

Building a Windows Azure™ Cloud Computing App

31

*The clouds methought would
open, and show riches
Ready to drop upon me, that
when I waked
I cried to dream again.
—William Shakespeare*

Objectives

In this chapter you'll:

- Learn what cloud computing is.
- Learn about Windows Azure's cloud computing capabilities.
- Be introduced to Windows Azure security, privacy and reliability.
- Download the tools you'll need to start developing Azure apps and learn how to register for a free Windows Azure trial.
- Code an app that uses Windows Azure Table Storage.
- Test your app using the Storage Emulator that comes with the Windows Azure SDK.
- Learn about other popular cloud app platforms.

- 31.1 Introduction
- 31.2 Installing the Windows Azure SDK for Visual Studio 2012
- 31.3 Windows Azure Cloud Services Accounts
 - 31.3.1 Signing Up for a Windows Azure Cloud Services Account
 - 31.3.2 Windows Azure Educator Grant
 - 31.3.3 Windows Azure for MSDN Subscribers
- 31.4 Favorite Twitter Searches: Introduction
- 31.5 Favorite Twitter Searches: Test-Drive
- 31.6 Favorite Twitter Searches: Technologies Overview
- 31.7 Favorite Twitter Searches: Code
 - 31.7.1 `TableEntity` for Storing Data in Windows Azure Table Storage
 - 31.7.2 Storing and Retrieving `TableEntity` Objects
- 31.8 Security, Privacy and Reliability
- 31.9 Microsoft Windows Azure Resources
- 31.10 Microsoft Windows Azure Code Samples
- 31.11 Additional Web Resources
- 31.12 Wrap-Up

Self-Review Exercises | Answers to Self-Review Exercises | Exercise

31.1 Introduction

As we discussed in Chapter 1, *cloud computing* allows you to use software and data stored in the “cloud”—i.e., accessed on remote computers (or servers) via the Internet and available on demand—rather than having it stored on your desktop, notebook computer or mobile device. Cloud computing allows you to instantaneously scale your computing resources (e.g., storage and processing power) to meet their occasional peak levels, making it more cost effective than purchasing expensive hardware. Using cloud computing services also saves money by shifting the burden of *managing* these apps to the service provider. Microsoft’s Windows Azure is a cloud computing platform that allows you to develop, manage and distribute your apps in the cloud. With Windows Azure, your apps can store their data in the cloud so that the data is available at all times from any of your desktop computers and mobile devices. Windows Azure also provides scalable, flexible and cost effective infrastructure. Figure 31.1 describes the key use cases for Windows Azure cloud computing.

| Use case | Description |
|-------------------------|---|
| Big data | The amount of data produced worldwide is enormous and growing quickly. Windows Azure enables you to scale your computing and storage capacity as needed, giving you flexibility and saving you the expense of buying hardware that’s needed only occasionally. You can also use the additional computing power to process the data (e.g., performing analytics to track customer behavior and find trends). |
| Testing and development | Use multiple virtual machines to develop and test your apps in a variety of scenarios rather than buying additional hardware and software and setting up a variety of platforms. |

Fig. 31.1 | Windows Azure use cases (www.windowsazure.com/en-us). (Part 1 of 2.)

| Use case | Description |
|--------------------------------|---|
| Websites and web apps | Host your websites and web apps on Windows Azure which can handle varying demand and shifts the administrative burden (e.g., security and reliability) to Microsoft. |
| Mobile apps | Use Windows Azure to support your mobile apps across a variety of platforms (e.g., Windows Phone 8, iOS, Android)—for example, authenticating app users, storing data and sending push notifications to users' devices. |
| Infrastructure | Set up servers in the cloud and scale your infrastructure (e.g., processor cycles, memory and secondary storage) as needed, paying for only what you use rather than purchasing additional costly hardware. |
| Storage, Backup and Recovery | Use Windows Azure's secure, reliable storage space to back up your data. The data is stored on servers in multiple locations worldwide to ensure that it's safe and accessible even in the case of a local disaster. |
| Identity and access management | Enable single sign-on to authenticate users just once to access multiple apps. Control access to apps or other data by setting up rules. |
| Media | Distribute media (e.g., stream video on demand) to several devices and platforms such as Windows, Android, iOS and others. You can also use Windows Azure to manage and protect your media content. |

Fig. 31.1 | Windows Azure use cases (www.windowsazure.com/en-us). (Part 2 of 2.)

