



# Using .NET with Caché eXTreme

Version 2018.1  
2018-12-13

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Caché Version 2018.1 2018-12-13

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# About This Book

Caché eXTreme is a set of .NET technologies that enable Caché to be leveraged as a high performance persistence storage engine in XTP (Extreme Transaction Processing) applications. Unlike the standard Caché .NET binding, all of the eXTreme APIs provide access to Caché data through an extremely high speed, in-process connection.

The following topics are discussed in this book:

- [Introduction](#) — provides an overview of the eXTreme platform architecture, and describes common installation procedures.
- [Using eXTreme Event Persistence](#) — describes the XEP API, which allows simple .NET objects to be projected as XTP persistent events.
- [Quick Reference for eXTreme Classes](#) — Provides a quick reference for methods of the eXTreme API classes.

There is also a detailed [Table of Contents](#).

## Related Documents

The following documents also contain related material:

- The .NET help file (<cache-root>/dev/dotnet/help/CacheExtreme.chm).
- [Using the Caché Managed Provider for .NET](#) — explains how to access Caché from .NET client applications over TCP/IP, using either the Caché native object interface for .NET or the ADO.NET API.
- [Using Java with Caché eXTreme](#) — describes how to use the Java version of Caché eXTreme.

For general information, see [Using InterSystems Documentation](#).



# 1

## Introduction

Caché eXTreme is a set of technologies that enable Caché to be leveraged as a high performance persistence storage engine optimized for XTP (Extreme Transaction Processing) applications.

Unlike the standard .NET binding, the eXTreme APIs do not use TCP/IP to communicate with Caché. Instead, they use a fast in-memory connection (implemented via standard .NET and the Caché [Callin API](#)), and run in the same process as the Caché instance. Although the Caché server and the .NET application must be on the same machine, the application can still use Caché [ECP](#) to access data on remote machines.

Caché eXTreme components include:

- *eXTreme Event Persistence (XEP)* — allows simple .NET objects to be projected as XTP persistent events for rapid storage and processing. This is a lightweight API for low latency object and event stream data access (see “[Using eXTreme Event Persistence](#)”).

## 1.1 Installation and Configuration

This section provides specifies requirements and provides instructions for installing Caché and configuring your environment to use the eXTreme APIs.

### 1.1.1 Requirements

- The .NET Framework, versions 2.0, 3.0, or 4.0.
- Caché 2012.2 or higher.
- The Caché User namespace must exist and must be writable if your application uses XEP (see “[Using eXTreme Event Persistence](#)”).

### 1.1.2 Installation

- 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.

## 1.1.3 Required Environment Variables

In order to run eXTreme applications, the following environment variable must be properly set:

- Your *PATH* environment variable must include `<install-dir>/bin`.

If your *PATH* variable includes more than one `<install-dir>/bin` path (for example, if you have installed more than one instance of Caché) only the first one will be used, and any others will be ignored.

## 1.1.4 Required Files

Your .NET project must include references to the following files:

- `InterSystems.CacheExtreme.dll` — located in `<install-dir>/dev/dotnet/bin/v2.0.50727`
- `InterSystems.Data.CacheClient.dll` — is provided in three different versions, one for each supported release of the .NET Framework. The different versions are located in appropriately named subdirectories of `<install-dir>/dev/dotnet/bin` (for example, `<install-dir>/dev/dotnet/bin/v4.0.30319` contains the file for .NET 4.0). Use the appropriate file for the release that will be used to compile your project.

# 1.2 eXTreme Sample Applications

Sample applications are available for all eXTreme APIs.

## 1.2.1 XEP Samples

XEP sample files are in `<install-dir>/dev/dotnet/samples/xep/` (see “[Default Caché Installation Directory](#)” for the location of `<install-dir>` on your system). To run them, compile the `XEPTest40.csproj` project, which includes the following components (located in subdirectory `/xep/test/`):

- `RunAll.cs` — is a program that runs all of the other sample programs in sequence.  
This program connects to Caché with a hard-coded superserver port value of 1972 (see “[DefaultPort](#)” in the *Caché Parameter File Reference*). If your system does not use this default value, change the port number in the first line of the program and recompile.
- `Coverage.cs` — tests basic functionality such as connecting, importing a schema, storing, querying, updating and deleting XEP events. It also exercises most of the supported data types.
- `SingleString.cs` — is the most basic XEP test program. It connects to the database, imports a simple class containing only one string field, then stores and loads a number of events corresponding to that class.
- `FlightLog.cs` — is an example that demonstrates the XEP full inheritance model. It tracks airline flight information such as times, locations, personnel, and passengers.
- `Benchmark.cs` — is a performance test for the XEP API.
- `IdKeys.cs` — extends the Benchmark test by adding the composite `IdKey` feature.
- `Threads.cs` — is a multithreaded XEP test program.

See the help file (`<install-dir>/dev/dotnet/help/CacheExtreme.chm`) for detailed documentation of these programs. Supporting files located in `<install-dir>/dev/dotnet/samples/xep/samples/` provide test data for the sample programs. The `xep.samples.SingleStringSample` class is used by several examples in this book.



# 2

## Using eXTreme Event Persistence

Caché eXTreme Event Persistence (XEP) provides extremely rapid storage and retrieval of .NET structured data. XEP provides ways to control schema generation for optimal mapping of complex data structures, but schemas for simpler data structures can often be generated and used without modification. XEP can use either in-process communications or a TCP/IP connection.

The following topics are discussed in this chapter:

- [Introduction to Event Persistence](#) — introduces persistent event concepts and terminology, and provides a simple example of code that uses the XEP API.
- [Creating and Connecting an EventPersister](#) — describes how to create an instance of the EventPersister class and use it to open, test, and close an eXTreme or TCP/IP database connection.
- [Importing a Schema](#) — describes the methods and attributes used to analyze a .NET class and generate a schema for the corresponding Caché event.
- [Storing and Modifying Events](#) — describes methods of the Event class used to store, modify, and delete persistent events.
- [Using Queries](#) — describes methods of the EventQuery<> class that create and process query resultsets.
- [Calling Caché Methods from XEP](#) — describes EventPersister methods that can call ObjectScript methods, functions, and procedures from an XEP application.
- [Schema Mapping and Customization](#) — provides a detailed description of how .NET classes are mapped to Caché event schemas, and how to generate customized schemas for optimal performance.

### 2.1 Introduction to Event Persistence

A *persistent event* is a Caché database object that stores a persistent copy of the data fields in a .NET object. By default, the eXTreme Event Persistence API stores each event as regular %Persistent object. Storage is automatically configured so that the data will be accessible to Caché by other means, such as objects, SQL, or direct global access.

Before a persistent event can be created and stored, XEP must analyze the corresponding .NET class and *import a schema*, which defines how the data structure of a .NET object is projected to a Caché persistent event. A schema can use either of the following two object projection models:

- The default model is the *flat schema*, where all referenced objects are serialized and stored as part of the imported class, and all fields inherited from superclasses are stored as if they were native fields of the imported class. This is the fastest and most efficient model, but does not preserve any information about the original .NET class structure.

- If structural information must be preserved, the *full schema* model may be used. This preserves the full .NET inheritance structure by creating a one-to-one relationship between .NET source classes and Caché projected classes, but may impose a slight performance penalty.

See “[Schema Import Models](#)” for a detailed discussion of both models.

Once a schema has been imported, XEP can be used to store, query, update and delete data at very high rates. Stored events are immediately available for querying, or for full object or global access. The `EventPersister`, `Event`, and `EventQuery<>` classes provide the main features of the XEP API. They are used in the following sequence:

- The `EventPersister` class provides methods to establish and control a database connection (see “[Creating and Connecting an EventPersister](#)”).
- Once the connection has been established, other `EventPersister` methods can be used to import a schema (see “[Importing a Schema](#)”).
- The `Event` class provides methods to store, update, or delete events, create a query, and control index updating (see “[Storing and Modifying Events](#)”).
- The `EventQuery<>` class is used to execute simple SQL queries that retrieve sets of events from the database. It provides methods to iterate through the resultset and update or delete individual events (see “[Using Queries](#)”).

The next section (see “[Simple Applications to Store and Query Persistent Events](#)”) describes two very short applications that demonstrate all of these features.

When importing a schema, XEP acquires basic information by analyzing the .NET class. You can supply additional information that allows XEP to generate indexes and override the default rules for importing fields (see “[Schema Customization](#)”).

Fields of a persistent event can be simple numeric types and their associated System types, strings, objects (projected as embedded/serial objects), enumerations, and types derived from collection classes. These types can also be contained in arrays, nested collections, and collections of arrays. See “[Schema Mapping Rules](#)” for detailed information.

## 2.1.1 Simple Applications to Store and Query Persistent Events

This section describes two very simple applications that use XEP to create and access persistent events:

- [The StoreEvents program](#) — opens an eXTreme connection to a Caché database, creates a schema for the events to be stored, uses an instance of `Event` to store the array of objects as persistent events, then closes the connection and terminates.
- [The QueryEvents program](#) — opens a new eXTreme connection accessing the same namespace as `StoreEvents`, creates an instance of `EventQuery<>` to read and delete the previously stored events, then closes the connection and terminates.

**Note:** It is assumed that these applications have exclusive use of the system, and run in two consecutive processes.

Both programs use instances of `xep.samples.SingleStringSample`, which is one of the classes defined in the XEP sample programs (see “[XEP Samples](#)” for details about the sample programs).

### 2.1.1.1 The StoreEvents Program

In `StoreEvents`, a new instance of `EventPersister` is created and connected to a specific namespace on the Caché server. A schema is imported for the `SingleStringSample` class, and the test database is initialized by deleting all existing events from the extent of the class. An instance of `Event` is created and used to store an array of `SingleStringSample` objects as persistent events. The connection is then terminated. The new events will persist in the Caché database, and will be accessed by the `QueryEvents` program (described in the next section).

## The StoreEvents Program: Creating a schema and storing events

```

using System;
using InterSystems.XEP;
using xep.samples; // compiled XEPTest.csproj

public class StoreEvents {
    private static String className = "xep.samples.SingleStringSample";
    private static SingleStringSample[] eventData = SingleStringSample.generateSampleData(12);

    public static void Main(String[] args) {
        for (int i=0; i < eventData.Length; i++) {
            eventData[i].name = "String event " + i;
        }
        try {
            Console.WriteLine("Connecting and importing schema for " + className);
            EventPersister myPersister = PersisterFactory.CreatePersister();
            myPersister.Connect("User", "_SYSTEM", "SYS");
            try { // delete any existing SingleStringSample events, then import new ones
                myPersister.DeleteExtent(className);
                myPersister.ImportSchema(className);
            }
            catch (XEPException e) { Console.WriteLine("import failed:\n" + e); }
            Event newEvent = myPersister.GetEvent(className);
            long[] itemIDs = newEvent.Store(eventData); // store array of events
            Console.WriteLine("Stored " + itemIDs.Length + " of "
                + eventData.Length + " objects. Closing connection...");
            newEvent.Close();
            myPersister.Close();
        }
        catch (XEPException e) { Console.WriteLine("Event storage failed:\n" + e); }
    } // end Main()
} // end class StoreEvents

```

Before `StoreEvents.Main()` is called, the `xep.samples.SingleStringSample.generateSampleData()` method is called to generate sample data array `eventData` (see “[XEP Samples](#)” for information on sample classes).

