET Sample Programs" for details). It is assumed that you are familiar with standard coding practices, so the fragments omit error trapping (try/catch) statements and other code that is not directly relevant to the examples. For complete, working versions of the code examples, see SampleCode.cs, located in <Cache-install-dir>\dev\dotnet\samples\bookdemos (see "Caché Installation Directory" in the *Caché Installation Guide* for the location of <Cache-install-dir> on your system).

3.1 Introduction to Proxy Objects

A Caché .NET project using proxy objects can be quite simple. Here is a complete, working console program that opens and reads an item from the `Sample.Person` database:

```
using System;
using InterSystems.Data.CacheClient;
using InterSystems.Data.CacheTypes;
```

```
namespace TinySpace {
  class TinyProxy {
    [STAThread]
    static void Main(string[] args) {

      CacheConnection CacheConnect = new CacheConnection();
      CacheConnect.ConnectionString = "Server = localhost; "
        + "Port = 1972; " + "Namespace = SAMPLES; "
        + "Password = SYS; " + "User ID = _SYSTEM;";
      CacheConnect.Open();

      Sample.Person person = Sample.Person.OpenId(CacheConnect, "1");
      Console.WriteLine("TinyProxy output: \r\n   "
          + person.Id() + ": "
          + person.Name
      );
      person.Close();
      CacheConnect.Close();
    } // end Main()
  } // end class TinyProxy
}
```

This project is almost identical to the one presented in "UsingCaché ADO.NET Managed Provider Classes" (which does not use proxy objects). Both projects contain the following important features:

- The same `Using` statements may be added:

  ```
  using InterSystems.Data.CacheClient;
  using InterSystems.Data.CacheTypes;
  ```

- The same code is used to create and open a connection to the Caché SAMPLES namespace:

  ```
  CacheConnection CacheConnect = new CacheConnection();
  CacheConnect.ConnectionString = "Server = localhost; "
    + "Port = 1972; " + "Namespace = SAMPLES; "
    + "Password = SYS; " + "User ID = _SYSTEM;";
  CacheConnect.Open();
  ```

- Both projects have code to open and read the instance of Sample.Person that has an `ID` equal to `1`.

It differs from the ADO.NET project in two significant ways:

1. The project includes a file (WizardCode.cs) containing code for the generated proxy classes. See "Generating Caché Proxy Classes" for a detailed description of how to generate this file and include it in your project.
2. The instance of Sample.Person is accessed through a proxy object rather than CacheCommand and CacheDataReader objects.

   No SQL statement is needed. Instead, the connection and the desired instance are defined by a call to the **OpenId()** class method:

   ```
   Sample.Person person = Sample.Person.OpenId(CacheConnect, "1");
   ```

   Each data item in the instance is treated as a method or property that can be directly accessed with dot notation, rather than a data column to be accessed with CacheReader:

   ```
   Console.WriteLine("TinyProxy output: \r\n   "
     + person.Id() + ": "
     + person.Name
   );
   ```

In many cases, code with proxy objects can be far simpler to write and maintain than the equivalent code using ADO.NET Managed Provider classes. Your project can use both methods of access interchangeably, depending on which approach makes the most sense in any given situation.

3.2 Generating Caché Proxy Classes

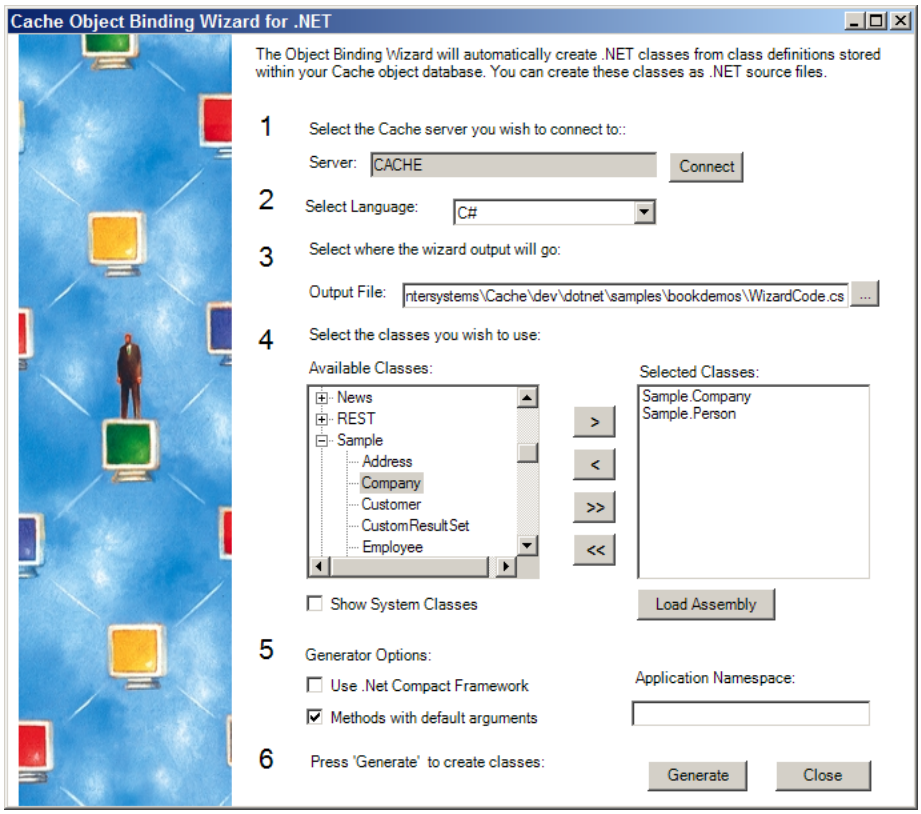
This section covers the following topics:

- Using the Caché Object Binding Wizard — a GUI program that leads you through the process of generating proxy classes.
- Running the Proxy Generator from the Command Line — a DOS program that allows you to generate proxy classes from a batch file or an ANT script.
- Generating Proxy Files Programmatically — calling the Proxy Generator methods directly to create proxy classes from within a .NET program.
- Adding Proxy Code to a Project — what to do with new proxy files once you've got them.
- Methods Inherited from Caché System Classes — a set of standard methods that the Proxy Generator adds to all proxy files.

3.2.1 Using the Caché Object Binding Wizard

The Caché Object Binding Wizard can be run either as a stand-alone program (CacheNetWizard.exe, located in <Cache-install-dir>\dev\dotnet\bin\v2.0.50727 by default) or as a tool integrated into Visual Studio (See "Adding the Caché Object Binding Wizard to Visual Studio").

When you start the Wizard, the following window is displayed:

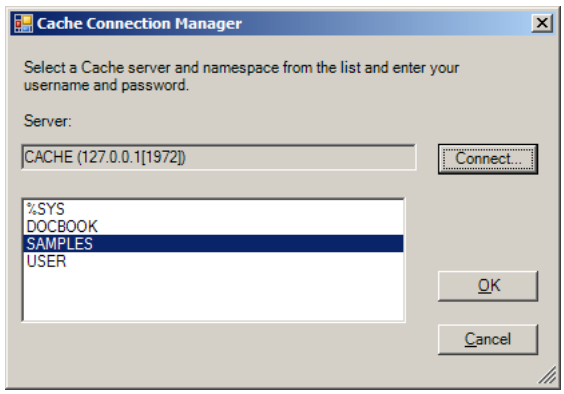


Enter the following information:

1. *Select the Caché server you wish to connect to:*

Select the server containing the Caché classes for which you want to generate .NET classes. To select the server:

- Click `Connect` and select your server
- Enter your username and password at the prompt. The `Cache Connection Manager` is displayed:



- Select the namespace containing your class (this will be SAMPLES for the bookdemos project)
- Click `OK`.

2. *Select language:*

   For the bookdemos project, you would select `Language: C#`.

3. *Select where the Wizard output will go:*

   Generally, this will be the same folder that contains the .csproj file for your project. In this example, the file will be named WizardCode.cs, and will be placed in the main bookdemos project directory.

4. *Select the classes you wish to use:*

   For this exercise, you should select the `Sample.Person` and `Sample.Company` classes from the SAMPLES namespace. The `Sample.Address` and `Sample.Employee` classes will be included automatically because they are used by `Sample.Person` and `Sample.Company`. If you check `Show System Classes`, classes from %SYS (the standard Caché Class Library) will be displayed along with those from SAMPLES.

5. *Generator options:*

   For this exercise, check `Methods with default arguments` and leave the other fields empty. The options are:

   - *Use .Net Compact Framework* — generate proxy code for mobile applications.
   - *Methods with default arguments* — generates some optional overloads for certain system methods.
   - *Application Namespace* — optional namespace that will be added to the names of all generated proxy classes. For example, if you entered `MyNamespace`, the generated code would contain references to `MyNamespace.Sample.Person` rather than just `Sample.Person`.

     Note: The server will not know about this namespace. To ensure that proxy objects referenced through relations will be generated properly, you should either use the name of your application's main assembly, or set CacheConnection.AppNamespace to the value you enter here (see "Instantiating a Proxy Object by Name" in "Using Caché Proxy Objects" for more information).

6. *Press 'Generate' to create classes:*

   The generated file can now be added to your project (see "Adding Proxy Code to a Project").