Figure 31.2 lists several other popular cloud computing platforms and apps.

| Platform or app | URL | Description |
|-------------------------------------|--|---|
| <i>Infrastructure</i> | | |
| Amazon Cloud Computing services | aws.amazon.com | Infrastructure, compute engine, database, big data, content delivery, storage, app deployment and more. |
| Google Drive™ | cloud.google.com | Data storage, compute engine, infrastructure, app and web site development, big data analysis and more. |
| <i>Hosting and sharing services</i> | | |
| NaviSite® | navisite.com | Infrastructure hosting. |
| Rackspace® | www.rackspace.com | Internet hosting. |
| Dropbox | dropbox.com | File hosting. |
| Microsoft SkyDrive® | windows.microsoft.com/en-us/skydrive/download | File hosting. |
| Box | www.box.com | File sharing. |
| <i>Media</i> | | |

Fig. 31.2 | Popular cloud computing platforms and apps. (Part 1 of 2.)

| Platform or app | URL | Description |
|---------------------------------|--------------------------|--|
| Audiobox | audiobox.fm | Media library management, synchronization and streaming. |
| Spotify® | www.spotify.com | Music streaming. |
| <i>App delivery</i> | | |
| Cloudbees® | www.cloudbees.com | Web- and mobile-app delivery. |
| Heroku | www.heroku.com | App delivery. |
| <i>Data storage and backup</i> | | |
| iCloud® | www.apple.com/icloud | Data storage and backup. |
| PrimaDesk | www.primadesk.com | Data backup, file sharing and single sign on. |
| SOS Online Backup | www.sosonlinebackup.com/ | Online backup. |
| <i>Miscellaneous cloud apps</i> | | |
| Evernote | www.evernote.com | Note taking. |
| Salesforce® | www.salesforce.com | Customer Relationship Management (CRM). |
| Waze | www.waze.com | GPS navigation. |

Fig. 31.2 | Popular cloud computing platforms and apps. (Part 2 of 2.)

31.2 Installing the Windows Azure SDK for Visual Studio 2012

To install the **Windows Azure SDK for Visual Studio 2012**, go to

www.windowsazure.com/en-us/downloads/?sdk=net

and follow these steps:

1. Under **Languages** on the left side of the page, click **.NET**.
2. Next, click **VS 2012** under **.NET SDKs** in the middle of the page to download the executable file to your computer.
3. Open the executable file and click **Yes**.
4. In the **Web Platform Installer** window, click **Install**.

Verified DreamSpark students (www.dreamspark.com/) can download Visual Studio 2012 Professional which includes built-in support for Windows 8 and Windows Azure.¹

31.3 Windows Azure Cloud Services Accounts

The example that you'll build in this chapter uses the **Windows Azure Storage Emulator** on your local computer rather than connecting to the fee-based Windows Azure cloud ser-

1. www.dreamspark.com/Product/Product.aspx?productid=44.

vices. By doing this, we're able to show you the basics of working with Windows Azure cloud-based storage without the need for a Windows Azure account.

31.3.1 Signing Up for a Windows Azure Cloud Services Account

To build real-world Azure apps, you'll need a Windows Azure cloud services account. To sign up for a free one-month trial,² visit

www.windowsazure.com/en-us/pricing/free-trial/

You must provide a credit card number even though it's a free trial.

31.3.2 Windows Azure Educator Grant

Instructors teaching Windows Azure in college courses may apply for an educator grant of Windows Azure academic passes at

academicpass.cloudapp.net

The grant provides students enrolled in the course with six months of access to Windows Azure cloud services. Educators receive 12 months of access. *No credit card information is required to use these services.* To learn more about the program, visit

www.windowsazure.com/en-us/community/education

Educators teaching Windows Azure should also check out the *Introduction to Cloud Computing: Faculty Resource Kit* provided by Microsoft's Faculty Connection. The kit includes:

- Cloud computing curriculum materials for computer science courses, such as course presentations, labs, tutorials, demos, papers from faculty who have taught Azure and more.
- Links to developer resources, forums, videos and sample code.
- Numerous presentations (videos and PDFs) from the Cloud Futures conference.