In this example, XEP methods perform the following actions:

- `PersisterFactory.CreatePersister()` creates `myPersister`, a new instance of `EventPersister`.
- `EventPersister.Connect()` establishes an eXTreme in-process connection to the User namespace.
- `EventPersister.ImportSchema()` analyzes the `SingleStringSample` class and imports a schema for it.
- `EventPersister.DeleteExtent()` is called to clean up the database by deleting any previously existing test data from the `SingleStringSample` extent.
- `EventPersister.GetEvent()` creates `newEvent`, a new instance of `Event` that will be used to process `SingleStringSample` events.
- `Event.Store()` accepts the `eventData` array as input, and creates a new persistent event for each object in the array. (Alternately, the code could have looped through the `eventData` array and called `Store()` for each individual object, but there is no need to do so in this example.)
- `Event.Close()` and `EventPersister.Close()` are called for `newEvent` and `myPersister` after the events have been stored. This is always necessary to release native code resources and prevent memory leaks.

All of these methods are discussed in detail later in this chapter. See “[Creating and Connecting an EventPersister](#)” for information on opening, testing, and closing an eXTreme connection. See “[Importing a Schema](#)” for details about schema creation. See “[Storing and Modifying Events](#)” for details about using the `Event` class and deleting an extent.

### 2.1.1.2 The QueryEvents Program

This example assumes that `QueryEvents` runs immediately after the `StoreEvents` process terminates (see “[The StoreEvents Program](#)”). `QueryEvents` establishes a new database connection that accesses the same namespace as `StoreEvents`. An instance of `EventQuery<>` is created to iterate through the previously stored events, print their data, and delete them.

**The QueryEvents Program: Fetching and processing persistent events**

```

using System;
using InterSystems.XEP;
using SingleStringSample = xep.samples.SingleStringSample; // compiled XEPTest.csproj

public class QueryEvents {
    public static void Main(String[] args) {
        EventPersister myPersister = null;
        EventQuery<SingleStringSample> myQuery = null;
        try {
            // Open a connection, then set up and execute an SQL query
            Console.WriteLine("Connecting to query SingleStringSample events");
            myPersister = PersisterFactory.CreatePersister();
            myPersister.Connect("User", "_SYSTEM", "SYS");
            try {
                Event newEvent = myPersister.GetEvent("xep.samples.SingleStringSample");
                String sql = "SELECT * FROM xep_samples.SingleStringSample WHERE %ID BETWEEN 3 AND ?";

                myQuery = newEvent.CreateQuery<SingleStringSample>(sql);
                newEvent.Close();
                myQuery.AddParameter(12); // assign value 12 to SQL parameter
                myQuery.Execute();
            }
            catch (XEPException e) {Console.WriteLine("createQuery failed:\n" + e);}
        }
        // Iterate through the returned data set, printing and deleting each event
        SingleStringSample currentEvent;
        currentEvent = myQuery.GetNext(); // get first item
        while (currentEvent != null) {
            Console.WriteLine("Retrieved " + currentEvent.name);
            myQuery.DeleteCurrent();
            currentEvent = myQuery.GetNext(); // get next item
        }
        myQuery.Close();
        myPersister.Close();
    }
    catch (XEPException e) {Console.WriteLine("QueryEvents failed:\n" + e);}
} // end Main()
} // end class QueryEvents

```

In this example, XEP methods perform the following actions:

- EventPersister.**CreatePersister()** and EventPersister.**Connect()** are called again (just as they were in StoreEvents) and a new connection to the User namespace is established.
- EventPersister.**GetEvent()** creates *newEvent*, a new instance of Event that will be used to create a query on the SingleStringSample extent. After the query is created, *newEvent* will be discarded by calling its **Close()** method.
- Event.**CreateQuery()** creates *myQuery*, an instance of EventQuery<> for SingleStringSample events. The SQL statement defines a query that will retrieve all persistent SingleStringSample events with object IDs between 3 and a variable parameter value.
- EventQuery<>.**AddParameter()** assigns value 12 to the SQL parameter.
- EventQuery<>.**Execute()** executes the query. If the query is successful, *myQuery* will now contain a resultset that lists the object IDs of all SingleStringSample events that match the query.
- EventQuery<>.**GetNext()** is called to fetch the first item in the resultset and assign it to variable *currentEvent*.
- In the while loop:
  - The name field of *currentEvent* is printed
  - EventQuery<>.**DeleteCurrent()** deletes the most recently fetched event from the database.
  - EventQuery<>.**GetNext()** is called again to fetch the next event and assign it to variable *currentEvent*.

If there are no more items, **GetNext()** will return null and the loop will terminate.

- `EventQuery<>.Close()` and `EventPersister.Close()` are called for *myQuery* and *myPersister* after all events have been printed and deleted. This is always necessary to release native code resources and prevent memory leaks.

All of these methods are discussed in detail later in this chapter. See “[Creating and Connecting an EventPersister](#)” for information on opening, testing, and closing an eXTreme connection. See “[Using Queries](#)” for details about creating and using an instance of `EventQuery<>`.

## 2.2 Creating and Connecting an EventPersister

The `EventPersister` class is the main entry point for the XEP API. It provides the methods for connecting to the database, importing schemas, handling transactions, and creating instances of `Event` to access events in the database.

An instance of `EventPersister` is created and destroyed by the following methods:

- `PersisterFactory.CreatePersister()` — returns a new instance of `EventPersister`.
- `EventPersister.Close()` — closes this `EventPersister` instance and releases the native code resources associated with it.

The following methods are used to create a connection:

- `EventPersister.Connect()` — takes `String` arguments for *namespace*, *username*, *password*, and establishes an eXTreme in-process connection to the specified Caché namespace.

Optionally takes additional *host* and *port* arguments, and establishes a TCP/IP connection instead of an eXTreme connection

It is important to understand that only one eXTreme connection can exist in a process, and all connected objects in the process will reference that connection instance. For example, an `Xep.EventPersister` object and a `Globals.Connection` object in the same process would share the same underlying connection.

The following example establishes an in-process eXTreme connection:

### **Creating and Connecting an EventPersister: Creating an eXTreme connection**

```
// Open an eXTreme connection
String namespc = "USER";
String username = "_SYSTEM";
String password = "SYS";
EventPersister myPersister = PersisterFactory.CreatePersister();
myPersister.Connect(namespc, username, password);
// perform event processing here . . .
myPersister.Close();
```

The `PersisterFactory.CreatePersister()` method creates a new instance of `EventPersister`. Only one instance is required in a process.

The `EventPersister.Connect()` method establishes an in-process eXTreme connection. If no connection exists in the current process, a new eXTreme connection is created. If a connection already exists, the method returns a reference to the existing connection object.

When the application is ready to exit, the `EventPersister.Close()` method must always be called to release resources used by the underlying native code.

#### **Important: Always call Close() to avoid memory leaks**

It is important to always call `Close()` on an instance of `EventPersister` before it goes out of scope. Failing to close it can cause serious memory leaks because .NET garbage collection cannot release resources allocated by the underlying native code.

## Establishing a TCP/IP Connection

When an XEP application requires access to a database on another machine, it may be desirable to establish a standard TCP/IP connection rather than an in-process eXTreme connection. Although the TCP/IP connection is somewhat slower, the difference depends on the complexity of the events that are being stored. For extremely simple events with only one or two fields, the eXTreme connection is much faster. For more complex events, the difference is much less pronounced, and may be negligible for very complex events.

A TCP/IP connection is established when the call to `Connect()` specifies the optional *host* and *port* arguments, as demonstrated in the following example:

### Creating and Connecting an EventPersister: Creating a TCP/IP connection

```
// Open a TCP/IP connection
string host = "127.0.0.1";
int port = 1972;
myPersister.Connect(host, port, "User", "_SYSTEM", "SYS");
// perform event processing here . . .
myPersister.Close();
```

The `EventPersister.Connect()` method is called with *host* and *port* arguments, followed by the same *namespace*, *username*, and *password* arguments as in the previous example (hard-coded in this example). This establishes a TCP/IP connection to the specified port of the specified host machine.

## Accessing the Underlying Connections

XEP is a layer over the Globals API, and uses the same underlying connections. The following methods return the underlying eXTreme and `DbConnection` connections:

- `EventPersister.GetConnection()` — returns the underlying eXTreme `Globals.Connection` object. Throws an exception if the connection is TCP/IP rather than eXTreme.
- `EventPersister.GetAdoNetConnection()` — returns the underlying `.NET DbConnection` object.

The eXTreme Connection object can be useful in XEP applications that also use the other APIs described in this book, since the same underlying connection is used by all of them.

## 2.3 Importing a Schema

Before an instance of a `.NET` class can be stored as a persistent event, a schema must be imported for the class. The schema defines the database structure in which the event will be stored. XEP provides two different schema import models: *flat schema* and *full schema*. The main difference between these models is the way in which `.NET` objects are projected to Caché events. A flat schema is the optimal choice if performance is essential and the event schema is fairly simple. A full schema offers a richer set of features for more complex schemas, but may have an impact on performance. See “[Schema Mapping and Customization](#)” for a detailed discussion of schema models and related subjects.

The following methods are used to analyze a `.NET` class and import a schema of the desired type:

- `EventPersister.ImportSchema()` — imports a *flat schema*. Takes an argument specifying a `.dll` file name, a fully qualified class name, or an array of class names, and imports all classes and any dependencies found in the specified locations. Returns a `String` array containing the names of all successfully imported classes.
- `EventPersister.ImportSchemaFull()` — imports a *full schema*. Takes the same arguments and returns the same class list as `ImportSchema()`. A class imported by this method must declare a user-generated `IdKey` (see “[Using IdKeys](#)”).
- `Event.IsEvent()` — a static `Event` method that takes a `.NET` object or class name of any type as an argument, tests to see if the specified object can be projected as a valid XEP event (see “[Requirements for Imported Classes](#)”), and throws an appropriate error if it is not valid.

The import methods are identical except for the schema model used. The following example imports a simple test class and its dependent class:

### **Importing a Schema: Importing a class and its dependencies**

The following classes are to be imported:

```
namespace test {
    public class MainClass {
        public MainClass() {}
        public String myString;
        public test.Address myAddress;
    }

    public class Address {
        public String street;
        public String city;
        public String state;
    }
}
```

The following code uses `ImportSchema()` to import the main class, `test.MainClass`, after calling `IsEvent()` to make sure it can be projected. Dependent class `test.Address` is also imported automatically when `test.MainClass` is imported:

```
try {
    Event.IsEvent("test.MainClass"); // throw an exception if class is not projectable
    myPersister.ImportSchema("test.MainClass");
}
catch (XEPException e) {Console.WriteLine("Import failed:\n" + e);}
```

In this example, instances of dependent class `test.Address` will be serialized and embedded in the same Caché object as other fields of `test.MainClass`. If `ImportSchemaFull()` had been used instead, stored instances of `test.MainClass` would contain references to instances of `test.Address` stored in a separate Caché class extent.