3.2.2 Running the Proxy Generator from the Command Line

The command-line proxy generator program (dotnet_generator.exe, located in <Cache-install-dir>\dev\dotnet\bin\v2.0.50727

by default) is useful when the same set of proxy files must be regenerated frequently. This is important when the Caché classes are still under development, since the proxy classes must be regenerated whenever the interface of a Caché class changes.

Required arguments

The command-line generator always requires information about the connection string, output path and type of output file (cs or vb), and a list of the classes to be generated. The following arguments are used:

- `-conn <connection string>` — standard connection string (see "Creating a Connection").
- If generating a single output file for all classes, use `-path`:
  - `-path <full filename>` — path and name of the output file for the generated code. Type of output file to be generated is determined by extension of the filename (for example, C:\somepath\WizardCode.vb will generate a Visual Basic code file).
- If generating one output file for each class, use `-dir` and `-src-kind`:
  - `-dir <path>` — directory where the generated proxy files will be placed.
  - `-src-kind <cs|vb>` — type of proxy file to generate. For each class, a file named `<namespace_classname>.<src-kind>` will be generated in the directory specified by `-dir`. Options are `cs` or `vb`.
- `-class-list <full filename>` — path and name of a text file containing a list of the classes to be used. Each class name must be on a separate line.

Optional arguments

The following optional arguments are also available:

- `-gen-default-args <true | false>` — switch that controls generation of optional overloads to certain generated system methods. Options are `true` or `false`.
- `-app-nsp<namespace>` — optional namespace that will be added to the names of all generated proxy classes. For example, if you entered `MyNamespace`, the generated code would contain references to `MyNamespace.Sample.Person` rather than just `Sample.Person`..
- `-use-cf <true | false>` — switch that controls whether code is generated for mobile devices or standard PCs. Options are `true` or `false`.

Example

The DOS batch file in this example calls `dotnet_generator` twice, generating the following output:

1. The first call generates a single file containing several proxy classes. This command generates exactly the same WizardCode.cs file as the Object Binding Wizard (see the example in "Using the Caché Object Binding Wizard").
2. The second call generates one proxy file for each class, and generates Visual Basic code rather than C#. The filenames will be of the form <namespace_classname>.vb.

Both calls use the same connection string, output directory, and class list file.

```
set netgen=C:\Intersystems\Cache\dev\dotnet\bin\v2.0.50727\dotnet_generator.exe
set clist=C:\Intersystems\Cache\dev\dotnet\samples\bookdemos\Classlist.txt
set out=C:\Intersystems\Cache\dev\dotnet\samples\bookdemos
set conn="Server=localhost;Port=1972;Namespace=SAMPLES;Password=SYS;User ID=_SYSTEM;"

rem CALL #1: Generate a single WizardCode.cs proxy file
%netgen% -conn %conn% -class-list %clist% -path %out%\WizardCode.cs -gen-default-args true

rem CALL #2: Generate one <namespace_classname>.vb proxy file for each class
%netgen% -conn %conn% -class-list %clist% -dir %out% -src-kind vb -gen-default-args true
```

The contents of the class list file, Classlist.txt, are:

```
Sample.Company
Sample.Person
```

Although only two classes are listed, proxy classes for Sample.Address and Sample.Employee are generated automatically because they are used by Sample.Person and Sample.Company.

3.2.3 Generating Proxy Files Programmatically

The CacheConnection class includes the following methods that can be used to generate proxy files from within a .NET program:

CacheConnection.GenSourceFile()

Generates a new CS or VB proxy file that may contain definitions for several classes.

```
CacheConnection.GenSourceFile(filepath, generator, classlist, options, errors);
```

Parameters:

- `filepath` — A string containing the path and filename of the file to be generated.
- `generator` — A CodeDomProvider object that generates either CS or VB code.
- `classlist` — An IEnumerator iterator pointing to the list of classes that will be generated.
- `options` — a CacheClient.ObjBind.GeneratorOptions object.
- `errors` — An IList array used to store any returned error messages.

CacheConnection.GenMultipleSourceFiles()

Generates a separate CS or VB proxy file named `<classname>.<filetype>` for each class in classlist.

```
CacheConnection.GenMultipleSourceFiles(dirpath, filetype, generator, classlist, options, errors);
```

Parameters:

- `dirpath` — A string containing the directory path for the files to be generated.
- `filetype` — A string containing either `".vb"` or `".cs"`, depending on the code to be generated.
- `generator` — A CodeDomProvider object that generates either CS or VB code.
- `classlist` — An IEnumerator iterator pointing to the list of classes that will be generated.
- `options` — A CacheClient.ObjBind.GeneratorOptions object.
- `errors` — An IList array used to store any returned error messages.

For a working example that uses both methods, see the **Proxy_8_MakeProxyFiles()** method in the bookdemos sample program (see "The Caché .NET Sample Programs").

3.2.3.1 Using the Proxy Generator Methods

The following code fragments provide examples for defining the method parameters, and for calling each of the proxy generator methods.

generator parameter

The generator can be either a CSharpCodeProvider or a VBCodeProvider.

```
System.CodeDom.Compiler.CodeDomProvider CS_generator = new CSharpCodeProvider();
System.CodeDom.Compiler.CodeDomProvider VB_generator = new VBCodeProvider();
```

classlist parameter

Each of the methods accepts an iterator pointing to the list of classes to be generated. Although only two classes are listed in the following example, proxy classes for Sample.Address and Sample.Employee are generated automatically because they are used by Sample.Person and Sample.Company.

```
ArrayList classes = new ArrayList();
classes.Add("Sample.Company");
classes.Add("Sample.Person");

System.Collections.IEnumerator classlist
classlist = classes.GetEnumerator();
```

options parameter

In this example, no special namespace will be generated for the proxy code, a complete set of inherited methods will be generated for each class, and no extra code will be generated for use by mobile applications.

```
InterSystems.Data.CacheClient.ObjBind.GeneratorOptions options
options = new GeneratorOptions();
options.AppNamespace = "";
options.GenDefaultArgMethods = true;
options.UseCF = false;
```

errors parameter

The errors parameter will store the error messages (if any) returned from the proxy generator method call. All three methods use this parameter.

```
System.Collections.IList errors
errors = new System.Collections.ArrayList();
```

Example 1: Generate a new CS proxy file

This example generates a C# proxy file named WizardCode.cs in directory C:\MyApp\. The file will contain code for Sample.Person, Sample.Company, Sample.Address, and Sample.Employee.

```
string filepath = @"C:\MyApp\WizardCode.cs";
System.CodeDom.Compiler.CodeDomProvider generator = new CSharpCodeProvider();
conn.GenSourceFile(filepath, generator, classlist, options, errors);
```

Example 2: Generate a set of single-class VB proxy files

This example generates a single VB proxy file for each class.

```
string dirpath = @"C:\MyApp\";
string filetype = ".vb";
System.CodeDom.Compiler.CodeDomProvider generator = new VBCodeProvider();
conn.GenMultipleSourceFiles(dirpath, filetype, generator, classlist, options, errors);
```

The following files will be generated in C:\MyApp\:

```
Person.vb
Company.vb
Address.vb
Employee.vb
```

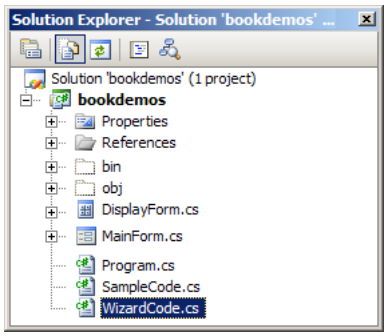
The proxy files for Sample.Address and Sample.Employee are generated automatically because they are used by Sample.Person and Sample.Company.

3.2.4 Adding Proxy Code to a Project

After generating .NET proxy files, add the code to your project as follows:

- From the Visual Studio main menu, select `Project > Add Existing Item...`
- Browse to the generated proxy file (or files, if you chose to generate one file for each class) and click Add.

The file will be listed in the Visual Studio Solution Explorer.



You can now use proxy objects as described in the following sections.

Important: A generated proxy class is not updated automatically when you change the corresponding Caché class. The generated classes will continue to work as long as there are no changes in the signatures of the properties, methods, and queries that were present when the proxy classes were generated. If any signatures have changed, the proxy class will throw CacheInvalidProxyException with a description of what was modified or deleted.

3.2.5 Methods Inherited from Caché System Classes

The proxy file generators also provide proxy methods for certain classes inherited from the standard Caché Class Library. For example, the Sample classes inherit methods from Caché %Library.Persistent and %Library.Populate. Proxies for these methods are automatically added when you generate the proxy files. This section provides a quick summary of the most commonly used methods. For more detailed information on a method, see the entries for these classes in the Caché Class Reference. For a generic guide to the use of Caché objects, see "Working with Registered Objects" in *Using Caché Objects*.

%Library.Persistent Methods

The following %Library.Persistent proxies are generated:

- **Id()** — Returns the persistent object ID, if there is one, of this object. Returns a null string if there is no object ID.

```
string ID = person.Id();
```

- **Save()** — Stores an in-memory version of an object to disk. If the object was stored previously (and thus, already has an OID), **Save()** updates the on-disk version. Otherwise, **Save()** saves the object and generates a new OID for it.

```
CacheStatus sc = person.Save();
```

- **Open()** — Loads an object from the database into memory and returns an OREF referring to the object.