To access the Faculty Resource Kit, visit

www.facultyresourcecenter.com/curriculum/resourcekits/cloudv3/

31.3.3 Windows Azure for MSDN Subscribers

At the time of this writing, MSDN (Microsoft Developer Network) subscribers who sign up for Windows Azure receive \$200 of Windows Azure credits for the first month after activation, then \$50 to \$150 of credits per month thereafter, depending on their MSDN subscription level. To learn more about the Windows Azure benefits included in the MSDN subscription, see

www.windowsazure.com/en-us/pricing/member-offers/msdn-benefits

2. This Microsoft offer is subject to change.

31.4 Favorite Twitter Searches: Introduction

Twitter's search mechanism makes it easy to follow the trending topics being discussed by the more than 500 million Twitter users. Searches can be fine tuned using Twitter's *search operators* (we overview several of these in Section 31.6), often resulting in lengthy search strings that are time consuming and cumbersome to enter. The **Favorite Twitter Searches** app saves your favorite Twitter search queries with short tag names that are easy to remember. You can then select from your saved searches to quickly and easily follow tweets on your favorite topics.


Your favorite searches are saved using **Windows Azure Table Storage**, which we'll discuss in more detail in Section 31.6. If you use an actual Windows Azure account, rather than the Storage Emulator, your saved searches will be available on any computer running the app.

31.5 Favorite Twitter Searches: Test-Drive

Opening the Completed Application

In this chapter's examples folder, open the FavoriteTwitterSearches folder and double click FavoriteTwitterSearches.sln to open the project.

Running the Windows Azure Storage Emulator

The Windows Azure Storage Emulator lets you test the Azure storage capabilities of your apps locally before you connect your apps to live Azure accounts in the cloud. To run the emulator on Windows 7, go to **Start > All Programs > Windows Azure > Emulator** and select **Windows Azure Storage Emulator**. On Windows 8, click **Windows Azure Storage Emulator** on your **Start** screen. Once the emulator is up and running the icon  will appear in the task tray of your Windows task bar. You can right click the icon to manage the emulator.

Running the App

In the IDE, select **Debug > Start Debugging** to run the app (Fig. 31.3). The TextBoxes in the **Add a Search** GroupBox allow you to enter new searches, and the ListBox in the

Tagged Searches GroupBox displays previously saved searches (in this case, none yet). When the app first executes both GroupBoxes (and their contents) are disabled.

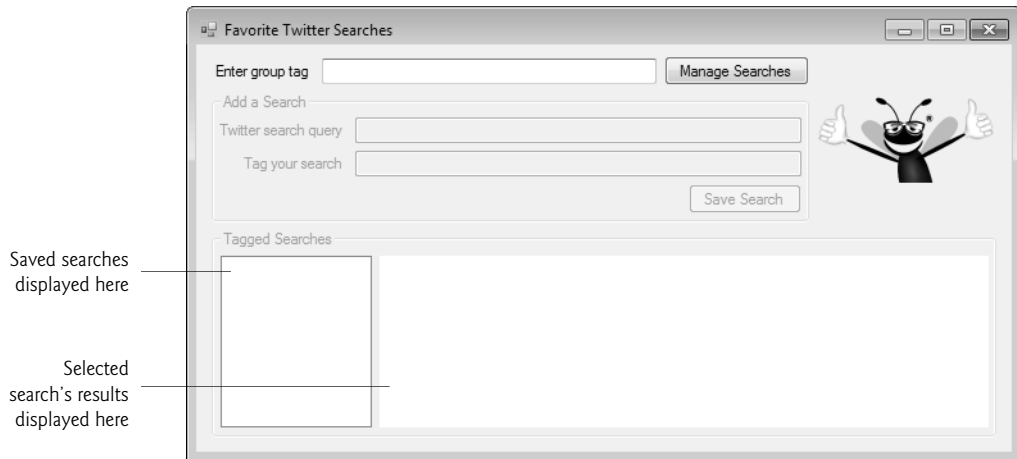


Fig. 31.3 | Favorite Twitter Searches app when it first executes.