## 2.4 Storing and Modifying Events

Once the schema for a class has been imported (see “[Importing a Schema](#)”), an instance of `Event` can be created to store and access events of that class. The `Event` class provides methods to store, update, or delete persistent events, create queries on the class extent, and control index updating. This section discusses the following topics:

- [Creating and Storing Events](#) — describes how to create an instance of `Event` and use it to store persistent events of the specified class.
- [Accessing Stored Events](#) — describes `Event` methods for fetching, changing, and deleting persistent events of the specified class.
- [Controlling Index Updating](#) — describes `Event` methods that can increase processing efficiency by controlling when index entries are updated.

### 2.4.1 Creating and Storing Events

Instances of the `Event` class are created and destroyed by the following methods:

- `EventPersister.GetEvent()` — takes a `className` String argument and returns an instance of `Event` that can store and access events of the specified class. Optionally takes an `indexMode` argument that specifies the default way to update index entries (see “[Controlling Index Updating](#)” for details).



**Note:** **Target Class**

An instance of `Event` can only store, access, or query events of the class specified by the `className` argument in the call to `GetEvent()`. In this chapter, class `className` is referred to as the *target class*.

- `Event.Close()` — closes the `Event` instance and releases the native code resources associated with it.

The following `Event` method stores .NET objects of the target class as persistent events:

- **Store()** — adds one or more instances of the target class to the database. Takes either an event or an array of events as an argument, and returns a long database ID (or 0 if the database id could not be returned) for each stored event.

**Important:** When an event is stored, it is not tested in any way, and it will never change or overwrite existing data. Each event is appended to the extent at the highest possible speed, or silently ignored if an event with the specified key already exists in the database.

The following example creates an instance of `Event` with `SingleStringSample` as the target class, and uses it to project an array of .NET `SingleStringSample` objects as persistent events. The example assumes that `myPersister` has already been created and connected, and that a schema has been imported for the `SingleStringSample` class. See “[Simple Applications to Store and Query Persistent Events](#)” for an example of how this is done. See “[XEP Samples](#)” for information on `SingleStringSample` and the sample programs that define and use it.

**Storing and Modifying Events: Storing an array of objects**

```
SingleStringSample[] eventItems = SingleStringSample.generateSampleData(12);
try {
    Event newEvent = myPersister.GetEvent("xep.samples.SingleStringSample");
    long[] itemIdList = newEvent.Store(eventItems); // store all events
    int itemCount = 0;
    for (int i=0; i < itemIdList.Length; i++) {
        if (itemIdList[i]>0) itemCount++;
    }
    Console.WriteLine("Stored " + itemCount + " of " + eventItems.Length + " events");
    newEvent.Close();
}
catch (XEPException e) { Console.WriteLine("Event storage failed:\n" + e); }
```

- The `generateSampleData()` method of `SingleStringSample` generates twelve `SingleStringSample` objects and stores them in an array named `eventData`.
- The `EventPersister.GetEvent()` method creates an `Event` instance named `newEvent` with `SingleStringSample` as the target class.
- The `Event.Store()` method is called to project each object in the `eventData` array as a persistent event in the database.

The method returns an array named `itemIdList`, which contains a long object ID for each successfully stored event, or 0 for an object that could not be stored. Variable `itemCount` is incremented once for each ID greater than 0 in `itemIdList`, and the total is printed.

- When the loop terminates, the `Event.Close()` method is called to release resources used by the underlying native code.

**Important:** **Always call Close() to avoid memory leaks**

It is important to always call `Close()` on instances of `Event` before they go out of scope or are reused. Failing to close them can cause serious memory leaks because .NET garbage collection cannot release resources allocated by the underlying native code.



## 2.4.2 Accessing Stored Events

Once a persistent event has been stored, an Event instance of that target class provides the following methods for reading, updating, deleting the event:

- **DeleteObject()** — takes a database object ID or IdKey as an argument and deletes the specified event from the database.
- **GetObject()** — takes a database object ID or IdKey as an argument and returns the specified event.
- **UpdateObject()** — takes a database object ID or IdKey and an Object of the target class as arguments, and updates the specified event.

If the target class uses a standard object ID, it is specified as a long value (as returned by the **Store()** method described in the previous section). If the target class uses an IdKey, it is specified as an array of Object where each item in the array is a value for one of the fields that make up the IdKey (see “Using IdKeys”).

In the following example, array *itemIdList* contains a list of object ID values for some previously stored SingleStringSample events. The example arbitrarily updates the first six persistent events in the list and deletes the rest.

**Note:** See “Creating and Storing Events” for the example that created the *itemIdList* array. This example also assumes that an EventPersister instance named *myPersister* has already been created and connected to the database.

### Storing and Modifying Events: Fetching, updating, and deleting events

```
// itemIdList is a previously created array of SingleStringSample event IDs
try {
    Event newEvent = myPersister.GetEvent("xep.samples.SingleStringSample");
    int itemCount = 0;
    for (int i=0; i < itemIdList.Length; i++) {
        try { // arbitrarily update events for first 6 Ids and delete the rest
            SingleStringSample eventObject = (SingleStringSample)newEvent.GetObject(itemIdList[i]);

            if (i<6) {
                eventObject.name = eventObject.name + " (id=" + itemIdList[i] + ")" + " updated!";
                newEvent.UpdateObject(itemIdList[i], eventObject);
                itemCount++;
            } else {
                newEvent.DeleteObject(itemIdList[i]);
            }
        }
        catch (XEPException e) {Console.WriteLine("Failed to process event:\n" + e);}
    }
    Console.WriteLine("Updated " + itemCount + " of " + itemIdList.Length + " events");
    newEvent.Close();
}
catch (XEPException e) {Console.WriteLine("Event processing failed:\n" + e);}
```

- The EventPersister.**GetEvent()** method creates an Event instance named *newEvent* with SingleStringSample as the target class.
- Array *itemIdList* contains a list of object ID values for some previously stored SingleStringSample events (see “Creating and Storing Events” for the example that created *itemIdList*).

In the loop, each item in *itemIdList* is processed. The first six items are changed and updated, and the rest of the items are deleted. The following operations are performed:

- The Event.**GetObject()** method fetches the SingleStringSample object with the object ID specified in *itemIdList[i]*, and assigns it to variable *eventObject*.
- The value of the *eventObject* name field is changed.
- If the *eventObject* is one of the first six items in the list, Event.**UpdateObject()** is called to update it in the database. Otherwise, Event.**DeleteObject()** is called to delete the object from the database.

- After all of the IDs in *itemIdList* have been processed, the loop terminates and a message displays the number of events updated.
- The Event.**Close()** method is called to release resources used by the underlying native code.

See “[XEP Samples](#)” for information on the sample programs that define and use the `SingleStringSample` class.

See “[Using Queries](#)” for a description of how to access and modify persistent events fetched by a simple SQL query.

### Deleting Test Data

When initializing a test database, it is frequently convenient to delete an entire class, or delete all events in a specified extent. The following `EventPersister` methods delete classes and extents from the Caché database:

- **DeleteClass()** — takes a *className* string as an argument and deletes the specified Caché class.
- **DeleteExtent()** — takes a *className* string as an argument and deletes all events in the extent of the specified class.

These methods are intended primarily for testing, and should be avoided in production code. See “[Classes and Extents](#)” in the *Caché Programming Orientation Guide* for a detailed definition of these terms.

## 2.4.3 Controlling Index Updating

By default, indexes are not updated when a call is made to one of the Event methods that act on an event in the database (see “[Accessing Stored Events](#)”). Indexes are updated asynchronously, and updating is only performed after all transactions have been completed and the Event instance is closed. No uniqueness check is performed for unique indexes.

**Note:** This section only applies to classes that use standard object IDs or generated `IdKeys` (see “[Using IdKeys](#)”). Classes with user-assigned `IdKeys` can only be updated synchronously.

There are a number of ways to change this default indexing behavior. When an Event instance is created by `EventPersister.GetEvent()` (see “[Creating and Storing Events](#)”), the optional *indexMode* parameter can be set to specify a default indexing behavior. The following options are available:

- `Event.INDEX_MODE_ASYNC_ON` — enables asynchronous indexing. This is the default when the *indexMode* parameter is not specified.
- `Event.INDEX_MODE_ASYNC_OFF` — no indexing will be performed unless the **StartIndexing()** method is called.
- `Event.INDEX_MODE_SYNC` — indexing will be performed each time the extent is changed, which can be inefficient for large numbers of transactions. This index mode must be specified if the class has a user-assigned `IdKey`.

The following Event methods can be used to control asynchronous index updating for the extent of the target class:

- **StartIndexing()** — starts asynchronous index building for the extent of the target class. Throws an exception if the index mode is `Event.INDEX_MODE_SYNC`.
- **StopIndexing()** — stops asynchronous index building for the extent. If you do not want the index to be updated when the Event instance is closed, call this method before calling `Event.Close()`.
- **WaitForIndexing()** — takes an int *timeout* value as an argument and waits for asynchronous indexing to be completed. The *timeout* value specifies the number of seconds to wait (wait forever if `-1`, return immediately if `0`). It returns `true` if indexing has been completed, or `false` if the wait timed out before indexing was completed. Throws an exception if the index mode is `Event.INDEX_MODE_SYNC`.

## 2.5 Using Queries

The Event class provides a way to create an instance of `EventQuery<>`, which can execute a limited SQL query on the extent of the target class. `EventQuery<>` methods are used to execute the SQL query, and to retrieve, update, or delete individual items in the query resultset.

The following topics are discussed:

- [Creating and Executing a Query](#) — describes how use methods of the `EventQuery<>` class to execute queries.
- [Processing Query Data](#) — describes how to access and modify items in an `EventQuery<>` resultset.
- [Defining the Fetch Level](#) — describes how to control the amount of data returned by a query.

**Note:** The examples in this section assume that `EventPersister` object *myPersister* has already been created and connected, and that a schema has been imported for the `SingleStringSample` class. See “[Simple Applications to Store and Query Persistent Events](#)” for an example of how this is done.

### 2.5.1 Creating and Executing a Query

The following methods create and destroy an instance of `EventQuery<>`:

- `Event.CreateQuery()` — takes a `String` argument containing the text of the SQL query and returns an instance of `EventQuery<E>`, where parameter `E` is the target class of the parent `Event`.
- `EventQuery<>.Close()` — closes this `EventQuery<>` instance and releases the native code resources associated with it.

Queries submitted by an instance of `EventQuery<E>` will return .NET objects of the specified generic type `E` (the target class of the `Event` instance that created the query object). Queries supported by the `EventQuery<>` class are a subset of SQL select statements, as follows:

- Queries must consist of a `SELECT` clause, a `FROM` clause, and (optionally) standard SQL clauses such as `WHERE` and `ORDER BY`.
- The `SELECT` and `FROM` clauses must be syntactically legal, but they are actually ignored during query execution. All fields that have been mapped are always fetched from the extent of target class `E`.
- SQL expressions may not refer to arrays of any type, nor to embedded objects or fields of embedded objects.
- The Caché system-generated object ID may be referred to as `%ID`. Due to the leading `%`, this will not conflict with any field called *id* in a .NET class.