- **OpenId()** — Loads an object from the database into memory and returns an OREF referring to the object. **OpenId()** is identical in operation to the **Open()** method except that it uses an ID value instead of an OID value to retrieve an instance.

```
Sample.Person person = Sample.Person.OpenId(CacheConnect, "1");
```

- **ExistsId()** — Checks to see if the object identified by the specified ID exists in the extent.

```
if (!(bool)Sample.Person.ExistsId(CacheConnect, ID)) {
  string Message = "No person with id " + ID + " in database."; };
```

- **DeleteId()** — Deletes the stored version of the object with the specified ID from the database.

```
CacheStatus sc = Sample.Person.DeleteId(CacheConnect, ID);
```

- **Extent()** — This is a system provided query that yields a result set containing every instance within this extent.

```
CacheCommand Command = Sample.Person.Extent(CacheConnect);
```

- **KillExtent()** — Deletes all instances of a class and its subclasses.

```
CacheStatus sc = Sample.Person.KillExtent(CacheConnect)
```

%Library.Populate Methods

The following %Library.Populate proxies are generated:

- **Populate()** — Creates a specified number of instances of a class and stores them in the database.

```
long newrecs = (long)Sample.Person.Populate(CacheConnect, 100);
```

- **OnPopulate()** — For additional control over the generated data you can define an **OnPopulate()** method within your class. If an **OnPopulate()** method is defined then the **Populate()** method will call it for each object it generates.
- **PopulateSerial()** — Create a single instance of a serial object.

For a working example that uses the **KillExtent()** and **Populate()** methods, see the **Proxy_6_Repopulate()** method in the bookdemos sample program (see "The Caché .NET Sample Programs").

3.3 Using Proxy Objects

Caché proxy objects can be used to perform most of the standard operations on instances in a database. This section describes how to open and read an instance, how to create or delete instances, and how to alter and save existing instances.

3.3.1 Opening and Reading Objects

Use the **OpenId()** method to access an instance by ID (instances can also be accessed through SQL queries, as discussed later in "Using Caché Queries"). **OpenId()** is a static class method, qualified with the type name rather than an instance name:

```
Sample.Person person = Sample.Person.OpenId(CacheConnect, "1");
```

Once the object has been instantiated, you can use standard dot notation to read and write the `person` information:

```
string Name = person.Name
string ID = person.Id();

person.Home.City = "Smallville";
person.Home.State = "MN";
```

In this example, `person.Home` is actually an embedded Sample.Address object. It is automatically created or destroyed along with the Sample.Person object.

For a working example, see the **Proxy_1_ReadObject()** method in the bookdemos sample program (see "The Caché .NET Sample Programs").

3.3.2 Creating and Saving Objects

Caché proxy object constructors use information in a CacheConnection object to create a link between the proxy object and a corresponding object on the Caché server:

```
Sample.Person person = new Sample.Person(CacheConnect);
person.Name = "Luthor, Lexus A.";
person.SSN = "999-45-6789";
```

Use the **Save()** method to create a persistent instance in the database. Once the instance has been saved, the **Id()** method can be used to get the newly generated ID number:

```
CacheStatus sc = person.Save();
Display.WriteLine("Save status: " + sc.IsOK.ToString());
string ID = person.Id();
Display.WriteLine("Saved id: " + person.Id());
```

The **ExistsId()** class method can be used to test whether or not an instance exists in the database:

```
string personExists = Sample.Person.ExistsId(CacheConnect, ID).ToString()
Display.WriteLine("person " + ID + " exists: " + personExists)
```

For a working example, see the **Proxy_2_SaveDelete()** method in the bookdemos sample program (see "The Caché .NET Sample Programs").

3.3.2.1 Instantiating a Proxy Object by Name

In some cases, an object that is returned from the server differs from the object that the client requested. For example, the client may request an instance of Sample.Person, but the server returns Sample.Employee. In order to instantiate an object of the desired class, the binding has to know the exact name of the proxy type, including the application namespace (if any).

When a proxy class is generated, there is an option to specify the namespace that contains it. For example, if the application namespace is MyAppNsp, the Sample.Person proxy class can be specified as MyAppNsp.Sample.Person. Alternatively, the object could be generated as Sample.Person and then `"MyAppNsp"` could be assigned to the connection.AppNamespace property. Either option allows the binding to deduce that the full name of the proxy type is `"MyAppNsp.Sample.Person"`.

The binding tries to avoid instantiation by name as much as possible, so if a class is already loaded in memory, the binding uses the type in memory to create an instance. In this case, the exact class name is not necessary. In the following example, **Y()** returns a proxy object that the client knows must be Sample.Person:

```
Sample.Person p = new Sample.Person(conn);
Sample.Person q = x.Y();
```

The first line creates object *p*, and loads Sample.Person in memory. In this case, the binding does not need to the full name, and **x.Y()** will not throw an exception. When the first line is commented out, the second line will fail if the full name of the proxy class is actually something like `"MyAppNsp.Sample.Person"`.

3.3.3 Closing Proxy Objects

The **Close()** method disconnects a proxy object and closes the corresponding object on the server, but does not change the persistent instance in the database:

```
person.Close();
```

Important: Always use **Close()** to destroy a proxy object.

Object reference counts are not maintained on the client. Every time the server returns an object (either by reference or as a return value) its reference count is increased. When **Close()** is called, the reference count is decreased. The object is closed on the server when the count reaches 0.

Do not use code such as:

```
person = nothing; //Do NOT do this!
```

This closes the proxy object on the client side, but does not decrement the reference count on the server. This could result in a situation where your code assumes that an object has been closed, but it remains open on the server.

By default **Close()** calls are cached. Although the proxy object can no longer be used, it is not actually destroyed until the reference count can be decremented on the server. This does not happen until the server is called again (for example, when a different proxy object calls a method).

In some situations, caching may not be desirable. For example, if an object is opened with Concurrency Level 4 (Exclusive Lock), the lock will not be released until the next server call. To destroy the object immediately, you can call **Close()** with the optional *useCache* parameter set to `false`:

```
person.Close(false);
```

This causes a message to be sent to the server immediately, destroying the proxy object and releasing its resources.

3.3.4 Deleting Persistent Objects from the Database

The **DeleteId()** class method deletes the instance from the database. You can use the **ExistsId()** method to make sure that it is gone:

```
CacheStatus sc = Sample.Person.DeleteId(CacheConnect, ID);
Display.WriteLine("Delete status: " + sc.IsOK.ToString());
Display.WriteLine("person " + ID + " exists: "
  + Sample.Person.ExistsId(CacheConnect, ID).ToString());
```

For a working example, see the **Proxy_2_SaveDelete()** method in the bookdemos sample program (see "The Caché .NET Sample Programs").

3.4 Using Caché Queries

A Caché Query is an SQL query defined as part of a Caché class. For example, the Sample.Person class defines the **ByName** query as follows:

```
Query ByName(name As %String = "") As %SQLQuery(CONTAINID = 1, SELECTMODE = "RUNTIME")
      [ SqlName = SP_Sample_By_Name, SqlProc ]
{
   SELECT ID, Name, DOB, SSN
   FROM Sample.Person
   WHERE (Name %STARTSWITH :name)
   ORDER BY Name
}
```

Since queries return relational tables, Caché proxy objects take advantage of certain ADO.NET classes to generate query results. In the Sample.Person proxy class, **ByName** is a class method. It accepts a connection object, and returns an ADO.NET Managed Provider CacheCommand object that can be used to execute the predefined SQL query:

```
CacheCommand Command = Sample.Person.ByName(CacheConnect);
```

In this example, the Command.Connection property has been set to `CacheConnect`, and Command.CommandText contains the predefined **ByName** query string.

To set the Command.Parameters property, we create and add a CacheParameter object with a value of A (which will get all records where the `Name` field starts with A):

```
CacheParameter Name_param = new CacheParameter("name", CacheDbType.NVarChar);
Name_param.Value = "A";
Command.Parameters.Add(Name_param);
```

The CacheParameter and CacheDataReader ADO.NET Managed Provider classes must be used to define parameters and execute the query, just as they are in an ADO.NET SQL query (see "Using SQL Queries with CacheParameter"). However, this example will use the query to return a set of object IDs that will be used to access objects.

A CacheDataReader object is used to get the ID of each row in the result set. Each ID is used to instantiate the corresponding Sample.Person proxy object, which is then used to access the data:

```
Sample.Person person;
string ID;

CacheDataReader reader = Command.ExecuteReader();
while (reader.Read()) {
  ID = reader[reader.GetOrdinal("ID")].ToString();
  person = Sample.Person.OpenId(CacheConnect, ID);

  Display.WriteLine(
      person.Id() + "\t"
    + person.Name + "\n\t"
    + person.SSN + "\t"
    + person.DOB.ToString().Split(' ')[0].ToString()
  );
};
```

For a working example, see the **Proxy_3_ByNameQuery()** method in the bookdemos sample program (see "The Caché .NET Sample Programs").