Entering a Group Tag

The app enables you to store *groups of searches*. For example, you might have groups for different areas of interest, like books, music, movies stars, etc. Before you can enter any searches, you must specify a *group tag*. The app uses that to store and load the searches in that group. Enter the group tag `deitel`, then press **Manage Searches** to enable the rest of the app's GUI.

Adding a New Favorite Search

In the **Twitter search query** TextBox, enter `from:deitel since:2013-08-16` as the search query (Fig. 31.4). The `from:` operator locates tweets from a specified Twitter account and the `since:` operator specifies a date in the format `yyyy-mm-dd`—tweets before that date will not appear in the search results. This query will return only tweets from the `@deitel` Twitter account that occurred on or after August 16, 2013. Figure 31.5 shows several Twitter search operators. A complete list can be found at

<http://bit.ly/TwitterSearchOperators>

In the **Tag your search** TextBox, enter `deiteltweets` as the tag for the search query. This will be the *short name* displayed in the ListBox at the **Tagged Searches** GroupBox's left side. Click **Save Search** to save the search into the Windows Azure Table Storage—the tag

name for the new search appears in the `ListBox` at the **Tagged Searches** `GroupBox`'s left side.

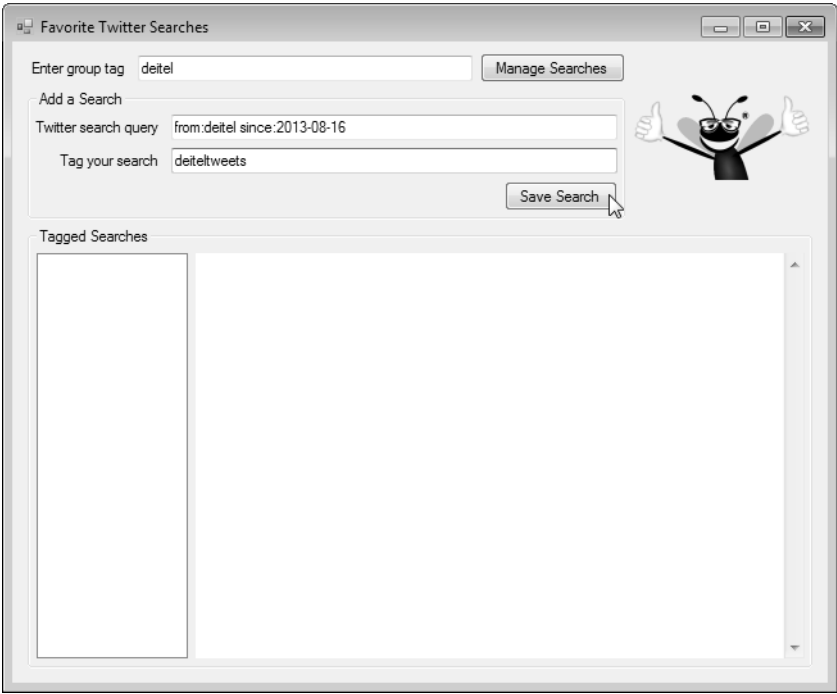


Fig. 31.4 | Entering a Twitter search.

| Example | Finds tweets containing |
|------------------|--|
| deitel iOS6 | Implicit <i>logical and</i> operator—find tweets containing <code>deitel</code> <i>and</i> <code>iOS6</code> . |
| deitel OR iOS6 | Logical OR operator—find tweets containing <code>deitel</code> <i>or</i> <code>iOS6</code> <i>or both</i> . |
| "how to program" | String in quotes("")—find tweets containing the exact phrase "how to program". |
| deitel ? | ? (question mark)—find tweets asking questions about <code>deitel</code> . |
| deitel -mervyn | - (minus sign)—find tweets containing <code>deitel</code> but not <code>mervyn</code> . |
| deitel :) | :) (happy face)—find <i>positive attitude</i> tweets containing <code>deitel</code> . |
| deitel :(| : ((sad face)—find <i>negative attitude</i> tweets containing <code>deitel</code> . |
| since:2012-08-12 | since:—find tweets that occurred <i>on or after</i> the specified date, which must be in the form YYYY-MM-DD. |
| from:deitel | from:—find tweets from the Twitter account @ <code>deitel</code> . |
| to:deitel | to:—find tweets to the Twitter account @ <code>deitel</code> . |

Fig. 31.5 | Some Twitter search operators.

