



Persisting .NET Objects with InterSystems XEP

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About This Book

XEP is a lightweight API that provides high-performance .NET technology for persisting simple to moderately complex object hierarchies. XEP projects the data in .NET objects as *persistent events* (database objects that store a persistent copy of the data fields) in an InterSystems IRIS® database. XEP is optimized for applications that must acquire and persist data at the highest possible speed.

The following topics are discussed in this book:

- [Introduction](#) — provides an overview of the platform architecture, and describes common installation procedures.
- [Using XEP Event Persistence](#) — describes how to use the XEP API.
- [Quick Reference for XEP Classes](#) — provides a quick reference for methods of the XEP API classes.

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

Related Documents

The following documents also contain related material:

- *Help files for the InterSystems .NET Connectivity APIs* are located in <install-dir>/dev/dotnet/help (where <install-dir> is the directory in which your instance of InterSystems IRIS is installed).
- [Using the InterSystems Managed Provider for .NET](#) — explains how to access InterSystems IRIS from .NET ADO client applications.

1

Introduction

XEP is a lightweight API that provides high-performance .NET technology for persisting simple to moderately complex object hierarchies. XEP projects the data in .NET objects as *persistent events* (database objects that store a persistent copy of the data fields) in an InterSystems IRIS® database. XEP is optimized for applications that must acquire and persist data at the highest possible speed.

InterSystems IRIS provides .NET APIs for easy database access via either objects or relational database tables. This book discusses the API for object access. See [Using the InterSystems Managed Provider for .NET](#) for relational table access.

1.1 Requirements and Configuration

The following sections provide instructions for including XEP when installing InterSystems IRIS, and for configuring your environment to use the XEP API.

1.1.1 Requirements

- The .NET Framework, version 2.0, 4.0, or 4.5.
- InterSystems IRIS.

Computers that run your .NET client applications do not require InterSystems IRIS, but they must have a connection to the InterSystems IRIS Server and must be running a supported version of the .NET Framework.

1.1.2 Installation

- When installing InterSystems IRIS in Windows, select the `Setup Type: Development` option.
- If InterSystems IRIS 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 InterSystems IRIS with security level 1 (minimal) it should already be checked.

1.1.3 Configuration

Your .NET project must include references to the following files. Different versions of these files 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 files for the release that will be used to compile your project:

- `InterSystems.Data.XEP.dll` — is provided for the 4.0 and 4.5 releases of the .NET Framework.
- `InterSystems.Data.IRISClient.dll` — is provided in three different versions, one for each supported release of the .NET Framework.

In order to run XEP applications:

- The InterSystems IRIS User namespace must exist and must be writable.
- Your *PATH* environment variable must include `<install-dir>/bin`. If your *PATH* includes multiple instances of `<install-dir>/bin` (for example, if you have installed more than one instance of InterSystems IRIS) only the first one will be used, and any others will be ignored.

1.2 XEP Sample Applications

XEP sample applications are available from GitHub (see “[Downloading Sample Applications from GitHub](#)”). To run them, compile the project as described in the ReadMe file. The project includes the following components:

- `RunAll.cs` — is a program that runs all of the other sample applications in sequence. Run this application with command line argument `-h` for a list of available command line options.
- `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 objects 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.

The sample package includes supporting files that provide test data for the applications. See the help files included in the sample package for detailed documentation of these programs.

`RunAll.cs` connects to InterSystems IRIS with a default superserver port value of 51773 (see “[DefaultPort](#)” in the *Configuration Parameter File Reference*). If your system does not use this default value, you can specify the superserver port as a command line parameter.

2

Using XEP Event Persistence

XEP provides extremely rapid storage and retrieval of .NET structured data. It 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.

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 a database connection.
- [Importing a Schema](#) — describes the methods and attributes used to analyze a .NET class and generate a schema for the corresponding persistent 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 XEP classes that create and process query resultsets.
- [Schema Customization and Mapping](#) — provides a detailed description of how .NET classes are mapped to database schemas, and how to generate customized schemas for optimal performance.

Note: Why “Persistent Event”?

The term *persistent event* originally referred to data acquired from real time events. The current implementation of XEP is designed for much more than simple event processing, so XEP “persistent events” are actually database objects that XEP has persisted from any source.