3.5 Using Collections and Lists

Caché proxy objects interpret Caché collections and streams as standard .NET objects. Collections can be manipulated by iterators such as `foreach`, and implement standard methods such as **add()** and **insert()**. Caché lists ($List format) are interpreted as CacheSysList objects and accessed by instances of CacheSysListReader (in the InterSystems.Data.CacheTypes namespace).

Collections of serial objects are exposed as .NET Dictionary objects. Serial objects are held as global nodes, where each node address and value is stored as a Dictionary key and value.

The Person class includes the FavoriteColors property, which is a Caché list of strings. The `foreach` iterator can be used to access elements of the list:

```
CacheListOfStrings colors = person.FavoriteColors
int row = 0;
foreach (string color in colors) {
  Display.WriteLine("   Element #" + row++ + " = " + color);
}
```

The standard collection methods are available. The following example removes the first element, inserts a new first element, and adds a new last element:

```
if (colors.Count > 0) colors.RemoveAt(0);
colors.Insert(0,"Blue");
colors.Add("Green");
```

For a working example, see the **Proxy_4_Collection()** method in the bookdemos sample program (see "The Caché .NET Sample Programs").

Note: Caché does not support the creation of proxy classes that inherit from collections. For example, the Caché Proxy Generator would throw an error when attempting to generate a proxy for the following ObjectScript class:

```
Class User.ListOfPerson Extends %Library.ListOfObjects
{Parameter ELEMENTTYPE = "Sample.Person";}
```

3.6 Using Relationships

If a Caché database defines a relationship, the Caché Proxy Generator will create a CacheRelationshipObject class that encapsulates the relationship. The Sample.Company class contains a one-to-many relationship with Sample.Employee (which is a subclass of Sample.Person). The following example opens an instance of Sample.Employee, and then uses the relationship to generate a list of the employee's co-workers.

The `employee` instance is opened by the standard **OpenId()** method. It contains a Company relationship, which is used to instantiate the corresponding `company` object :

```
Sample.Employee employee = Sample.Employee.OpenId(CacheConnect,ID)
Sample.Company company = employee.Company;

Display.WriteLine("ID:    " + (string)employee.Id());
Display.WriteLine("Name:   " + employee.Name)
Display.WriteLine("Works at: " + company.Name);
```

The `company` object contains the inverse **Employees** relationship, which this example instantiates as an object named `colleagues`. The `colleagues` object can then be treated as a collection containing a set of Employee objects:

```
CacheRelationshipObject colleagues = company.Employees;

Display.WriteLine("Colleagues: ");
foreach (Sample.Employee colleague in colleagues) {
  Display.WriteLine("\t" + colleague.Name);
}
```

For a working example, see the **Proxy_5_Relationship()** method in the bookdemos sample program (see "The Caché .NET Sample Programs").

3.7 Using I/O Redirection

When a Caché method calls a Read or Write statement, the statement is associated with standard input or standard output on the client machine by default. For example, the **PrintPerson()** method in the Sample.Employee class includes the following line:

```
Write !,"Name: ", ..Name, ?30, "Title: ", ..Title
```

The following example calls **PrintPerson()** from a Sample.Employee proxy object:

```
Sample.Employee employee = Sample.Employee.OpenId(CacheConnect, "102");
employee.PrintPerson();
```

By default, output from this call will be redirected to the client console using the **CacheConnection.DefaultOutputRedirection** delegate object, which is implemented in the following code:

```
public static OutputRedirection DefaultOutputRedirection =
   new OutputRedirection(CacheConnection.OutputToConsole);

static void OutputToConsole(string output)
{
  Console.Out.Write(output);
}
```

The default redirection delegates are defined when a CacheConnection object is created. The constructor executes code similar to the following example:

```
private void Init() {
   OutputRedirectionDelegate = DefaultOutputRedirection;
   InputRedirectionDelegate = DefaultInputRedirection;
}
```

In order to provide your own output redirection, you need to implement an output method with the same signature as **OutputToConsole**, create an OutputRedirection object with the new method as its delegate, and then assign the new object to the OutputRedirectionDelegate field of a connection object.

Example: Redirecting Output to a Stream

This example redirects output to a System.IO.StringWriter stream. First, a new output redirection method is defined:

```
static System.IO.StringWriter WriteOutput;

static void RedirectToStream(string output)
{
  MyClass.WriteOutput.Write(output);
}
```

The new method will redirect output to the WriteOutput stream, which can later be accessed by a StringReader. To use the new delegate, the WriteOutput stream is instantiated, a new connection conn is opened, and **RedirectToStream()** is set as the delegate to be used by conn:

```
WriteOutput = new System.IO.StringWriter();
conn = new CacheConnection(MyConnectString);
conn.Open();

conn.OutputRedirectionDelegate =
  new CacheConnection.OutputRedirection(MyClass.RedirectToStream);
```

When **PrintPerson()** is called, the resulting output is redirected to WriteOutput (which stores it in an underlying StringBuilder). Now a StringReader can be used to recover the stored text:

```
ReadOutput = new System.IO.StringReader(WriteOutput.ToString());
string capturedOutput = ReadOutput.ReadToEnd();
```

The redirection delegate for the connection object can be changed as many times as desired. The following code sets conn back to the default redirection delegate:

```
conn.OutputRedirectionDelegate = CacheConnection.DefaultOutputRedirection;
```

Input from Caché Read statements can be redirected in a similar way, using an InputRedirection delegate.

For a working example, see the **Proxy_7_Redirection()** method in the bookdemos sample program (see "The Caché .NET Sample Programs").

4

Using Caché ADO.NET Managed Provider Classes

The Caché ADO.NET Managed Provider allows your .NET projects to access Caché databases with fully compliant versions of generic ADO.NET Managed Provider classes such as Connection, Command, CommandBuilder, DataReader, and DataAdapter. The following classes are Caché-specific implementations of the standard ADO.NET Managed Provider classes:

- CacheConnection — Represents the connection between your application and the databases in a specified Caché namespace. See "Connecting to the Caché Database" for a detailed description of how to use CacheConnection.
- CacheCommand — Encapsulates an SQL statement or stored procedure to be executed against databases in the namespace specified by a CacheConnection.
- CacheCommandBuilder — Automatically generates SQL commands that reconcile a Caché database with changes made by objects that encapsulate a single-table query.
- CacheDataReader — Provides the means to fetch the resultset specified by a CacheCommand. A CacheDataReader object provides quick forward-only access to the resultset, but is not designed for random access.
- CacheDataAdapter — Encapsulates a resultset that is mapped to data in the namespace specified by a CacheConnection. It is used to fill an ADO.NET DataSet and to update the Caché database, providing an effective random access connection to the resultset.

This chapter gives some concrete examples of code using Caché ADO.NET Managed Provider classes. The following subjects are discussed:

- Introduction to ADO.NET Managed Provider Classes — provides a simple demonstration of how Caché ADO.NET Managed Provider classes are used.
- Using CacheCommand and CacheDataReader — demonstrates how to execute a simple read-only query.
- Using SQL Queries with CacheParameter — demonstrates passing a parameter to a query.
- Using CacheDataAdapter and CacheCommandBuilder — changing and updating data.
- Using Transactions — demonstrates how to commit or rollback transactions.

Although the examples in this chapter use only SQL statements to access Caché data, it is also possible to access database instances as objects rather than rows in a relational database (as described in "Using the Caché Object Binding for .NET"). Both types of access can be used in the same program.

Note: The examples presented in this chapter are fragments from samples provided in the bookdemos project (see "The Caché .NET Sample Programs" for details). It is assumed that you are familiar with standard coding practices, so the fragments omit error trapping (try/catch) statements and other code that is not directly relevant to the examples. For complete, working versions of the code examples, see the main code file, SampleCode.cs, located in <Cache-install-dir>\dev\dotnet\samples\bookdemos (see "Caché Installation Directory" in the *Caché Installation Guide* for the location of <Cache-install-dir> on your system).

4.1 Introduction to ADO.NET Managed Provider Classes

A project using the Caché implementations of ADO.NET Managed Provider classes can be quite simple. Here is a complete, working console program that opens and reads an item from the `Sample.Person` database:

```
using System;
using InterSystems.Data.CacheClient;
using InterSystems.Data.CacheTypes;

namespace TinySpace {
  class TinyProvider {
    [STAThread]
    static void Main(string[] args) {

      CacheConnection CacheConnect = new CacheConnection();
      CacheConnect.ConnectionString = "Server = localhost; "
        + "Port = 1972; " + "Namespace = SAMPLES; "
        + "Password = SYS; " + "User ID = _SYSTEM;";
      CacheConnect.Open();

      string SQLtext = "SELECT * FROM Sample.Person WHERE ID = 1";
      CacheCommand Command = new CacheCommand(SQLtext, CacheConnect);
      CacheDataReader Reader = Command.ExecuteReader();
      while (Reader.Read()) {
        Console.WriteLine("TinyProvider output: \r\n   "
          + Reader[Reader.GetOrdinal("ID")] + ": "
          + Reader[Reader.GetOrdinal("Name")]);
      };
      Reader.Close();
      Command.Dispose();
      CacheConnect.Close();
    } // end Main()
  } // end class TinyProvider
}
```

This project contains the following important features:

- The `Using` statements provide access to the CacheClient assembly:

  ```
  using InterSystems.Data.CacheClient;
  using InterSystems.Data.CacheTypes;
  ```

- The CacheConnection object is used to create and open a connection to the Caché SAMPLES namespace:

  ```
  CacheConnection CacheConnect = new CacheConnection();
  CacheConnect.ConnectionString = "Server = localhost; "
    + "Port = 1972; " + "Namespace = SAMPLES; "
    + "Password = SYS; " + "User ID = _SYSTEM;";
  CacheConnect.Open();
  ```

- The CacheCommand object uses the CacheConnection object and an SQL statement to open the instance of `Sample.Person` that has an `ID` equal to `1`.

  ```
  string SQLtext = "SELECT * FROM Sample.Person WHERE ID = 1";
  CacheCommand Command = new CacheCommand(SQLtext, CacheConnect);
  ```

- The CacheDataReader object is used to access the data items in the row:

```
    CacheDataReader Reader = Command.ExecuteReader();
    while (Reader.Read()) {
      Console.WriteLine("TinyProvider output: \r\n   "
        + Reader[Reader.GetOrdinal("ID")] + ": "
        + Reader[Reader.GetOrdinal("Name")]);
    };
```

4.2 Using CacheCommand and CacheDataReader

Simple read-only queries can be performed using only CacheCommand and CacheDataReader. Like all database transactions, such queries also require an open CacheConnection object.