The following `EventQuery<>` methods define and execute the query:

- `AddParameter()` — binds a parameter for the SQL query associated with this `EventQuery<>`. Takes `Object value` as the argument specifying the value to bind to the parameter.
- `Execute()` — executes the SQL query associated with this `EventQuery<>`. If the query is successful, this `EventQuery<>` will contain a resultset that can be accessed by the methods described later (see “[Processing Query Data](#)”).

The following example executes a simple query on events in the `xep.samples.SingleStringSample` extent (see “[XEP Samples](#)” for information on the sample programs that define and use the `SingleStringSample` class.).

## Using Queries: Creating and executing a query

```

Event newEvent = myPersister.GetEvent("xep.samples.SingleStringSample");
EventQuery<SingleStringSample> myQuery = null;
String sql =
    "SELECT * FROM xep_samples.SingleStringSample WHERE %ID BETWEEN ? AND ?";

myQuery = newEvent.CreateQuery<SingleStringSample>(sql);
myQuery.AddParameter(3); // assign value 3 to first SQL parameter
myQuery.AddParameter(12); // assign value 12 to second SQL parameter
myQuery.Execute(); // get resultset for IDs between 3 and 12

```

The EventPersister.[GetEvent\(\)](#) method creates an Event instance named *newEvent* with SingleStringSample as the target class.

The Event.[CreateQuery\(\)](#) method creates an instance of EventQuery<> named *myQuery*, which will execute the SQL query and hold the resultset. The *sql* variable contains an SQL statement that selects all events in the target class with IDs between two parameter values.

The EventQuery<>.[AddParameter\(\)](#) method is called twice to assign values to the two parameters.

When the EventQuery<>.[Execute\(\)](#) method is called, the specified query is executed for the extent of the target class, and the resultset is stored in *myQuery*.

By default, all data is fetched for each object in the resultset, and each object is fully initialized. See “[Defining the Fetch Level](#)” for options that limit the amount and type of data fetched with each object.

## 2.5.2 Processing Query Data

After a query has been executed, the following EventQuery<> methods can be used to access items in the query resultset, and update or delete the corresponding persistent events in the database:

- [GetNext\(\)](#) — returns the next object of the target class from the resultset. Returns null if there are no more items in the resultset.
- [UpdateCurrent\(\)](#) — takes an object of the target class as an argument and uses it to update the persistent event most recently returned by [GetNext\(\)](#).
- [DeleteCurrent\(\)](#) — deletes the persistent event most recently returned by [GetNext\(\)](#) from the database.
- [GetAll\(\)](#) — uses [GetNext\(\)](#) to get all items from the resultset, and returns them in a List. Cannot be used for updating or deleting. [GetAll\(\)](#) and [GetNext\(\)](#) cannot access the same resultset — once either method has been called, the other method cannot be used until [Execute\(\)](#) is called again.

See “[Accessing Stored Events](#)” for a description of how to access and modify persistent events identified by Id or IdKey.

### Using Queries: Updating and Deleting Query Data

```

myQuery.Execute(); // get resultset
SingleStringSample currentEvent = myQuery.GetNext();
while (currentEvent != null) {
    if (currentEvent.name.StartsWith("finished")) {
        myQuery.DeleteCurrent(); // Delete if already processed
    } else {
        currentEvent.name = "in process: " + currentEvent.name;
        myQuery.UpdateCurrent(currentEvent); // Update if unprocessed
    }
    currentEvent = myQuery.GetNext();
}
myQuery.Close();

```

In this example, the call to EventQuery<>.[Execute\(\)](#) is assumed to execute the query described in the previous example (see “[Creating and Executing a Query](#)”), and the resultset is stored in *myQuery*. Each item in the resultset is a SingleStringSample object.

The first call to [GetNext\(\)](#) gets the first item from the resultset and assigns it to *currentEvent*.

In the `while` loop, the following process is applied to each item in the resultset:

- If `currentEvent.name` starts with the string "finished", `DeleteCurrent()` deletes the corresponding persistent event from the database.
- Otherwise, the value of `currentEvent.name` is changed, and `UpdateCurrent()` is called. It takes `currentEvent` as its argument and uses it to update the persistent event in the database.
- The call to `GetNext()` returns the next `SingleStringSample` object from the resultset and assigns it to `currentEvent`.

After the loop terminates, `Close()` is called to release the native code resources associated with `myQuery`.

**Important:**     **Always call `Close()` to avoid memory leaks**

It is important to always call `Close()` on instances of `EventQuery<>` before they go out of scope or are reused. Failing to close them can cause serious memory leaks because .NET garbage collection cannot release resources allocated by the underlying native code.

## 2.5.3 Defining the Fetch Level

The fetch level is an Event property that can be used to control the amount of data returned when running a query. This is particularly useful when the underlying event is complex and only a small subset of event data is required.

The following `EventQuery<>` methods set and return the current fetch level:

- `GetFetchLevel()` — returns an `int` indicating the current fetch level of the Event.
- `SetFetchLevel()` — takes one of the values in the Event fetch level enumeration as an argument and sets the fetch level for the Event.

The following fetch level values are supported:

- `Event.OPTION_FETCH_LEVEL_ALL` — This is the default. All data is fetched, and the returned event is fully initialized.
- `Event.OPTION_FETCH_LEVEL_DATATYPES_ONLY` — Only datatype fields are fetched. This includes all simple numeric types and their associated System types, strings, and enumerations. All other fields are set to `null`.
- `Event.OPTION_FETCH_LEVEL_NO_ARRAY_TYPES` — All types are fetched except arrays. All fields of array types, regardless of dimension, are set to `null`. All datatypes, object types (including serialized types) and collections are fetched.
- `Event.OPTION_FETCH_LEVEL_NO_COLLECTIONS` — All types are fetched except implementations of collection classes.
- `Event.OPTION_FETCH_LEVEL_NO_OBJECT_TYPES` — All types are fetched except object types. Serialized types are also considered object types and are not fetched. All datatypes, array types and collections are fetched.

## 2.6 Calling Caché Methods from XEP

The following `EventPersister` methods call Caché class methods:

- `CallClassMethod()` — calls the specified ObjectScript class method. Takes String arguments for `className` and `methodName`, plus 0 or more arguments that will be passed to the class method. Returns an Object that may be of type `int`, `long`, `double`, or `String`.

- **CallBytesClassMethod()** — identical to **CallClassMethod()** except that string values are returned as instances of `byte[]`.
- **CallListClassMethod()** — identical to **CallClassMethod()** except that string values are returned as instances of `ValueList`.
- **CallVoidClassMethod()** — identical to **CallClassMethod()** except that nothing is returned.

The following `EventPersister` methods call Caché functions and procedures (see “[User-defined Code](#)” in *Using Caché ObjectScript*):

- **CallFunction()** — calls the specified ObjectScript function. Takes String arguments for *functionName* and *routineName*, plus 0 or more arguments that will be passed to the function. Returns an Object that may be of type `int`, `long`, `double`, or `String`.
- **CallBytesFunction()** — identical to **CallFunction()** except that string values are returned as instances of `byte[]`.
- **CallListFunction()** — identical to **CallFunction()** except that string values are returned as instances of `ValueList`.
- **CallProcedure()** — calls the specified ObjectScript procedure. Takes String arguments for *procedureName* and *routineName*, plus 0 or more arguments that will be passed to the procedure.

## 2.7 Schema Mapping and Customization

This section provides details about how a .NET class is mapped to a Caché event schema, and how a schema can be customized for optimal performance. The following subjects are discussed:

- [Schema Import Models](#) — describes the two schema import models supported by XEP.
- [Schema Customization](#) — describes various options for customizing a schema by adding indexes or overriding the default rules for importing a field.
- [Schema Mapping Rules](#) — provides a detailed description of how .NET classes are mapped to Caché event schemas.

### 2.7.1 Schema Import Models

XEP provides two different schema import models: flat schema and full schema. The main difference between these models is the way in which .NET objects are projected to Caché events.

- **The Embedded Object Projection Model (Flat Schema)** — imports a *flat schema* where all objects referenced by the imported class are serialized and embedded, and all fields declared in all ancestor classes are collected and projected as if they were declared in the imported class itself. All data for an instance of the class is stored as a single Caché `%Library.Persistent` object, and information about the original .NET class structure is not preserved.
- **The Full Object Projection Model (Full Schema)** — imports a *full schema* where all objects referenced by the imported class are projected as separate Caché `%Persistent` objects. Inherited fields are projected as references to fields in the ancestor classes, which are also imported as Caché `%Persistent` classes. There is a one-to-one correspondence between .NET source classes and Caché projected classes, so the .NET class inheritance structure is preserved.

Full object projection preserves the inheritance structure of the original .NET classes, but may have an impact on performance. Flat object projection is the optimal choice if performance is essential and the event schema is fairly simple. Full object projection can be used for a richer set of features and more complex schemas if the performance penalty is acceptable.

### 2.7.1.1 The Embedded Object Projection Model (Flat Schema)

By default, XEP imports a schema that projects referenced objects by *flattening*. In other words, all objects referenced by the imported class are serialized and embedded, and all fields declared in all ancestor classes are collected and projected as if they were declared in the imported class itself. The corresponding Caché event extends %Library.Persistent, and contains embedded serialized objects where the original .NET object contained references to external objects.

This means that a flat schema does not preserve inheritance in the strict sense on the Caché side. For example, consider these three .NET classes:

```
class A {
    String a;
}
class B : class A {
    String b;
}
class C : class B {
    String c;
}
```

Importing class C results in the following Caché class:

```
Class C : %Persistent ... {
    Property a As %String;
    Property b As %String;
    Property c As %String;
}
```

No corresponding Caché events will be generated for the A or B classes unless they are specifically imported. Event C on the Caché side does not extend either A or B. If imported, A and B would have the following structures:

```
Class A : %Persistent ... {
    Property a As %String;
}
Class B : %Persistent ... {
    Property a As %String;
    Property b As %String;
}
```

All operations will be performed only on the corresponding Caché event. For example, calling **Store()** on objects of type C will only store the corresponding C Caché events.

If a .NET child class hides a field of the same name that is also declared in its superclass, the XEP engine always uses the value of the child field.

### 2.7.1.2 The Full Object Projection Model (Full Schema)

The full object model imports a schema that preserves the .NET inheritance model by creating a matching inheritance structure in Caché. Rather than serializing all object fields and storing all data in a single Caché object, the schema establishes a one-to-one relationship between the .NET source classes and Caché projected classes. The full object projection model stores each referenced class separately, and projects fields of a specified class as references to objects of the corresponding Caché class.