2.1 Introduction to Event Persistence

A *persistent event* is an InterSystems IRIS database object that holds a persistent copy of the data fields in a .NET object. By default, XEP stores each event as a standard `%Persistent` object. Storage is automatically configured so that the data will be accessible to InterSystems IRIS 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 persistent object in the database. 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 InterSystems IRIS projected classes, but may impose a slight performance penalty.

See “[Schema Import Models](#)” for a detailed discussion of both models, and “[Schema Mapping Rules](#)” for detailed information about how various datatypes are projected.

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

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.

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<T> 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<T> 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 following section describes two very short applications that demonstrate all of these features.

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 a connection to an InterSystems IRIS 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 connection accessing the same namespace as StoreEvents, creates an instance of EventQuery<T> 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 applications (see “[XEP Sample Applications](#)” for details).

2.1.1.1 The StoreEvents Program

In StoreEvents, a new instance of EventPersister is created and connected to a specific InterSystems IRIS namespace. 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 InterSystems IRIS 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[] eventItems = SingleStringSample.generateSampleData(12);

    public static void Main(String[] args) {
        for (int i=0; i < eventItems.Length; i++) {
            eventItems[i].name = "String event " + i;
        }
        try {
            Console.WriteLine("Connecting and importing schema for " + className);
            EventPersister myPersister = PersisterFactory.CreatePersister();
            myPersister.Connect("127.0.0.1", 51773, "User", "_SYSTEM", "SYS");
            try { // delete any existing SingleStringSample events, then import new ones
                myPersister.DeleteExtent(className);
                myPersister.ImportSchema(className);
            }
            catch (XEPEException e) { Console.WriteLine("import failed:\n" + e); }
            Event newEvent = myPersister.GetEvent(className);
            long[] itemIDs = newEvent.Store(eventItems); // store array of events
            Console.WriteLine("Stored " + itemIDs.Length + " of "
                + eventItems.Length + " objects. Closing connection...");
            newEvent.Close();
            myPersister.Close();
        }
        catch (XEPEException 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 `eventItems` (see “[XEP Sample Applications](#)” 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 a 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 `eventItems` array as input, and creates a new persistent event for each object in the array. (Alternately, the code could have looped through the `eventItems` 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 a 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<T>` 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("127.0.0.1", 51773, "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 (XEPEException 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 (XEPEException 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`, an 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<T>` where `T` is target class `SingleStringSample`. The SQL statement defines a query that will retrieve all persistent `SingleStringSample` events with object IDs between 3 and a variable parameter value.
- `EventQuery<T>.AddParameter()` assigns value 12 to the SQL parameter.
- `EventQuery<T>.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<T>.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<T>.DeleteCurrent()` deletes the most recently fetched event from the database.
 - `EventQuery<T>.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<T>.Close()` and `EventPersister.Close()` are called for *myQuery* and *myPersister* after all events have been printed and deleted.

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 a connection. See “[Using Queries](#)” for details about creating and using an instance of `EventQuery<T>`.

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 associated resources.

The following method is used to create a connection:

- `EventPersister.Connect()` — takes String arguments for *namespace*, *username*, *password*, and establishes a connection to the specified InterSystems IRIS namespace.

The following example establishes a connection:

Creating and Connecting an EventPersister: Creating a connection

```
// Open a connection
string host = "127.0.0.1";
int port = 51773;
string namespace = "USER";
string username = "_SYSTEM";
string password = "SYS";
EventPersister myPersister = PersisterFactory.CreatePersister();
myPersister.Connect(host, port, namespace, username, password);
// perform event processing here . . .
myPersister.Close();
```

The `EventPersister.Connect()` method establishes a connection to the specified port and namespace of the host machine. If no connection exists in the current process, a new connection is created. If a connection already exists, the method returns a reference to the existing connection object.

If the server address is `127.0.0.1` or `localhost`, the connection will default to a local *shared memory connection*, which is faster than the standard TCP/IP connection (see “[Shared Memory Connections](#)” in [Using the InterSystems Managed Provider for .NET](#)).

Note: Always call `close()` to release resources

Always call `Close()` on an instance of `EventPersister` before it goes out of scope to ensure that all locks, licenses, and other resources associated with the connection are released.