In this example, an SQL query string is passed to a new CacheCommand object, which will use the existing connection:

```
string SQLtext = "SELECT * FROM Sample.Person WHERE ID < 10";
CacheCommand Command = new CacheCommand(SQLtext, CacheConnect);
```

Results of the query are returned in a CacheDataReader object. Properties are accessed by referring to the names of columns specified in the SQL statement.

```
CacheDataReader reader = Command.ExecuteReader();
while (reader.Read()) {
  Display.WriteLine(
    reader[reader.GetOrdinal("ID")] + "\t"
  + reader[reader.GetOrdinal("Name")] + "\r\n\t"
  + reader[reader.GetOrdinal("Home_City")] + " "
  + reader[reader.GetOrdinal("Home_State")] + "\r\n");
};
```

The same report could be generated using column numbers instead of names. Since CacheDataReader objects can only read forward, the only way to return to beginning of the data stream is to close the reader and reopen it by executing the query again.

```
reader.Close();
reader = Command.ExecuteReader();
while (reader.Read()) {
  Display.WriteLine(
    reader[0] + "\t"
  + reader[4] + "\r\n\t"
  + reader[7] + " "
  + reader[8] + "\n");
}
```

For a working example, see the **ADO_1_CommandReader()** method in the bookdemos sample program (see “The Caché .NET Sample Programs”).

4.3 Using SQL Queries with CacheParameter

The CacheParameter object is required for more complex SQL queries. The following example selects data from all rows where `Name` starts with a string specified by the CacheParameter value:

```
string SQLtext =
    "SELECT ID, Name, DOB, SSN "
  + "FROM Sample.Person "
  + "WHERE Name %STARTSWITH ?"
  + "ORDER BY Name";
CacheCommand Command = new CacheCommand(SQLtext, CacheConnect);
```

The parameter value is set to get all rows where `Name` starts with A, and the parameter is passed to the CacheCommand object:

```
CacheParameter Name_param =
  new CacheParameter("Name_col", CacheDbType.NVarChar);
Name_param.Value = "A";
Command.Parameters.Add(Name_param);
```

Note: Be default, the SQL statement is not validated before being executed on the Server, since this would require two calls to the Server for each query. If validation is desirable, call CacheCommand**.Prepare()** to validate the syntax for the SQL statement against the Cache Server.

A CacheDataReader object can access the resulting data stream just as it did in the previous example:

```
CacheDataReader reader = Command.ExecuteReader();
while (reader.Read()) {
  Display.WriteLine(
    reader[reader.GetOrdinal("ID")] + "\t"
  + reader[reader.GetOrdinal("Name")] + "\r\n\t"
  + reader[reader.GetOrdinal("DOB")] + " "
  + reader[reader.GetOrdinal("SSN")] + "\r\n");
};
```

For a working example, see the **ADO_2_Parameter()** method in the bookdemos sample program (see "The Caché .NET Sample Programs").

The CacheCommand, CacheParameter, and CacheDataReader classes are also used to execute a Caché Query method from a proxy object. See "Using Caché Queries" for details.

4.4 Using CacheDataAdapter and CacheCommandBuilder

The CacheCommand and CacheDataReader classes are inadequate when your application requires anything more than sequential, read-only data access. In such cases, the CacheDataAdapter and CacheCommandBuilder classes can provide full random read/write access. The following example uses these classes to get a set of `Sample.Person` rows, read and change one of the rows, delete a row and add a new one, and then save the changes to the Caché database.

The CacheDataAdapter constructor accepts an SQL command and a CacheConnection object as parameters, just like a CacheCommand. In this example, the resultset will contain data from all Sample.Person rows where `Name` starts with A or B. The `Adapter` object will map the resultset to a table named `Person`:

```
string SQLtext =
    " SELECT ID, Name, SSN "
  + " FROM Sample.Person "
  + " WHERE Name < 'C' "
  + " ORDER BY Name ";
CacheDataAdapter Adapter = new CacheDataAdapter(SQLtext, CacheConnect);
Adapter.TableMappings.Add("Table", "Person");
```

A CacheCommandBuilder object is created for the `Adapter` object. When changes are made to the data mapped by the `Adapter` object, `Adapter` can use SQL statements generated by `Builder` to update corresponding items in the Caché database:

```
CacheCommandBuilder Builder = new CacheCommandBuilder(Adapter);
```

An ADO DataSet object is created and filled by `Adapter`. It contains only one table, which is used to define the `PersonTable` object.

```
System.Data.DataSet DataSet = new System.Data.DataSet();
Adapter.Fill(DataSet);
System.Data.DataTable PersonTable = DataSet.Tables["Person"];
```

A simple **foreach** command can be used to read each row in `PersonTable`. In this example, we save `Name` in the first row and change it to `"Fudd, Elmer"`. When the data is printed, all names will be in alphabetical order except the first,

which now starts with F. After the data has been printed, the first Name is reset to its original value. Both changes were made only to the data in DataSet. The original data in the Caché database has not yet been touched.

```
if (PersonTable.Rows.Count > 0) {
  System.Data.DataRow FirstPerson = PersonTable.Rows[0];
  string OldName = FirstPerson["Name"].ToString();
  FirstPerson["Name"] = "Fudd, Elmer";

  foreach (System.Data.DataRow PersonRow in PersonTable.Rows) {
    Display.WriteLine("\t"
      + PersonRow["ID"] + ":\t"
      + PersonRow["Name"] + "\t"
      + PersonRow["SSN"]);
  }
  FirstPerson["Name"] = OldName;
}
```

The following code marks the first row for deletion, and then creates and adds a new row. Once again, these changes are made only to the DataSet object.

```
FirstPerson.Delete();

System.Data.DataRow NewPerson = PersonTable.NewRow();
NewPerson["Name"] = "Budd, Billy";
NewPerson["SSN"] = "555-65-4321";
PersonTable.Rows.Add(NewPerson);
```

Finally, the **Update()** method is called. Adapter now uses the CacheCommandBuilder code to update the Caché database with the current data in the DataSet object's Person table.

```
Adapter.Update(DataSet, "Person");
```

For a working example, see the **ADO_3_AdapterBuilder()** method in the bookdemos sample program (see The Caché .NET Sample Programs).

4.5 Using Transactions

The Transaction class is used to specify an SQL transaction (see "Transaction Processing" in *Using Caché SQL* for an overview of how to use transactions with Caché). In the following example, transaction Trans will fail and be rolled back if SSN is not unique.

```
CacheTransaction Trans =
  CacheConnect.BeginTransaction(System.Data.IsolationLevel.ReadCommitted);
try {
  string SQLtext = "INSERT into Sample.Person(Name, SSN) Values(?,?)";
  CacheCommand Command = new CacheCommand(SQLtext, CacheConnect, Trans);

  CacheParameter Name_param =
    new CacheParameter("name", CacheDbType.NVarChar);
  Name_param.Value = "Rowe, Richard";
  Command.Parameters.Add(Name_param);

  CacheParameter SSN_param =
    new CacheParameter("ssn", CacheDbType.NVarChar);
  SSN_param.Value = "234-56-3454";
  Command.Parameters.Add(SSN_param);

  int rows = Command.ExecuteNonQuery();
  Trans.Commit();
  Display.WriteLine("Added record for " + SSN_param.Value.ToString());
}
catch (Exception eInsert) {
  Trans.Rollback();
  WriteErrorMessage("TransFail", eInsert);
}
```

For a working example, see the **ADO_4_Transaction()** method in the bookdemos sample program (see "The Caché .NET Sample Programs").

5

Using the Caché Dynamic Binding

The Caché dynamic binding allows an application to access Caché objects on the server without first generating proxy classes (described in "Using the Caché Object Binding for .NET"). Instead, a dynamic proxy class, CacheObject, can be created at runtime and used to access properties and call methods by name. Argument values and return types are specified by creating instances of the CacheMethodSignature class.