Viewing Twitter Search Results

We rebind the `ListBox`'s `DataSource` to the list of searches when a new search is added. This selects the `ListBox`'s first item and displays its search results. Since `deiteltweets` is the only item in the `ListBox` at the moment, its search results are displayed automatically. After adding more than one saved search, you can select your new search in the `ListBox` to see its results in the `WebBrowser` control on the right (Fig. 31.6).

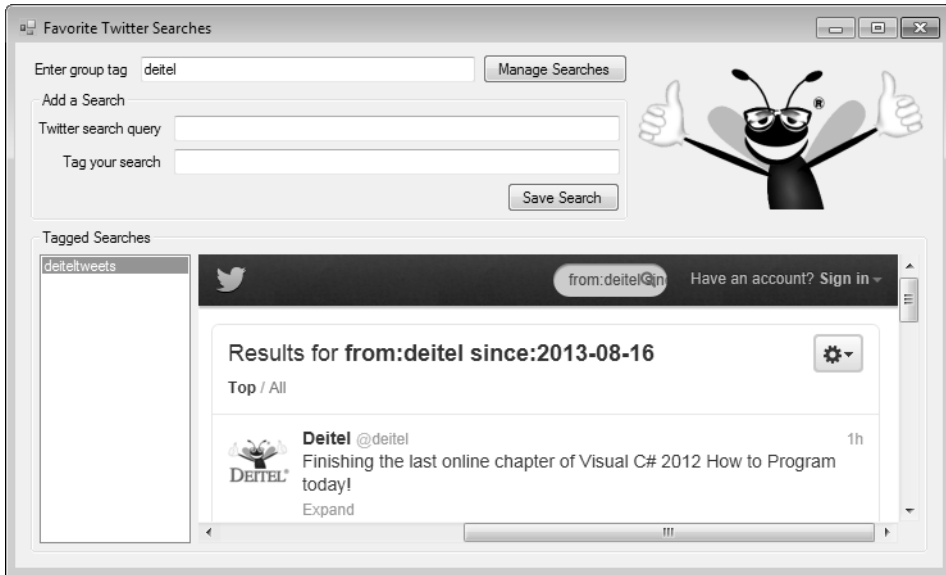


Fig. 31.6 | Viewing search results.

31.6 Favorite Twitter Searches: Technologies Overview

This section overviews the Windows Azure technologies used in the **Favorite Twitter Searches** app.

Windows Azure Table Storage Service

Windows Azure provides three primary storage services:

- **BLOB (Binary Large Object)**—Stores arbitrary binary data, such as images, audio and video.
- **Table**—Stores unstructured data (known as *entities*) that does not require complex manipulations like those that can be performed on data in a SQL database.
- **SQL Database**—Stores structured relational database data using techniques like those you learned in Chapter 22.

The **Favorite Twitter Searches** app demonstrates the Table service. Classes required for using these services are located in namespace `Microsoft.WindowsAzure.Storage`. To use these classes, you must add the Windows Azure Storage NuGet package to your app. After

creating a project, right click the project name in **Solution Explorer**, then select **Manage NuGet Packages....** In the dialog that appears, select the **Online** category, then use the **Search Online** field in the dialog's top-right corner to search for Windows Azure Storage. When the search completes, select **Windows Azure Storage** in the dialog's center column, then click **Install**. Once the installation is complete, click the dialog's **Close** button. Your project now contains the features required for accessing Windows Azure Storage services.

Storage Account

When you sign up for Windows Azure, you get your own *storage account*. Each storage account is currently limited to a maximum of 100 Terabytes of data across all three storage services. In this example, you'll use the so-called *development storage account*, which allows you to locally test your apps that use Windows Azure Storage services before attaching them to a paid Azure account. You specify the storage account in an app with an instance of class **CloudStorageAccount** (namespace `Microsoft.WindowsAzure.Storage`).