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 InterSystems IRIS 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 Customization and Mapping](#)” 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 from namespace test 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 (XEPEException e) {Console.WriteLine("Import failed:\n" + e);}
```

In this example, instances of dependent class `test.Address` will be serialized and embedded in the same InterSystems IRIS 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 InterSystems IRIS 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*. In the examples, the target class is always SingleStringSample.

- 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 Sample Applications](#)” 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 (XEPEException e) { Console.WriteLine("Event storage failed:\n" + e); }
```

- The **generateSampleData()** method of `SingleStringSample` generates twelve `SingleStringSample` objects and stores them in an array named `eventItems`.
- 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 `eventItems` 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 associated resources.

Note: **Always call Close() to release resources**

Always call **Close()** on an instance of `EventPersister` before it goes out of scope to ensure that all locks, licenses, and other resources associated with the connection are released.

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 (XEPEException e) {Console.WriteLine("Failed to process event:\n" + e);}
}
Console.WriteLine("Updated " + itemCount + " of " + itemIdList.Length + " events");
newEvent.Close();
}
catch (XEPEException 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 associated resources.

See “[XEP Sample Applications](#)” 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 InterSystems IRIS database:

- [DeleteClass\(\)](#) — takes a *className* string as an argument and deletes the specified InterSystems IRIS 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 *Orientation Guide for Server-Side Programming* 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<T>`, which can execute a limited SQL query on the extent of the target class. `EventQuery<T>` 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<T>` class to execute queries.
- [Processing Query Data](#) — describes how to access and modify items in an `EventQuery<T>` 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<T>`:

- `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>.Close()` — closes this `EventQuery<T>` instance and releases the native code resources associated with it.

Queries submitted by an instance of `EventQuery<T>` will return .NET objects of the specified generic type `T` (the target class of the Event instance that created the query object). Queries supported by the `EventQuery<T>` 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 `T`.
- SQL expressions may not refer to arrays of any type, nor to embedded objects or fields of embedded objects.
- The InterSystems IRIS 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<T>` methods define and execute the query:

- **AddParameter()** — binds a parameter for the SQL query associated with this `EventQuery<T>`. Takes `Object value` as the argument specifying the value to bind to the parameter.
- **Execute()** — executes the SQL query associated with this `EventQuery<T>`. If the query is successful, this `EventQuery<T>` 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 Sample Applications](#)” 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<T>` 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<T>.AddParameter()` method is called twice to assign values to the two parameters.

When the `EventQuery<T>.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<T>` 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<T>.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`.

Note: **Always call Close() to release resources**

Always call `Close()` on an instance of `EventPersister` before it goes out of scope to ensure that all locks, licenses, and other resources associated with the connection are released.

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<T>` 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 Schema Customization and Mapping

This section provides details about how a .NET class is mapped to an InterSystems IRIS event schema, and how a schema can be customized for optimal performance. 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 provide information on customized schemas and how to generate them:

- [Schema Import Models](#) — describes the two schema import models supported by XEP.
- [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](#) — Annotations 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, a flat schema does not import fields declared as interfaces. Implementations of the InterfaceResolver interface can be used during schema import to specify the actual class of a field declared as an interface.
- [Schema Mapping Rules](#) — provides a detailed description of how .NET classes are mapped to InterSystems IRIS event schemas.

2.6.1 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 InterSystems IRIS 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 InterSystems IRIS %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 InterSystems IRIS %Persistent objects. Inherited fields are projected as references to fields in the ancestor classes, which are also imported as InterSystems IRIS %Persistent classes. There is a one-to-one correspondence between .NET source classes and InterSystems IRIS 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.

2.6.1.1 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 InterSystems IRIS 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 InterSystems IRIS 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 InterSystems IRIS class:

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

No corresponding InterSystems IRIS events will be generated for the A or B classes unless they are specifically imported. Event C on the InterSystems IRIS 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 InterSystems IRIS event. For example, calling **Store()** on objects of type C will only store the corresponding C InterSystems IRIS 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.

2.6.1.2 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 InterSystems IRIS. Rather than serializing all object fields and storing all data in a single InterSystems IRIS object, the schema establishes a one-to-one relationship between the .NET source classes and InterSystems IRIS 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 InterSystems IRIS 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 Sample Applications](#)”) for a demonstration of how to use the full object model.