The dynamic binding can be useful for writing generic tools, and can be used as an alternative to regenerating proxy classes whenever a Caché class changes on the server.

This chapter covers the following topics:

- Using Dynamic Objects — an overview of how to use the CacheObject and CacheMethodSignature classes.
- Example: Accessing Sample.Person — a simple demonstration of how the dynamic binding is used.
- CacheMethodSignature Methods and Properties — A quick reference to the CacheMethodSignature class.

5.1 Using Dynamic Objects

The examples in this chapter assume that a connection to the database has already been established through a CacheConnection object named `conn` (see "Connecting to the Caché Database" for more information about CacheConnection). Before dynamic objects can be used, the connection object's DynamicMode property must be set to `true`:

```
conn.DynamicMode = true;
```

A new InterSystems.Data.CacheTypes.CacheObject can be created with a statement such as the following:

```
CacheObject dynamicObj = new CacheObject(conn, className);
```

where *conn* is an open CacheConnection object, and *className* is a string containing the complete name of the class to be accessed.

5.1.1 Using Method Signature Objects

Before you can use a CacheObject instance to call a method, you must create a CacheMethodSignature object. The method signature object is used to specify the values of any arguments that are to be passed to the method, and the datatype of the method return value.

Use the **GetMtdSignature()** method of the connection object to create a CacheMethodSignature object:

```
CacheMethodSignature mtdSignature = conn.GetMtdSignature()
```

The **Add()** and **SetReturnType()** methods of the CacheMethodSignature object are used to define the signature:

- Use the **Add()** method to specify the values that will be passed as arguments to the method. Call **Add()** once for each argument to be passed. The method is called as follows:

  ```
  mtdSignature.Add(value, isByRef);
  ```

  where *value* is a value of the appropriate type, and *isByRef* is a boolean that specifies whether or not the argument is passed by reference.

- If the method returns a value, use the **SetReturnType()** method to specify the return type:

  ```
  SetReturnType(conn, typeId)
  ```

  where *typeId* is one of the constants of the `ClientTypeId` enumeration.

After the CacheMethodSignature object has been used to call a method, the ReturnValue and Arguments properties can be used to retrieve the results.

- The ReturnValue property will contain a value of the type specified by **SetReturnType()**.
- The Arguments property will contain an array with one element for each argument specified by **Add()**. Each element contains the current value of an argument (including arguments passed by reference).

A method signature object can be used for more than one call. Use the **Clear()** method to reinitialize the object before using **Add()** and **SetReturnType()** again to define the new signature.

5.1.2 Calling Methods

The **RunMethod()** and **RunClassMethod()** methods of CacheObject are used to make method calls:

- For an instance method, the call is:

  ```
  dynamicObj.RunMethod(methodName, mtdSignature);
  ```

- For a class method, the call is:

  ```
  CacheObject.RunClassMethod(conn, className, methodName, mtdSignature);
  ```

After the method has been called, any returned values can be retrieved from the Arguments and ReturnValue properties of the CacheMethodSignature object (as described in "Using Method Signature Objects"). The returned values must be cast to the appropriate type for the container object. For example the following line gets an integer return value and casts it to class CacheIntReturnValue:

```
long? mtdRes = ((CacheIntReturnValue)(mtdSignature.ReturnValue)).Value;
```

The following line accesses the Arguments array to retrieve the current value of a string argument passed by reference, and casts it to class CacheStringArgument:

```
response = ((CacheStringArgument)(mtdSignature.Arguments[1])).Value;
```

A complete description of the available Cache(type)Argument and Cache(type)ReturnValue classes can be found in the InterSystems.Data.CacheTypes namespace section of the Caché .NET Help File.

5.1.3 Accessing Properties

CacheMethodSignature objects are also used to specify property signatures. Once the signature has been specified, the **GetProperty()** and **SetProperty()** methods of the CacheObject object can be used to access the property value. For

example, the following code specifies a signature that will be used for the Name property of a Sample.Person object, and then sets the property to the specified value:

```
CacheMethodSignature mtdSignature = conn.GetMtdSignature();
string value = "Smith, Wilbur"
mtdSignature.Add(value, false);

string propertyName = "Name"
person.SetProperty(propertyName, mtdSignature);
```

The following code redefines the method signature, and then retrieves the value of the property:

```
mtdSignature.Clear();
mtdSignature.SetReturnType(conn, ClientTypeId.tString);
person.GetProperty(propertyName, mtdSignature);
string newName = ((CacheStringReturnValue)(mtdSignature.ReturnValue)).Value;
```

5.2 Example: Accessing Sample.Person

This section provides sample code that uses the dynamic interface to access a Sample.Person object.

GetMtdSignature()

The following code creates the CacheObject and CacheMethodSignature objects used by these examples:

```
CacheObject person = new CacheObject(conn, "Sample.Person");
CacheMethodSignature mtdSignature = conn.GetMtdSignature();
```

Add(), SetProperty()

The following code sets the Person.Name property to the value of *valueOfName*:

```
string valueOfName = "test";
mtdSignature.Add(valueOfName, false);
person.SetProperty("Name", mtdSignature);
```

Clear(), SetReturnType(), GetProperty()

Now the method signature is cleared, the return type is set, and the new value of the Person.Name property is retrieved:

```
mtdSignature.Clear();
mtdSignature.SetReturnType(conn, ClientTypeId.tString);
person.GetProperty("Name", mtdSignature);
string returnedNameValue = ((CacheStringReturnValue)(mtdSignature.ReturnValue)).Value;
```

The .NET TestTools.UnitTesting.Assert class is used to compare the property value to the value in the original variable.

```
Assert.AreEqual(valueOfName, returnedNameValue);
```

Accessing an object property

The following code gets the Person.Home object property, tests the object to see if it is connected, then closes the Person object and tests to see if the Person.Home object has been disconnected.

```
mtdSignature.Clear();
mtdSignature.SetReturnType(conn, ClientTypeId.tObject);
person.GetProperty("Home", mtdSignature);
ICacheObject home = ((CacheObjReturnValue)(mtdSignature.ReturnValue)).Value;

Assert.IsTrue(home.IsConnected);
person.Close();
Assert.IsFalse(home.IsConnected);
```

RunClassMethod()

This example calls the **StoredProcTest()** class method, which is declared as follows in the Sample.Person server class:

```
classmethod StoredProcTest(name As %String, ByRef response As %String) as %Integer
```

StoredProcTest() concatenates two copies of *name* and returns the resulting string in *response*. It always sets the return value of the method to 29.

The following code sets the signature values and return type for the method:

```
string nameValue = "test";
string responseValue = "";

mtdSignature.Clear();
mtdSignature.Add(nameValue, false);
mtdSignature.Add(responseValue, true);
mtdSignature.SetReturnType(conn, ClientTypeId.tInt);
```

Now the method is called, and the results are retrieved and tested:

```
CacheObject.RunClassMethod(conn, "Sample.Person", "StoredProcTest", mtdSignature)

responseValue = ((CacheStringArgument)(mtdSignature.Arguments[1])).Value;
string expectedValue = nameValue + "||" + nameValue;
Assert.AreEqual(responseValue, expectedValue);

long? returnValue = ((CacheIntReturnValue)(mtdSignature.ReturnValue)).Value;
Assert.AreEqual(returnValue, 29);
```

5.3 CacheMethodSignature Methods and Properties

This section provides a quick overview of the CacheMethodSignature class. It is not intended to be your primary reference for the class, and therefore omits some items (such as methods inherited from System.Object) that are not used in this chapter.

Note: For the most complete and up to date information on this class and related enumerations, refer to the entry in the Caché .NET Help File.

The CacheMethodSignature class provides the following methods and properties:

- **Add()** — Specifies an argument value to be added to the method signature.
- **Arguments** — Field containing an array of method argument values.
- **Clear()** — Initializes this instance by deleting any previously specified argument values and method return settings.
- **Get()** — Gets the value of the argument at the specified index.
- **ReturnValue** — Field containing the method return value.
- **SetColnReturnType()** — Sets the method return type if a collection is to be returned.
- **SetReturnType()** — Sets the method return type.

The following related enumerations are also listed here:

- ClientTypeId Enumeration
- ClientObjTypeId Enumeration

Add()

Adds the specified argument value to the method signature. This method has the following overloads:

```
public void Add(Object arg, CacheConnection conn, Type argType, ClientTypeId typeId, bool byRef)

public void Add(ICacheObject arg, CacheConnection conn, Type argType, bool byRef)

public void Add(CacheStatus arg, CacheConnection conn, bool byRef)
public void Add(CacheSysList arg, CacheConnection conn, bool byRef)

public void Add(CacheDate arg, int typeId, bool byRef)

public void Add(Nullable<(long> arg, bool byRef)
public void Add(Nullable<double> arg, bool byRef)
public void Add(Nullable<DateTime> arg, bool byRef)
public void Add(Nullable<bool> arg, bool byRef)
public void Add(Nullable<decimal> arg, bool byRef)
public void Add(byte[] arg, bool byRef)
public void Add(string arg, bool byRef)
public void Add(CacheTime arg, bool byRef)
```

- `arg` (*various data types*) — An argument value.
- `conn` (CacheConnection) — The connection object.
- `argType` (Type) — The argument type.
- `typeId` (ClientTypeId) — if `arg` is an object, specifies the object type as a constant from the `ClientTypeId` enumeration.
- `byRef` (Boolean) — If set to true, the argument is passed by reference.