Referenced classes must include an attribute that creates a user-defined IdKey (either **[Id]** or **[Index]** — see “[Using IdKeys](#)”). When an object is stored, all referenced objects are stored first, and the resulting IdKeys are stored in the parent object. As with the rest of XEP, there are no uniqueness checks, and no attempts to change or overwrite existing data. The data is simply appended at the highest possible speed. If an IdKey value references an event that already exists, it will simply be skipped, without any attempt to overwrite the existing event.

The **[Embedded]** class level attribute can be used to optimize a full schema by embedding instances of the marked class as serialized objects rather than storing them separately.

**Note:** See the FlightLog sample program (listed in “[XEP Samples](#)”) for a demonstration of how to use the full object model.



## 2.7.2 Schema Customization

In many cases, a schema can be imported for a simple class without providing any meta-information. In other cases, it may be necessary or desirable to customize the way in which the schema is imported. The following sections describe various options for generating customized schemas by adding indexes and overriding the default rules for importing fields:

- **Using Attributes** — XEP attributes can be added to a .NET class to specify the indexes that should be created. They can also be added to optimize performance by specifying fields that should not be imported or fields that should be serialized.
- **Using IdKeys** — Attributes can be used to specify IdKeys (index values used in place of the default object ID), which are required when importing a full schema.
- **Implementing an InterfaceResolver** — By default, fields declared as interfaces are not imported into a flat schema. Implementations of the InterfaceResolver interface can be used to during schema import to specify the actual class of a field declared as an interface.

### 2.7.2.1 Using Attributes

The XEP engine infers XEP event metadata by examining a .NET class. Additional information can be specified in the .NET class via attributes, which can be found in the `Intersystems.XEP.attributes` namespace. As long a .NET object conforms to the definition of an XEP persistent event (see “[Requirements for Imported Classes](#)”), it is projected as a Caché event, and there is no need to customize it.

Some attributes are applied to individual fields in the class to be projected, while others are applied to the entire class:

- *Field Attributes* — are applied to a field in the class to be imported:
  - `[Id]` — specifies that the field will act as an IdKey.
  - `[Serialized]` — indicates that the field should be stored and retrieved in its serialized form.
  - `[Transient]` — indicates that the field should be excluded from import.
- *Class Attributes* — are applied to the entire class to be imported:
  - `[Embedded]` — indicates that a field of this class in a full schema should be embedded (as in a flat schema) rather than referenced.
  - `[Index]` — declares an index for the class.

#### **[Id] (field level attribute)**

The value of a field marked with `[Id]` will be used as an IdKey that replaces the standard object ID (see “[Using IdKeys](#)”). Only one field per class can use this attribute, and the field must be a String, int, or long (double is permitted but not recommended). To create a compound IdKey, use the `[Index]` attribute instead. A class marked with `[Id]` cannot also declare a compound primary key with `[Index]`. An exception will be thrown if both attributes are used on the same class.

The following parameter must be specified:

- `generated` — a bool specifying whether or not XEP should generate key values.
  - `generated = true` — (the default setting) key value will be generated by Caché and the field marked as `[Id]` must be `Int64`. This field is expected to be null prior to insert/store and will be filled automatically by XEP upon completion of such an operation.



- `generated=false` — the user-assigned value of the marked field will be used as the IdKey value. Fields can be String, int, Int32, long or Int64.

In the following example, the user-assigned value of the `ssn` field will be used as the object ID:

```
using Id = InterSystems.XEP.Attributes.Id;
public class Person {
    [Id(generated=false)]
    public String ssn;
    public String name;
    public String dob;
}
```

### [Serialized] (field level attribute)

The `[Serialized]` attribute indicates that the field should be stored and retrieved in its serialized form.

This attribute optimizes storage of serializable fields (including arrays, which are implicitly serializable). The XEP engine will call the relevant read or write method for the serial object, rather than using the default mechanism for storing or retrieving data. An exception will be thrown if the marked field is not serializable.

*Example:*

```
using Serialized = InterSystems.XEP.Attributes.Serialized;
public class MyClass {
    [Serialized]
    public xep.samples.Serialized serialized;
    [Serialized]
    public int[,,,] quadIntArray;
    [Serialized]
    public String[,] doubleStringArray;
}

// xep.samples.Serialized:
[Serializable]
public class Serialized {
    public String name;
    public int value;
}
```

### [Transient] (field level attribute)

The `[Transient]` attribute indicates that the field should be excluded from import. The marked field will not be projected to Caché, and will be ignored when events are stored or loaded.

*Example:*

```
using Transient = InterSystems.XEP.Attributes.Transient;
public class MyClass {
    // this field will NOT be projected:
    [Transient]
    public String transientField;

    // this field WILL be projected:
    public String projectedField;
}
```

### [Embedded] (class level attribute)

The `[Embedded]` attribute can be used when a full schema is to be generated (see “[Schema Import Models](#)”). It indicates that a field of this class should be serialized and embedded (as in a flat schema) rather than referenced when projected to Caché.

*Examples:*

```

using Embedded = InterSystems.XEP.Attributes.Embedded;
[Embedded]
public class Address {
    String street;
    String city;
    String zip;
    String state;
}

```

### [Index] (class level attribute)

The [Index] attribute can be used to declare one or more composite indexes.

Arguments must be specified for the following parameters:

- name — a String containing the name of the composite index
- fields — an array of String containing the names of the fields that comprise the composite index
- type — the index type. The `xep.attributes.IndexType` enumeration includes the following possible types:
  - `IndexType.none` — default value, indicating that there are no indexes.
  - `IndexType.bitmap` — a bitmap index (see “[Bitmap Indices](#)” in *Using Caché SQL*).
  - `IndexType.bitslice` — a bitslice index (see “[Overview](#)” in *Using Caché SQL*).
  - `IndexType.simple` — a standard index on one or more fields.
  - `IndexType.idkey` — an index that will be used in place of the standard ID (see “[Using IdKeys](#)”).

*Example:*

```

using Index = InterSystems.XEP.Attributes.Index;
using IndexType = InterSystems.XEP.Attributes.IndexType;

[Index(name="indexOne",fields=new string[]{"ssn","dob"},type=IndexType.idkey)]
public class Person {
    public String name;
    public String dob;
    public String ssn;
}

```

## 2.7.2.2 Using IdKeys

IdKeys are index values that are used in place of the default object ID. Both simple and composite IdKeys are supported by XEP, and a user-generated IdKey is required for a .NET class that is imported with a full schema (see “[Importing a Schema](#)”). IdKeys on a single field can be created with the [Id] attribute. To create a composite IdKey, add an [Index] attribute with `IndexType idkey`. For example, given the following class:

```

class Person {
    String name;
    int id;
    String dob;
}

```

the default storage structure uses the standard object ID as a subscript:

```
^PersonD(1)=$LB("John",12,"1976-11-11")
```

The following attribute uses the name and id fields to create a composite IdKey named *newIdKey* that will replace the standard object ID:

```
[Index(name="newIdKey", fields=new String[]{"name","id"},type=IndexType.idkey)]
```

This would result in the following global structure:

```
^PersonD("John",12)=$LB("1976-11-11")
```

XEP will also honor IdKeys added by other means, such as SQL commands (see “[Using the Unique, PrimaryKey, and IDKey Keywords with Indices](#)” in *Using Caché SQL*). The XEP engine will automatically determine whether the underlying class contains an IdKey, and generate the appropriate global structure.

There are a number of limitations on IdKey usage:

- An IdKey value must be unique. If the IdKey is user-generated, uniqueness is the responsibility of the calling application, and is not enforced by XEP. If the application attempts to add an event with a key value that already exists in the database, the attempt will be silently ignored and the existing event will not be changed.
- A class that declares an IdKey cannot be indexed asynchronously if it also declares other indexes.
- There is no limit of the number of fields in a composite IdKey, but the fields must be String, int, or long, or their corresponding System types. Although double can also be used, it is not recommended.
- There may be a performance penalty in certain rare situations requiring extremely high and sustained insert rates.

See “[Accessing Stored Events](#)” for a discussion of Event methods that allow retrieval, updating and deletion of events based on their IdKeys.

See “[SQL and Object Use of Multidimensional Storage](#)” in *Using Caché Globals* for information on IdKeys and the standard Caché storage model. See “[Defining and Building Indices](#)” in *Using Caché SQL* for information on IdKeys in SQL.

Sample programs IdKeyTest and FlightLog provide demonstrations of IdKey usage (see “[XEP Samples](#)” for details about the sample programs).

### 2.7.2.3 Implementing an InterfaceResolver

When a flat schema is imported, information on the inheritance hierarchy is not preserved (see “[Schema Import Models](#)”). This creates a problem when processing fields whose types are declared as interfaces, since the XEP engine must know the actual class of the field. By default, such fields are not imported into a flat schema. This behavior can be changed by creating implementations of `Intersystems.XEP.InterfaceResolver` to resolve specific interface types during processing.

**Note:** `InterfaceResolver` is only relevant for the flat schema import model, which does not preserve the .NET class inheritance structure. The full schema import model establishes a one-to-one relationship between .NET and Caché classes, thus preserving the information needed to resolve an interface.

An implementation of `InterfaceResolver` is passed to `EventPersister` before calling the flat schema import method, `ImportSchema()` (see “[Importing a Schema](#)”). This provides the XEP engine with a way to resolve interface types during processing. The following `EventPersister` method specifies the implementation that will be used:

- `EventPersister.SetInterfaceResolver()` — takes an instance of `InterfaceResolver` as an argument. When `ImportSchema()` is called, it will use the specified instance to resolve fields declared as interfaces.

The following example imports two different classes, calling a different, customized implementation of `InterfaceResolver` for each class:

#### **Schema Customization: Applying an InterfaceResolver**

```
try {
    myPersister.SetInterfaceResolver(new test.MyFirstInterfaceResolver());
    myPersister.ImportSchema("test.MyMainClass");

    myPersister.SetInterfaceResolver(new test.MyOtherInterfaceResolver());
    myPersister.ImportSchema("test.MyOtherClass");
}
catch (XEPException e) {Console.WriteLine("Import failed:\n" + e);}
```

The first call to **SetInterfaceResolver()** sets a new instance of `MyFirstInterfaceResolver` (described in the next example) as the implementation to be used during calls to the import methods. This implementation will be used in all calls to **ImportSchema()** until **SetInterfaceResolver()** is called again to specify a different implementation.

The first call to **ImportSchema()** imports class `test.MyMainClass`, which contains a field declared as interface `test.MyFirstInterface`. The instance of `MyFirstInterfaceResolver` will be used by the import method to resolve the actual class of this field.

The second call to **SetInterfaceResolver()** sets an instance of a different `InterfaceResolver` class as the new implementation to be used when **ImportSchema()** is called again.

All implementations of `InterfaceResolver` must define the following method:

- `InterfaceResolver.GetImplementationClass()` returns the actual type of a field declared as an interface. This method has the following parameters:
  - *interfaceClass* — the interface to be resolved.
  - *declaringClass* — class that contains a field declared as *interfaceClass*.
  - *fieldName* — string containing the name of the field in *declaringClass* that has been declared as an interface.

The following example defines an interface, an implementation of that interface, and an implementation of `InterfaceResolver` that resolves instances of the interface.