2.6.2 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 an InterSystems IRIS 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 InterSystems IRIS 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 InterSystems IRIS, 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 InterSystems IRIS.

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 InterSystems SQL*).
- `IndexType.bitslice` — a bitslice index (see “[Overview](#)” in *Using InterSystems 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;
}
```

2.6.3 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 InterSystems 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 Globals* for information on IdKeys and the standard InterSystems IRIS storage model. See “[Defining and Building Indices](#)” in *Using InterSystems SQL* for information on IdKeys in SQL.

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

2.6.4 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 InterSystems IRIS 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 (XEPEException 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.

2.6.5 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 InterSystems IRIS naming rules.

2.6.5.1 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 InterSystems IRIS 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 XEPEException 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 InterSystems IRIS 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 InterSystems IRIS. The fields within the objects are not projected as separate InterSystems IRIS 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.

2.6.5.2 Naming Conventions

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

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

XEP Quick Reference

This chapter is a quick reference for the InterSystems.XEP namespace, which contains the public API described in [Using XEP Event Persistence](#).

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

3.1 XEP Quick Reference

This section is a reference for the XEP API (namespace `InterSystems.XEP`). See [Using XEP 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 a connection or get an existing connection object, import schema, produce XEP Event objects, 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<T>` — encapsulates a query that retrieves individual events of target class T 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

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

- **Commit()** — commits one level of transaction.
- **Connect()** — connects to InterSystems IRIS using the arguments specified.
- **DeleteClass()** — deletes an InterSystems IRIS class.
- **DeleteExtent()** — deletes all objects in the given extent.
- **GetAdoNetConnection()** — returns the underlying ADO.NET connection.
- **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.

Event

- **Close()** — releases all resources held by this instance.
- **CreateQuery()** — creates an EventQuery<T> 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<T>

- **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 control XEP options, establish a connection, import schema, and produce XEP Event objects. It also provides methods to control transactions and perform other tasks.

Close()

EventPersister.**Close()** releases all resources held by this instance. Always call **Close()** on the EventPersister object before it goes out of scope to ensure that all locks, licenses, and other resources associated with the connection are released.

```
void Close()
```

Commit()

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

```
void Commit()
```

Connect()

EventPersister.**Connect()** establishes a connection to the specified InterSystems IRIS namespace.

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

parameters:

- `nmspace` — 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.

If the host address is 127.0.0.1 or localhost, the connection will default to a *shared memory connection*, which is faster than the standard TCP/IP connection (see “[Shared Memory Connections](#)” in [Using the InterSystems Managed Provider for .NET](#)).

see also:

[Creating and Connecting an EventPersister](#)

DeleteClass()

`EventPersister.DeleteClass()` deletes an InterSystems IRIS 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 *Defining and Using Classes* 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 ADO.NET connection underlying an `EventPersister` connection.

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

see also:

[Creating and Connecting an EventPersister](#)

Important: The ADO.NET connection is also used by the XEP engine, so the users should be careful not to close or corrupt the connection obtained by this method as that might cause the XEP engine to fail.

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 EventPersiser 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\(\)](#)

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. Always call `Close()` on the `Event` object before it goes out of scope to ensure that all locks, licenses, and other resources associated with the connection are released.

```
void Close()
```

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. 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<T>

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

AddParameter()

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

```
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<T>.Close()` releases all resources held by this instance. Always call `Close()` before the `EventQuery<T>` object goes out of scope to ensure that all locks, licenses, and other resources associated with the connection are released.

```
void Close()
```

DeleteCurrent()

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

```
void DeleteCurrent()
```

see also:

[Processing Query Data](#)**Execute()**

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

```
void Execute()
```

see also:

[Creating and Executing a Query](#)

GetAll()

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

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

Uses `GetNext()` to get all target class `T` 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<T>.GetFetchLevel()` returns the current fetch level (see “[Defining the Fetch Level](#)”).

```
int GetFetchLevel()
```

GetNext()

`EventQuery<T>.GetNext()` returns an object of target class `T` 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<T>.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<T>.UpdateCurrent()` updates the object most recently fetched by `GetNext()`.

```
void UpdateCurrent(T 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<T>`. This class inherits methods and properties from `System.SystemException`.