Arguments

Field containing an array of currently defined method arguments.

```
public ArrayList Arguments
```

Clear()

Initializes this instance by deleting any previously specified argument values and method return settings.

```
public void Clear()
```

Get()

Gets the argument at the specified index. This method has the following overloads:

```
public void Get(int idx, out ICacheObject arg)
public void Get(int idx, out Nullable<long> arg)
public void Get(int idx, out Nullable<double> arg)
public void Get(int idx, out Byte[] arg)
public void Get(int idx, out String arg)
public void Get(int idx, out CacheStatus arg)
public void Get(int idx, out CacheTime arg)
public void Get(int idx, out CacheDate arg)
public void Get(int idx, out Nullable<DateTime> arg)
public void Get(int idx, out Nullable<bool> arg)
public void Get(int idx, out Nullable<decimal> arg)
public void Get(int idx, out CacheSysList arg)
```

- `idx` (Int32) — The index specifying which argument to return.
- `arg` (*various data types*) — The argument to be returned.

ReturnValue

Field containing a Server method return value.

```
public CacheReturnValue ReturnValue
```

SetColnReturnType()

Sets the method return type if a collection is to be returned.

```
public void SetColnReturnType(CacheConnection conn, ClientObjTypeId objTypeId, ClientTypeId
colnTypeId)
```

- `conn` (CacheConnection) — The connection object.
- `objTypeId` (ClientObjTypeId) — The data type id for the collection elements (from the `ClientObjTypeId` enumeration).
- `colnTypeId` (ClientTypeId) — The collection type id (from the `ClientTypeId` enumeration).

SetReturnType()

Sets the method return type. This method has the following overloads:

```
public void SetReturnType(CacheConnection conn, int typeId)
public void SetReturnType(CacheConnection conn, ClientTypeId typeId)
public void SetReturnType(CacheConnection conn, Type clientType)
public void SetReturnType(CacheConnection conn, int objTypeId , int colnTypeId )
```

- `conn` (CacheConnection) — The connection object.
- `typeId` (Int32 or ClientTypeId) — The type of the return value, specified as either an integer or a constant from the `ClientTypeId` enumeration.
- `clientType` (System.Type) — The type of the return value, specified as a type declaration.
- `objTypeId` (Int32) — If the return value is a collection, specifies the data type id for the collection elements (see the `ClientTypeId` enumeration).
- `colnTypeId` (Int32) — If the return value is a collection, specifies the collection type (see the `ClientObjTypeId` enumeration).

ClientTypeId Enumeration

The InterSystems.Data.CacheTypes.ClientTypeId enumeration includes the following values:

```
tVoid = -1
tObject = 0
tInt = 1
tDouble = 2
tBinary = 3
tString = 4
tStatus = 5
tTime = 6
tDate = 7
tTimeStamp = 8
tBool = 9
tCurrency = 10
tList = 11
tLongString = 12
tLongBinary = 13
tDecimal = 14
tMVDate = 15
```

ClientObjTypeId Enumeration

The InterSystems.Data.CacheTypes.ClientObjTypeId enumeration includes the following values:

```
tUnknown = 0
tListOfDT = 1
tArrayOfDT = 2
tListOfObj = 3
tArrayOfObj = 4
tRelationship = 5
tBinStream = 6
tCharStream = 7
```

6

Using the Caché Entity Framework Provider

Entity Framework is an object-relational mapper that enables .NET developers to work with relational data using domain-specific objects. It eliminates the need for most of the data-access code that developers usually need to write. Caché includes the Caché Entity Framework Provider which enables you to use Entity Framework 6 technology to access a Caché database. (If you are using Entity Framework 5, ask your Intersystems representative for instructions.) For more information on the .NET Entity Framework, see http://www.asp.net/entity-framework.

This chapter contains the following sections:

- Setting Up Caché Entity Framework Provider—Contains system requirements, install, and setup information.
- Getting Started with Entity Framework —Describes approaches to getting started using EF.
  - Code First Start by defining data classes and generate a database from the class properties.
  - Database FirstDatabase First — Start with an existing database. You can set one up by following the steps in the section Set Up a Sample Database. Then use Entity Framework to generate code for a web application based on the fields of that database.
  - Model First Model First — Start by creating a database model showing entities and relationships. Then generate a database from the model.

This section describes three approaches to getting started with Entity Framework.

6.1 Setting Up Caché Entity Framework Provider

Follow the instructions in this section to install and set up Caché Entity Framework Provider.

6.1.1 System Requirements

To use Caché Entity Framework Provider, you need the following software:

- Visual Studio 2013 (Professional or Ultimate) with Update 5 (or later update)
- Caché Entity Framework Provider distribution, located in the directory *installdir*\dev\dotnet\bin\v4.0.30309. This directory includes the following files, which you use in the setup instructions:

- CacheEF.zip, installation files.
- CacheEF.zip\setup.cmd, which installs the DLLs InterSystems.Data.CacheClient.dll and InterSystems.Data.CacheVSTools.dll.
- CacheEF.zip\Nuget\InterSystems.Data.Entity6.4.5.0.0.nupkg which installs Caché Entity Framework Provider.
- CacheEF.zip\CreateNorthwindEFDB.sql which is used to create a sample database.

6.1.2 Run Setup and Set Variables

Follow these steps:

1. Extract the contents of *installdir*\dev\dotnet\bin\v4.0.30309\CacheEF.zip into a folder (in the same directory as the zip file) called CacheEF. Run \CacheEF\setup.cmd.
2. In Windows, select **All Programs** > **Visual Studio 2013** > **Visual Studio Tools**.
3. In the displayed Windows Explorer folder, right-click **Developer Command Prompt for VS2013** > **Run as Administrator** and enter:

   ```
   devenv /setup
   ```

   This command repopulates this key from HKEY_LOCAL_MACHINE:

   ```
   HKEY_CURRENT_USER\Software\Microsoft\VisualStudio\12.0_Config //VS 2013
   ```

6.1.3 Copy Files to Visual Studio

Copy the two files from the CacheEF directory to Visual Studio:

- SSDLToCacheSQL.tt
- GenerateCacheSQL.Utility.ttinclude

from the directory <*cacheinstalldir*>\dev\dotnet\bin\v4.0.30319\CacheEF\Templates to the directory C:\Program Files (x86)\Microsoft Visual Studio 1x.0\Common7\IDE\Extensions\Microsoft\Entity Framework Tools\DBGen

6.1.4 Connect Visual Studio to Caché Server

To connect Visual Studio to a Caché instance, follow the steps below:

1. Open Visual Studio and select **View** > **Server Explorer**.
2. Right-click **Data Connections** and select **Add Connection**. In the Add Connection Dialog:
   a. Select **Data source** as `Cache Data Source (.Net Framework Data Provider for Cache)`
   b. Select **Server**
   c. Enter **Username** and **password**. Click **Connect**.
   d. Select a namespace from the list. Click **OK**.

6.1.5 Configure Caché Nuget Local Repository

Follow these steps to configure the Package Manager to find the local Nuget repository:

1. Create a directory as a Nuget repository. You might call it `Nuget Repository`. You could put it anywhere – a good choice might be <*yourdoclibraryVS2013*>\Projects (where Visual Studio stores projects by default).
2. Copy the file <*installdir*>\dev\dotnet\bin\v4.0.30319\CacheEF\Nuget\InterSystems.Data.Entity6.4.5.0.0.nupkg and paste it into your Nuget repository directory. Click **OK**.
3. In Visual Studio, select **Project** > **Manage Nuget Packages** > **Settings** > **Package Manager** > **Package Sources**.
4. Click the plus sign**+**. Enter the path that contains InterSystems.Data.Entity6.4.5.0.0.nupkg. Click **OK**

6.2 Getting Started with Entity Framework

This section describes three approaches to getting started with Entity Framework.

- Code First Start by defining data classes and generate a database from the class properties.
- Database FirstDatabase First — Start with an existing database. You can set one up by following the steps in the section Set Up a Sample Database. Then use Entity Framework to generate code for a web application based on the fields of that database.
- Model First Model First — Start by creating a database model showing entities and relationships. Then generate a database from the model.

The sections below show examples of each of these approaches.

6.2.1 Code First

This section shows an example of how to write code to define data classes and then generate tables from the class properties. The example in this section is based on the Entity Framework Tutorial from EntityFrameworkTutorial.net (http://www.entityframeworktutorial.net/code-first/simple-code-first-example.aspx).

1. Create a new project in Visual Studio 2013 with **FILE** > **New** > **Project**. With a Template of **Visual C#** and **Console Application** highlighted, enter a name for your project, such as **CodeStudents**. Click **OK**
2. Add Caché Entity Framework Provider to the project: Click **TOOLS** > **Nuget Package Manager** > **Manage Nuget Packages for Solution**. Expand **Online** > **Package Source**. **Caché Entity Framework Provider 6** is displayed. Click **Install** > **Ok** > **I Accept**. Wait for the installation to complete and then click **Close**.
3. Compile the project with **Build** > **Build Solution**.
4. Tell the project which system to connect to by identifying it in the App.config file as follows. From the Solution Explorer window, open the App.config file. Add a `<connectionStrings>` section (like the example shown here) as the last section in the `<configuration>` section after the `<entityFramework>` section.