### Schema Customization: Implementing an InterfaceResolver

In this example, the interface to be resolved is `test.MyFirstInterface`:

```
namespace test {
    public interface MyFirstInterface{ }
}
```

The `test.MyFirstImpl` class is the implementation of `test.MyFirstInterface` that should be returned by the `InterfaceResolver`:

```
namespace test {
    public class MyFirstImpl : MyFirstInterface {
        public MyFirstImpl() {}
        public MyFirstImpl(String s) { fieldOne = s; }
        public String fieldOne;
    }
}
```

The following implementation of `InterfaceResolver` returns class `test.MyFirstImpl` if the interface is `test.MyFirstInterface`, or `null` otherwise:

```
using Intersystems.XEP;
namespace test {
    public class MyFirstInterfaceResolver : InterfaceResolver {
        public MyFirstInterfaceResolver() {}
        public Type GetImplementationType(Type declaringClass,
            String fieldName, Type interfaceClass) {
            if (interfaceClass == typeof(test.MyFirstInterface)) {
                return typeof(test.MyFirstImpl);
            }
            return null;
        }
    }
}
```

When an instance of `MyFirstInterfaceResolver` is specified by **SetInterfaceResolver()**, subsequent calls to **ImportSchema()** will automatically use that instance to resolve any field declared as `test.MyFirstInterface`. For such each field, the **GetImplementationClass()** method will be called with parameter *declaringClass* set to the class that contains the field, *fieldName* set to the name of the field, and *interfaceClass* set to `test.MyFirstInterface`. The method will resolve the interface and return either `test.MyFirstImpl` or `null`.

## 2.7.3 Schema Mapping Rules

This section provides details about how an XEP schema is structured. The following topics are discussed:

- [Requirements for Imported Classes](#) — describes the structural rules that a .NET class must satisfy to produce objects that can be projected as persistent events.
- [Naming Conventions](#) — describes how .NET class and field names are translated to conform to Caché naming rules.

### 2.7.3.1 Requirements for Imported Classes

The XEP schema import methods cannot produce a valid schema for a .NET class unless it satisfies the following requirements:

- If the imported Caché class or any derived class will be used to execute queries and access stored events, the .NET source class must explicitly declare an argumentless public constructor.
- The .NET source class cannot contain fields declared as `Object`, or arrays or collections that use `Object` as part of their declaration. An exception will be thrown if the XEP engine encounters such fields. Use the `[Transient]` attribute (see “[Using Attributes](#)”) to prevent them from being imported.

The `Event.IsEvent()` method can be used to analyze a .NET class or object and determine if it can produce a valid event in the XEP sense. In addition to the conditions described above, this method throws an `XEPException` if any of the following conditions are detected:

- a circular dependency
- an untyped collection
- a Dictionary key value that is not a `String`, a simple numeric type or its associated `System` type, or an enumeration.

Fields of a persistent event can be simple numeric types or their associated `System` types, objects (projected as embedded/serial objects), enumerations, and types derived from collection classes. These types can also be contained in arrays, nested collections, and collections of arrays.

By default, projected fields may not retain all features of the .NET class. Certain fields are changed in the following ways:

- Although the .NET class may contain static fields, they are excluded from the projection by default. There will be no corresponding Caché properties. Additional fields can be excluded by using the `[Transient]` attribute (see “[Using Attributes](#)”).
- In a flat schema (see “[Schema Import Models](#)”), all object types, including inner (nested) .NET classes, are projected as `%SerialObject` classes in Caché. The fields within the objects are not projected as separate Caché properties, and the objects are opaque from the viewpoint of `ObjectScript`.
- A flat schema projects all inherited fields as if they were declared in the child class.

### 2.7.3.2 Naming Conventions

Corresponding Caché class and property names are identical to those in .NET, with the exception of two special characters allowed in .NET but not Caché:

- \$ (dollar sign) is projected as a single "d" character on the Caché side.
- \_ (underscore) is projected as a single "u" character on the Caché side.

Class names are limited to 255 characters, which should be sufficient for most applications. However, the corresponding global names have a limit of 31 characters. Since this is typically not sufficient for a one-to-one mapping, the XEP engine

transparently generates unique global names for class names longer than 31 characters. Although the generated global names are not identical to the originals, they should still be easy to recognize. For example, the `xep.samples.SingleStringSample` class will receive global name `xep.samples.SingleStrinA5BFD`.

# 3

## Quick Reference for eXTreme Classes

This chapter is a quick reference for the classes that are most important to an understanding of the following Caché eXTreme APIs:

- [XEP Quick Reference](#)

The InterSystems.XEP namespace contains the public API described in [Using eXTreme Event Persistence](#).

**Note:** This is not the definitive reference for these APIs. For the most complete and up-to-date information, see the help file, located in <install-dir>/dev/dotnet/help/CacheExtreme.chm.

### 3.1 XEP Quick Reference

This section is a reference for the XEP API (eXTreme Event Persistence — namespace InterSystems.XEP). See [Using eXTreme Event Persistence](#) for a details on how to use the API. It contains the following classes and interfaces:

- Class [PersisterFactory](#) — provides a factory method to create EventPersister objects.
- Class [EventPersister](#) — encapsulates an XEP database connection. It provides methods that set XEP options, establish an XEP connection or get an existing connection object, import schema, produce XEP event objects, call Caché functions and methods on the server, and control transactions.
- Class [Event](#) — encapsulates a reference to an XEP persistent event. It provides methods to store or delete events, create a query, and start or stop index creation.
- Class [EventQuery](#)<> — encapsulates a query that retrieves individual events of a specific type from the database for update or deletion.
- Interface [InterfaceResolver](#) — resolves the actual type of a property during flat schema importation if the property was declared as an interface.
- Class [XEPException](#) — is the exception thrown by most XEP methods.

#### 3.1.1 List of XEP Methods

The following classes and methods of the XEP API are described in this reference:

##### **PersisterFactory**

- [CreatePersister\(\)](#) — creates a new EventPersister object.

**EventPersister**

- **CallBytesClassMethod()** — calls a Caché class method, returning strings as byte[].
- **CallBytesFunction()** — calls a Caché function, returning strings as byte[].
- **CallClassMethod()** — calls a Caché class method.
- **CallFunction()** — calls a Caché function.
- **CallListClassMethod()** — calls a Caché class method, returning strings as ValueList.
- **CallListFunction()** — calls a Caché function, returning strings as ValueList.
- **CallProcedure()** — calls a Caché procedure.
- **CallVoidClassMethod()** — calls a Caché class method with no return value.
- **Close()** — releases all resources held by this instance.
- **Commit()** — commits one level of transaction.
- **Connect()** — connects to Caché using the arguments specified.
- **DeleteClass()** — deletes a Caché class.
- **DeleteExtent()** — deletes all objects in the given extent.
- **GetConnection()** — Returns the underlying eXTreme connection.
- **GetAdoNetConnection()** — returns the .NET DbConnection object.
- **GetEvent()** — returns an event object that corresponds to the class name supplied.
- **GetInterfaceResolver()** — returns the currently specified instance of InterfaceResolver.
- **GetTransactionLevel()** — returns the current transaction level (or 0 if not in a transaction).
- **ImportSchema()** — imports a flat schema.
- **ImportSchemaFull()** — imports a full schema.
- **Rollback()** — rolls back the specified number of transaction levels, or all levels if no level is specified.
- **SetInterfaceResolver()** — specifies the InterfaceResolver object to be used.
- **StartTransaction()** — starts a transaction (which may be a nested transaction).

**Event**

- **Close()** — releases all resources held by this instance.
- **CreateQuery()** — creates a EventQuery<> instance.
- **DeleteObject()** — deletes an event given its database Id or IdKey.
- **GetObject()** — returns an event given its database Id or IdKey.
- **IsEvent()** — checks whether an object (or class) is an event in the XEP sense.
- **StartIndexing()** — starts index building for the underlying class.
- **StopIndexing()** — stops index building for the underlying class.
- **Store()** — stores the specified object or array of objects.
- **UpdateObject()** — updates an event given its database Id or IdKey.
- **WaitForIndexing()** — waits for asynchronous indexing to be completed for this class.



**EventQuery<>**

- **AddParameter()** — binds a parameter for this query.
- **Close()** — releases all resources held by this instance.
- **DeleteCurrent()** — deletes the event most recently fetched by **GetNext()**.
- **Execute()** — executes this XEP query.
- **GetAll()** — fetches all events in the resultset as an array.
- **GetFetchLevel()** — returns the current fetch level.
- **GetNext()** — fetches the next event in the resultset.
- **SetFetchLevel()** — controls the amount of data returned.
- **UpdateCurrent()** — updates the event most recently fetched by **GetNext()**

**InterfaceResolver**

- **GetImplementationClass()** — if a property was declared as an interface, an implementation of this method can be used to resolve the actual property type during schema importation.

## 3.1.2 Class PersisterFactory

Class `InterSystems.XEP.PersisterFactory` creates a new `EventPersister` object.

**PersisterFactory() Constructor**

Creates a new instance of `PersisterFactory`.

```
PersisterFactory()
```

**CreatePersister()**

`PersisterFactory.CreatePersister()` returns an instance of `EventPersister`.

```
static EventPersister CreatePersister()
```

*see also:*

[Creating and Connecting an EventPersister](#)

## 3.1.3 Class EventPersister

Class `InterSystems.XEP.EventPersister` is the main entry point for the XEP module. It provides methods that can be used to set XEP options up, establish an XEP connection, import schema, and produce XEP Event objects. It also provides methods to control transactions and perform other tasks.

**CallBytesClassMethod()**

`EventPersister.CallBytesClassMethod()` — calls an ObjectScript class method and returns an Object that may be of type `int`, `long`, `double`, or `byte[]`.

This method is identical to [CallClassMethod\(\)](#) except that it returns string values as instances of `byte[]` rather than `String`.

```
Object CallBytesClassMethod(string className, string methodName, params Object[] args)
```

*parameters:*

- `className` — fully qualified name of the Caché class to which the called method belongs.
- `methodName` — name of the Caché class method.
- `args` — a list of 0 or more arguments to pass to the class method.

Arguments may be of type `int`, `long`, `double`, `String`, `byte[]`, `ValueList`, or `Globals`. **ByteArrayRegion**. Trailing arguments may be omitted, causing default values to be used for those arguments, either by passing fewer than the full number of arguments, or by passing `null` for trailing arguments. Throws an exception if a non-null argument is passed to the right of a null argument.

**CallBytesFunction()**

`EventPersister.CallBytesFunction()` calls an ObjectScript function (see “[User-defined Code](#)” in *Using Caché ObjectScript*) and returns an Object that may be of type `int`, `long`, `double`, or `byte[]`.

This method is identical to **CallFunction()** except that it returns string values as instances of `byte[]` rather than `String`.

```
Object CallBytesFunction(string functionName, string routineName, params Object[] args)
```

*parameters:*

- `functionName` — name of the function.
- `routineName` — name of the routine containing the function.
- `args` — a list of 0 or more arguments to pass to the function.

Arguments may be of type `int`, `long`, `double`, `String`, `byte[]`, `ValueList`, or `Globals`. **ByteArrayRegion**. Trailing arguments may be omitted, causing default values to be used for those arguments, either by passing fewer than the full number of arguments, or by passing `null` for trailing arguments. Throws an exception if a non-null argument is passed to the right of a null argument.

**CallClassMethod()**

`EventPersister.CallClassMethod()` — calls an ObjectScript class method and returns an Object that may be of type `int`, `long`, `double`, or `String`. Use **CallVoidClassMethod()** to call a method that doesn't return a value, **CallBytesClassMethod()** to return string values as `byte[]`, or **CallListClassMethod()** to return string values as `ValueList`.

```
Object CallClassMethod(string className, string methodName, params Object[] args)
```

*parameters:*

- `className` — fully qualified name of the Caché class to which the called method belongs.
- `methodName` — name of the Caché class method.
- `args` — a list of 0 or more arguments to pass to the class method.

Arguments may be of type `int`, `long`, `double`, `String`, `byte[]`, `ValueList`, or `Globals`. **ByteArrayRegion**. Trailing arguments may be omitted, causing default values to be used for those arguments, either by passing fewer than the full number of arguments, or by passing `null` for trailing arguments. Throws an exception if a non-null argument is passed to the right of a null argument.

## CallFunction()

EventPersister.**CallFunction()** — calls an ObjectScript function (see “[User-defined Code](#)” in *Using Caché ObjectScript*) and returns an Object that may be of type int, long, double, or String. Use **CallBytesFunction()** to return string values as byte[], or **CallListFunction()** to return string values as ValueList.

```
Object CallFunction(string functionName, string routineName, params Object[] args)
```

*parameters:*

- `functionName` — name of the function.
- `routineName` — name of the routine containing the function.
- `args` — a list of 0 or more arguments to pass to the function.

Arguments may be of type int, long, double, String, byte[], ValueList, or Globals.**ByteArrayRegion**. Trailing arguments may be omitted, causing default values to be used for those arguments, either by passing fewer than the full number of arguments, or by passing `null` for trailing arguments. Throws an exception if a non-null argument is passed to the right of a null argument.

## CallListClassMethod()

EventPersister.**CallListClassMethod()** — calls an ObjectScript class method and returns an Object that may be of type int, long, double, or ValueList.

This method is identical to **CallClassMethod()** except that it returns string values as instances of ValueList rather than String.

```
Object CallListClassMethod(string className, string methodName, params Object[] args)
```

Throws an exception if the return value is a string but is not in valid ValueList format.

*parameters:*

- `className` — fully qualified name of the Caché class to which the called method belongs.
- `methodName` — name of the Caché class method.
- `args` — a list of 0 or more arguments to pass to the class method.

Arguments may be of type int, long, double, String, byte[], ValueList, or Globals.**ByteArrayRegion**. Trailing arguments may be omitted, causing default values to be used for those arguments, either by passing fewer than the full number of arguments, or by passing `null` for trailing arguments. Throws an exception if a non-null argument is passed to the right of a null argument.

## CallListFunction()

EventPersister.**CallListFunction()** calls an ObjectScript function (see “[User-defined Code](#)” in *Using Caché ObjectScript*) and returns an Object that may be of type int, long, double, or ValueList.

This method is identical to **CallFunction()** except that it returns string values as instances of ValueList rather than String.

```
Object CallListFunction(string functionName, string routineName, params Object[] args)
```

Throws an exception if the return value is a string but is not in valid ValueList format.

*parameters:*

- `functionName` — name of the function.
- `routineName` — name of the routine containing the function.

- `args` — a list of 0 or more arguments to pass to the function.

Arguments may be of type `int`, `long`, `double`, `String`, `byte[]`, `ValueList`, or `Globals`. **ByteArrayRegion**. Trailing arguments may be omitted, causing default values to be used for those arguments, either by passing fewer than the full number of arguments, or by passing `null` for trailing arguments. Throws an exception if a non-null argument is passed to the right of a null argument.

### CallProcedure()

`EventPersister.CallProcedure()` calls an ObjectScript procedure (see “[User-defined Code](#)” in *Using Caché ObjectScript*).

```
void CallProcedure(string procedureName, string routineName, params Object[] args)
```

*parameters:*

- `procedureName` — name of the procedure.
- `routineName` — name of the routine containing the procedure.
- `args` — a list of 0 or more arguments to pass to the procedure.

Arguments may be of type `int`, `long`, `double`, `String`, `byte[]`, `ValueList`, or `Globals`. **ByteArrayRegion**. Trailing arguments may be omitted, causing default values to be used for those arguments, either by passing fewer than the full number of arguments, or by passing `null` for trailing arguments. Throws an exception if a non-null argument is passed to the right of a null argument.

### CallVoidClassMethod()

`EventPersister.CallVoidClassMethod()` — calls an ObjectScript class method with no return value, passing 0 or more arguments. This method may be used to call any Caché class method (regardless of whether it normally returns a value) when the caller does not need the return value. Use [CallClassMethod\(\)](#) to call a method that returns a value.

```
void CallVoidClassMethod(string className, string methodName, params Object[] args)
```

*parameters:*

- `className` — fully qualified name of the Caché class to which the called method belongs.
- `methodName` — name of the Caché class method.
- `args` — a list of 0 or more arguments to pass to the class method.
- Arguments may be of any of the types `String`, `int`, `long`, `double`, `byte[]`, or `Globals`. **ByteArrayRegion**. Trailing arguments may be omitted, causing default values to be used for those arguments, either by passing fewer than the full number of arguments, or by passing `null` for trailing arguments. Throws an exception if a non-null argument is passed to the right of a null argument.

### Close()

`EventPersister.Close()` releases all resources held by this instance.

```
void Close()
```

It is important to always call **Close()** on an instance of `EventPersister` before it goes out of scope. Failing to close it can cause serious memory leaks because .NET garbage collection cannot release resources allocated by the underlying native code.

## Commit()

EventPersister.**Commit()** commits one level of transaction

```
void Commit()
```

## Connect()

EventPersister.**Connect()** connects to Caché using either an eXTreme connection or a TCP/IP connection, depending on the arguments specified. If only *namespace*, *username*, and *password* arguments are specified, an in-process eXTreme connection is established. If *host* and *port* are also specified, a TCP/IP connection is established.

```
void Connect(string namespace, string username, string password)
void Connect(string host, int port, string namespace, string username, string password)
```

*parameters:*

- `namespace` — namespace to be accessed.
- `username` — username for this connection.
- `password` — password for this connection.
- `host` — host address for TCP/IP connection.
- `port` — port number for TCP/IP connection.

*see also:*

[Creating and Connecting an EventPersister](#)

## DeleteClass()

EventPersister.**DeleteClass()** deletes a Caché class definition. It does not delete objects associated with the extent (since objects can belong to more than one extent), and does not delete any dependencies (for example, inner or embedded classes).

```
void DeleteClass(string className)
```

*parameter:*

- `className` — name of the class to be deleted.

If the specified class does not exist, the call silently fails (no error is thrown).

*see also:*

“Deleting Test Data” in [Accessing Stored Events](#)

## DeleteExtent()

EventPersister.**DeleteExtent()** deletes the extent definition associated with a .NET event, but does not destroy associated data (since objects can belong to more than one extent). See “[Extents](#)” in *Using Caché Objects* for more information on managing extents.

```
void DeleteExtent(string className)
```

- `className` — name of the extent.

Do not confuse this method with the deprecated Event.**DeleteExtent()**, which destroys all extent data as well as with the extent definition.

*see also:*

“Deleting Test Data” in [Accessing Stored Events](#)

### GetAdoConnection()

EventPersister.**GetAdoNetConnection()** returns the .NET DbConnection object underlying an EventPersister connection.

```
System.Data.Common.DbConnection GetAdoNetConnection()
```

*see also:*

[Creating and Connecting an EventPersister](#)

### GetConnection()

EventPersister.**GetConnection()** — returns the instance of Intersystems.Globals.Connection underlying an EventPersister eXTreme connection. Throws an exception if the EventPersister has a TCP/IP connection.

```
Intersystems.Globals.Connection\1\2\3
```

*see also:*

[Creating and Connecting an EventPersister](#)

### GetEvent()

EventPersister.**GetEvent()** returns an Event object that corresponds to the class name supplied, and optionally specifies the indexing mode to be used.

```
Event GetEvent(string className)
Event GetEvent(string className, int indexMode)
```

*parameter:*

- `className` — class name of the object to be returned.
- `indexMode` — indexing mode to be used.

The following *indexMode* options are available:

- `Event.INDEX_MODE_ASYNC_ON` — enables asynchronous indexing. This is the default when the *indexMode* parameter is not specified.
- `Event.INDEX_MODE_ASYNC_OFF` — no indexing will be performed unless the **StartIndexing()** method is called.
- `Event.INDEX_MODE_SYNC` — indexing will be performed each time the extent is changed, which can be inefficient for large numbers of transactions. This index mode must be specified if the class has a user-assigned `IdKey`.

The same instance of Event can be used to store or retrieve all instances of a class, so a process should only call the **GetEvent()** method once per class. Avoid instantiating multiple Event objects for a single class, since this can affect performance and may cause memory leaks.

*see also:*

[Creating Event Instances and Storing Persistent Events, Controlling Index Updating](#)

### GetInterfaceResolver()

EventPersister.**GetInterfaceResolver()** — returns the currently set instance of InterfaceResolver that will be used by **ImportSchema()** (see “[Implementing an InterfaceResolver](#)”). Returns `null` if no instance has been set.

```
InterfaceResolver GetInterfaceResolver()
```

*see also:*

[SetInterfaceResolver\(\)](#), [ImportSchema\(\)](#)

### GetTransactionLevel()

EventPersister.**GetTransactionLevel()** returns the current transaction level (0 if not in a transaction)

```
int GetTransactionLevel()
```

### ImportSchema()

EventPersister.**ImportSchema()** produces a flat schema (see “[Schema Import Models](#)”) that embeds all referenced objects as serialized objects. The method imports the schema of each event declared in the class or a .dll file specified (including dependencies), and returns an array of class names for the imported events.

```
string[] ImportSchema(string classOrDLLName)
string[] ImportSchema(string[] classes)
```

*parameters:*

- `classes` — an array containing the names of the classes to be imported.
- `classOrDLLName` — a class name or the name of a .dll file containing the classes to be imported. If a .dll file is specified, all classes in the file will be imported.

If the argument is a class name, the corresponding class and any dependencies will be imported. If the argument is a .dll file, all classes in the file and any dependencies will be imported. If such schema already exists, and it appears to be in sync with the .NET schema, import will be skipped. Should a schema already exist, but it appears different, a check will be performed to see if there is any data. If there is no data, a new schema will be generated. If there is existing data, an exception will be thrown.