   Note: Check that the server, port, namespace, username, and password are correct for your configuration.

```
<connectionStrings>
   <add
      name="SchoolDBConnectionString"
      connectionString="SERVER = localhost;
         NAMESPACE = USER;
         port=1972;
         METADATAFORMAT = mssql;
         USER = _SYSTEM;
         password = SYS;
         LOGFILE = C:\\Users\\Public\\logs\\cprovider.log;
         SQLDIALECT = cache;"
      providerName="InterSystems.Data.CacheClient"
   />
</connectionStrings>
```

5. In the Program.cs file, add

```
using System.Data.Entity;
using System.Data.Entity.Validation;
using System.Data.Entity.Infrastructure;
```

6. Define classes:

```
public class Student
{
   public Student()
   {
   }
   public int StudentID { get; set; }
   public string StudentName { get; set; }
   public DateTime? DateOfBirth { get; set; }
   public byte[] Photo { get; set; }
   public decimal Height { get; set; }
   public float Weight { get; set; }
   public Standard Standard { get; set; }
}

public class Standard
{
   public Standard()
   {
   }
   public int StandardId { get; set; }
   public string StandardName { get; set; }
   public ICollection<Student> Students { get; set; }
}

public class SchoolContext : DbContext
{
   public SchoolContext() : base("name=SchoolDBConnectionString")
   {
   }
   public DbSet<Student> Students { get; set; }
   public DbSet<Standard> Standards { get; set; }
}
```

   Check that class SchoolContext points to your connection in App.config.

7. Add code to **Main**.

```
using (var ctx = new SchoolContext())
{
   Student stud = new Student() { StudentName = "New Student" };
   ctx.Students.Add(stud);
   ctx.SaveChanges();
}
```

8. Compile and run.

Check the namespace (USER in this case). You see three tables created: dbo.Standards, dbo.Students (which has a new student added), and dbo._MigrationHistory (which holds information about table creation).

6.2.2 Set Up a Sample Database

If you want to set up a sample database for use with the Database First section, follow the steps in this section. These steps set up and load the sample database CreateNorthwindEFDB.sql.

1. In the Management Portal, select **System** > **Configuration** > **Namespaces** and click **Create New Namespace**.
2. Name your namespace NORTHWINDEF.
   a. For **Select an Existing Database for Globals**, click **Create New Database**. Enter NORTHWINDEF as the database and <*installdir*>\mgr\EFdatabase as the directory. Click **Next** and **Finish**
   b. For **Select an Existing Database for Routines**, select **NORTHWINDEF** from the dropdown list.

c. Click **Save**.

3. In the Management Portal, select **System** > **Configuration** > **SQL and Object Settings** > **General SQL Settings**.
   a. In the SQL tab, enter the **Default SQL Schema Name** as `dbo`.
   b. In the SQL tab, select **Support Delimited Identifiers** (default is on)
   c. In the DDL tab, select all items.
   d. Click **Save**.
4. Select **System** > **Configuration** > **SQL and Object Settings** > **TSQL Compatability Settings**
   a. Set the **DIALECT** to **MSSQL**.
   b. Set **QUOTED_IDENTIFIER** to **ON**.
   c. Click **Save**.
5. In a Terminal window, change to your new namespace with

```
zn “NORTHWINDEF”
```

6. If this is not the first time you are setting up the database, purge existing data with:

```
do $SYSTEM.OBJ.DeleteAll("e") d Purge^%apiSQL()
```

7. If you have not already done so, using an unzip program, extract files from *installdir*\dev\dotnet\bin\v4.0.30319\CacheEF.zip to a folder called CacheEF.
8. To load the ddl, enter

```
do
$SYSTEM.SQL.DDLImport("MSSQL","_system","<installdir>\dev\dotnet\bin\v4.0.30319\CacheEF\CreateNorthwindEFDB.sql")
```

In the Server Explorer window, you can expand the Caché server entry to view NorthwindEF database elements: Tables, Views, Function, Procedures. You can examine each element, retrieve Data for Tables and Views, Execute Functions and Procedures. If you right-click an element and select **Edit**, Studio opens showing corresponding class and position on requested element if applicable.

6.2.3 Database First

To use the database first approach, start with an existing database and use Entity Framemaker to generate code for a web application based on the fields of that database.

1. Create a new project in Visual Studio 2013 with **FILE** > **New** > **Project** of type **Visual C#** > **Console Application** > **OK**.
2. Click **TOOLS** > **Nuget Package Manager** > **Manage Nuget Packages for Solution**. Expand **Online** > **Package Source**, which lists **Caché Entity Framework Provider 6**. Click **Install** > **Ok** > **Accept the license** > **Close**.
3. Compile the project with **Build** > **Build Solution**.
4. Select **PROJECT** > **Add New Item** > **Visual C# Items** > **Ado.NET Entity Data Model**. You can give your model a name. Here we use the default of `Model1`. Click **Add**.
5. In the Entity Data Model Wizard:
   a. Select **EF Designer from database** > **Next**
   b. In the **Choose Your Data Connection** screen, the data connection field should already be to your Northwind database. It doesn’t matter whether you select `Yes, Include` or `No, exclude` to the sensitive data question.

c. On the bottom of screen you can define a connection settings name. The default is `localhostEntities`. This name is used later on.

d. In the **Choose Your Database Objects and Settings** screen, answer the question **Which Database objects do you want to include in your model?** by selecting all objects: `Tables`, `Views`, and `Stored Procedures and Functions`. This includes all Northwind tables.

e. Click **Finish**.

f. In several seconds, you'll see a `Security Warning`. Click **OK** to run the template.

g. Visual Studio may display an Error List with many warnings. You can ignore these.

6. For a model name of `Model1`, Visual Studio generates multiple files under Model1.edmx – including a UI diagram as Model1.edmx itself, classes representing tables under Model1.tt, and context class localhostEntities in Model1.Context.tt->Model1.Context.cs.

   In the Solution Explorer window, you can inspect Model1.Context.cs. The constructor `Constructer public localhostEntities() : base("name=localhostEntities")` points to App.Config connection string:

```
<connectionStrings>
   <add
      name="localhostEntities"
      connectionString="metadata=res://*/Model1.csdl|
            res://*/Model1.ssdl|
            res://*/Model1.msl;provider=InterSystems.Data.CacheClient;
         provider connection string=&quot;
         ApplicationName=devenv.exe;
         ConnectionLifetime=0;
         ConnectionTimeout=30;
         ConnectionReset=False;
         Server=localhost;
         Namespace=NORTHWINDEF;
         IsolationLevel=ReadUncommitted;
         LogFile=C:\Users\Public\logs\cprovider.log;
         MetaDataFormat=mssql;
         MinPoolSize=0;
         MaxPoolSize=100;
         Pooling=True;
         PacketSize=1024;
         Password=SYS;
         Port=1972;
         PreparseCacheSize=200;
         SQLDialect=cache;
         Ssl=False;
         SoSndBuf=0;
         SoRcvBuf=0;
         StreamPrefetch=0;
         TcpNoDelay=True;
         User=_SYSTEM;
         WorkstationId=DMITRY1&quot;"
      providerName="System.Data.EntityClient"
   />
</connectionStrings>
```

7. Compile your project with **BUILD** > **Build Solution**.

Below are two program samples that you can paste into **Main()** in Program.cs:

You can traverse a list of customers using:

```
using (var context = new localhostEntities()) {
   var customers = context.Customers;
   foreach (var customer in customers) {
      string s = customer.CustomerID + '\t' + customer.ContactName;
   }
}
```

You can get a list of orders for CustomerID using:

```
using (var context = new localhostEntities()) {
   var customerOrders = from c in context.Customers
      where (c.CustomerID == CustomerID)
```

```
         select new { c, c.Orders };

   foreach (var order in customerOrders) {
      for (int i = 0 ; i < order.Orders.Count; i++) {
         var orderElement = order.Orders.ElementAt(i);
         string sProduct = "";
         //Product names from OrderDetails table
         for (int j = 0; j < orderElement.OrderDetails.Count; j++)
         {
            var product = orderElement.OrderDetails.ElementAt(j);
            sProduct += product.Product.ProductName;
            sProduct += ",";
         }
         string date = orderElement.OrderDate.ToString();
      }
   }
}
```

6.2.4 Model First

Use the model first approach by generating a database model basd on the diagram you created in the Database First section. Then generate a database from the model.

This example shows you how to create a database that contains two entities,

1. Look at the Entity Framework UI edmx diagram Model1.edmx. In a blank area of the diagram, right-click and select **Properties**.
2. Change **DDL Generation Template** to **SSDTLtoCacheSQL.tt**.
3. Compile Project.
4. In a blank area of the diagram, right-click and select **Generate Database From Model**. After the DDL is generated, click **Finish**.
5. Studio creates and opens the file Model1.edmx.sql.
6. Import your table definitions into Caché by executing the following command in a terminal:

```
do $SYSTEM.SQL.DDLImport("MSSQL","_system","C:\\<myPath>\\Model1.edmx.sql")
```