*see also:*

[Importing a Schema](#)

### ImportSchemaFull()

EventPersister.**ImportSchemaFull()** — produces a full schema (see “[Schema Import Models](#)”) that preserves the object hierarchy of the source classes. The method imports the schema of each event declared in the class or .dll file specified (including dependencies), and returns an array of class names for the imported events.

```
string[] ImportSchemaFull(string classOrDLLName)
string[] ImportSchemaFull(string[] classes)
```

*parameters:*

- `classes` — an array containing the names of the classes to be imported.
- `classOrDLLName` — a class name or the name of a .dll file containing the classes to be imported. If a .dll file is specified, all classes in the file will be imported.

If the argument is a class name, the corresponding class and any dependencies will be imported. If the argument is a .dll file, all classes in the file and any dependencies will be imported. If such schema already exists, and it appears to be in sync with the .NET schema, import will be skipped. Should a schema already exist, but it appears different, a check will be performed to see if there is any data. If there is no data, a new schema will be generated. If there is existing data, an exception will be thrown.

*see also:*

## Importing a Schema

### Rollback()

EventPersister.**Rollback()** rolls back the specified number of levels of transaction, where *level* is a positive integer, or roll back all levels of transaction if no level is specified.

```
void Rollback()  
void Rollback(int level)
```

*parameter:*

- `level` — optional number of levels to roll back.

This method does nothing if *level* is less than 0, and stops rolling back once the transaction level reaches 0 if *level* is greater than the initial transaction level.

### SetInterfaceResolver()

EventPersister.**SetInterfaceResolver()** — sets the instance of `InterfaceResolver` to be used by **ImportSchema()** (see “[Implementing an InterfaceResolver](#)”). All instances of `Event` created by this `EventPersister` will share the specified `InterfaceResolver` (which defaults to `null` if this method is not called).

```
void SetInterfaceResolver(InterfaceResolver interfaceResolver)
```

*parameters:*

- `interfaceResolver` — an implementation of `InterfaceResolver` that will be used by **ImportSchema()** to determine the actual type of properties declared as interfaces. This argument can be `null`.

*see also:*

[GetInterfaceResolver\(\)](#), [ImportSchema\(\)](#)

### StartTransaction()

EventPersister.**StartTransaction()** starts a transaction (which may be a nested transaction)

```
void StartTransaction()
```

## 3.1.4 Class Event

Class `InterSystems.XEP.Event` provides methods that operate on XEP events (storing events, creating a query, indexing etc.). It is created by the `EventPersister`.[GetEvent\(\)](#) method.

### Close()

`Event`.**Close()** releases all resources held by this instance.

```
void Close()
```

It is important to always call **Close()** on an instance of `Event` before it goes out of scope. Failing to close it can cause serious memory leaks because .NET garbage collection cannot release resources allocated by the underlying native code.

### CreateQuery()

`Event`.**CreateQuery()** takes a `String` argument containing the text of the SQL query and returns an instance of `EventQuery<T>`, where parameter `T` is the target class of the parent `Event`.



```
EventQuery<T> CreateQuery(string sqlText)
```

*parameter:*

- `sqlText` — text of the SQL query.

*see also:*

[Creating and Executing a Query](#)

## DeleteObject()

`Event.DeleteObject()` deletes an event identified by its database object ID or `IdKey`.

```
void DeleteObject(long id)
void DeleteObject(object[] idkeys)
```

*parameter:*

- `id` — database object ID
- `idkeys` — an array of objects that make up the `IdKey` (see “[Using IdKeys](#)”). An `XEPException` will be thrown if the underlying class has no `IdKeys` or if any of the keys supplied is equal to null or of an invalid type.

*see also:*

[Accessing Stored Events](#)

## GetObject()

`Event.GetObject()` fetches an event identified by its database object ID or `IdKey`. Returns `null` if the specified object does not exist.

```
object GetObject(long id)
object GetObject(object[] idkeys)
```

*parameter:*

- `id` — database object ID
- `idkeys` — an array of objects that make up the `IdKey` (see “[Using IdKeys](#)”). An `XEPException` will be thrown if the underlying class has no `IdKeys` or if any of the keys supplied is equal to null or of an invalid type.

*see also:*

[Accessing Stored Events](#)

## IsEvent()

`Event.IsEvent()` throws an `XEPException` if the object (or class) is not an event in the XEP sense (see “[Requirements for Imported Classes](#)”). The exception message will explain why the object is not an XEP event.

```
static void IsEvent(object objectOrClass)
```

*parameter:*

- `objectOrClass` — the object to be tested.

## StartIndexing()

Event.**StartIndexing()** starts asynchronous index building for the extent of the target class. Throws an exception if the index mode is `Event.INDEX_MODE_SYNC` (see “[Controlling Index Updating](#)”).

```
void StartIndexing()
```

## StopIndexing()

Event.**StopIndexing()** stops asynchronous index building for the extent. If you do not want the index to be updated when the Event instance is closed, call this method before calling `Event.Close()`.

```
void StopIndexing()
```

*see also:*

[Controlling Index Updating](#)

## Store()

Event.**Store()** stores a .NET object or array of objects as persistent events. There is no significant performance difference between passing an array and passing individual objects in a loop, but all objects in the array must be of the same type. Returns a long database ID for each newly inserted object, or 0 if the ID could not be returned or the event uses an `IdKey`.

```
long Store(object obj)
long[] Store(object[] objects)
```

*parameters:*

- `obj` — .NET object to be added to the database.
- `objects` — array of .NET objects to be added to the database. All objects must be of the same type.

## UpdateObject()

Event.**UpdateObject()** updates an event identified by its database ID or `IdKey`.

```
void UpdateObject(long id, object obj)
void UpdateObject(object[] idkeys, object obj)
```

*parameter:*

- `id` — database object ID
- `idkeys` — an array of objects that make up the `IdKey` (see “[Using IdKeys](#)”). An `XEPEXception` will be thrown if the underlying class has no `IdKeys` or if any of the keys supplied is equal to null or of an invalid type.
- `obj` — new object that will replace the specified event.

*see also:*

[Accessing Stored Events](#)

## WaitForIndexing()

Event.**WaitForIndexing()** waits for asynchronous indexing to be completed, returning `true` if indexing has been completed, or `false` if the wait timed out before indexing was completed. Throws an exception if the index mode is `Event.INDEX_MODE_SYNC`.

```
bool WaitForIndexing(int timeout)
```

*parameter:*

- `timeout` — number of seconds to wait before timing out (wait forever if `-1`, return immediately if `0`).

*see also:*

[Controlling Index Updating](#)

### 3.1.5 Class `EventQuery<>`

Class `InterSystems.XEP.EventQuery<>` can be used to retrieve, update and delete individual events from the database.

#### **AddParameter()**

`EventQuery<>.AddParameter()` binds the next parameter in sequence for the SQL query associated with this `EventQuery<>`.

```
void AddParameter(object val)
```

*parameter:*

- `val` — the value to be used for the next parameter in this query string.

*see also:*

[Creating and Executing a Query](#)

#### **Close()**

`EventQuery<>.Close()` releases all resources held by this instance.

```
void Close()
```

It is important to always call **Close()** on an instance of `EventQuery<>` before it goes out of scope. Failing to close it can cause serious memory leaks because .NET garbage collection cannot release resources allocated by the underlying native code.

#### **DeleteCurrent()**

`EventQuery<>.DeleteCurrent()` deletes the event most recently fetched by **GetNext()**.

```
void DeleteCurrent()
```

*see also:*

[Processing Query Data](#)

#### **Execute()**

`EventQuery<>.Execute()` executes the SQL query associated with this `EventQuery<>`. If the query is successful, this `EventQuery<>` will contain a resultset that can be accessed by other `EventQuery<>` methods.

```
void Execute()
```

*see also:*

[Creating and Executing a Query](#)

#### **GetAll()**

`EventQuery<>.GetAll()` returns objects of target class `E` from all rows in the resultset as a single list.

```
System.Collections.Generic.List<E> GetAll()
```

Uses **GetNext()** to get all target class E objects in the resultset, and returns them in a List. The list cannot be used for updating or deleting (although Event methods **UpdateObject()** and **DeleteObject()** can be used if you have some way of obtaining the Id or IdKey of each object). **GetAll()** and **GetNext()** cannot access the same resultset — once either method has been called, the other method cannot be used until **Execute()** is called again.

This method is more resource-intensive than a loop that explicitly calls **GetNext()** for each item, since there is a high cost associated with maintaining a list of objects.

*see also:*

[Processing Query Data](#), [Event.UpdateObject\(\)](#), [Event.DeleteObject\(\)](#)

### GetFetchLevel()

EventQuery<>.GetFetchLevel() returns the current fetch level (see “[Defining the Fetch Level](#)”).

```
int GetFetchLevel()
```

### GetNext()

EventQuery<>.GetNext() returns an object of target class E from the next row of the resultset. Returns null if there are no more items in the resultset.

```
E GetNext()
```

*see also:*

[Processing Query Data](#)

### SetFetchLevel()

EventQuery<>.SetFetchLevel() controls the amount of data returned by setting a fetch level (see “[Defining the Fetch Level](#)”).

For example, by setting the fetch level to `Event.FETCH_LEVEL_DATATYPES_ONLY`, objects returned by this query will only have their datatype properties set, and any object type, array, or collection properties will not get populated. Using this option can dramatically improve query performance.

```
void SetFetchLevel(int level)
```

*parameter:*

- `level` — fetch level constant (defined in the Event class).

Supported fetch levels are:

- `Event.FETCH_LEVEL_ALL` —default, all properties populated
- `Event.FETCH_LEVEL_DATATYPES_ONLY` —only datatype properties filled in
- `Event.FETCH_LEVEL_NO_ARRAY_TYPES` —all arrays will be skipped
- `Event.FETCH_LEVEL_NO_OBJECT_TYPES` —all object types will be skipped
- `Event.FETCH_LEVEL_NO_COLLECTIONS` —all collections will be skipped

### UpdateCurrent()

EventQuery<>.UpdateCurrent() updates the event most recently fetched by **GetNext()**.

```
void UpdateCurrent(E obj)
```

*parameter:*

- `obj` — the .NET object that will replace the current event.

*see also:*

[Processing Query Data](#)

## 3.1.6 Interface `InterfaceResolver`

By default, properties declared as interfaces are ignored during schema generation. To change this behavior, an implementation of `InterfaceResolver` can be passed to the `ImportSchema()` method, providing it with information that allows it to replace an interface type with the correct concrete type.

### `GetImplementationClass()`

`InterfaceResolver.GetImplementationClass()` returns the actual type of a property declared as an interface. See “[Implementing an InterfaceResolver](#)” for details.

```
Type GetImplementationType(Type declaringClass, string fieldName, Type interfaceClass)
```

*parameters:*

- `declaringClass` — class where `fieldName` is declared as `interfaceClass`.
- `fieldName` — name of the property in `declaringClass` that has been declared as an interface.
- `interfaceClass` — the interface to be resolved.

## 3.1.7 Class `XEPException`

Class `InterSystems.XEP.XEPException` implements the exception thrown by most methods of `Event`, `EventPersister`, and `EventQuery<>`. This class inherits methods and properties from `System.SystemException`.