Table

For each storage account, the Windows Azure Table service can manage any number of *tables* provided that they all have unique names. For this app, you'll create a table named "FTS" that will store the information for groups of tagged Twitter searches.

TableEntity

To use Table Storage, you first create a subclass of **TableEntity** (namespace `Microsoft.WindowsAzure.Storage.Table`) that defines up to 252 properties to store, each with a *name* and a *value*. The total storage space for an entity cannot exceed one megabyte. Property values can have various types, including byte arrays, `bool`, `DateTime`, `double`, `int`, `long` and `string`. Both byte arrays and strings are limited to 64KB size.

In addition, every **TableEntity** has three inherited properties:

- **PartitionKey**—A unique string that's used by the Windows Azure Table Storage service to partition a table across multiple servers. This service is designed for fast access to massive amounts of data. Partitioning a table into pieces helps the Windows Azure Table Storage service perform *load balancing*—a technique that distributes massive numbers of web requests across multiple servers so that all requests can receive better response times. Operations on entities that have the same **PartitionKey** are more efficient than those with different **PartitionKeys**.
- **RowKey**—A unique name that identifies an entity within a partition.
- **TimeStamp**—A `DateTime` value (maintained by Windows Azure) that represents when the entity was last modified.

Together, an entity's **PartitionKey** and **RowKey** are the primary key that uniquely identifies the entity in the table. Entities in a table are *not* required to have the same properties.

Complete details of the Windows Azure Table Storage service's restrictions on tables, entities and properties can be found at:

<http://msdn.microsoft.com/en-us/library/windowsazure/dd179338.aspx>

31.7 Favorite Twitter Searches: Code

The following subsections discuss the code for classes TaggedSearchEntity and FTSForm.

31.7.1 TableEntity for Storing Data in Windows Azure Table Storage

Figure 31.7 presents the TaggedSearchEntity subclass of TableEntity for storing tagged Twitter searches using the Windows Azure Table Storage service. (Recall that you can right click your project name in **Solution Explorer** and select **Add > Class...** to add a new class to your project.) The inherited property PartitionKey stores the name for a group of saved searches. Thus, all saved searches in a group will be stored on the same Azure Table storage server. The inherited RowKey property stores the short tag name that you specify for a Twitter search. The Query property (line 10) stores the search to submit to Twitter. Each subclass of TableEntity is required to provide a no-argument constructor so that the Windows Azure Table Storage service can serialize objects. We defined an empty no-argument constructor, because the compiler will not provide a default constructor if you define any constructors of your own (as we did in lines 16–26).

```

1  // Fig. 31.7: TaggedSearchEntity.cs
2  // TableEntity that stores tagged Twitter searches
3  using Microsoft.WindowsAzure.Storage.Table;
4
5  namespace FavoriteTwitterSearches
6  {
7      // class to represent a tagged search
8      public class TaggedSearchEntity : TableEntity
9      {
10         public string Query { get; set; } // Twitter query to perform
11
12         public TaggedSearchEntity()
13         {
14             } // end constructor
15
16         public TaggedSearchEntity( string groupname, string tag,
17             string query )
18         {
19             Query = query; // query to submit to Twitter
20
21             // set partition key to group name for group of tagged searches
22             PartitionKey = groupname;
23
24             // set row key to tag for specific search
25             RowKey = tag;
26         } // end constructor
27     } // end class TaggedSearchEntity
28 } // end namespace FavoriteTwitterSearches

```

Fig. 31.7 | TableEntity that stores tagged Twitter searches.

31.7.2 Storing and Retrieving `TableEntity` Objects

Figures 31.8–31.12 present class `FTSForm`, which enables you to store your tagged Twitter searches and view search results.

FTSForm Instance Variables and Constructor

Figure 31.8 contains class `FTSForm`'s instance variables and constructor. The string `groupTag` (line 14) is used as the `PartitionKey` in each `TaggedSearchEntity`.

```

1 // Fig. 31.8: FTSForm.cs
2 // Storing tagged Twitter searches in Azure Table Storage
3 using Microsoft.WindowsAzure.Storage;
4 using Microsoft.WindowsAzure.Storage.Table;
5 using System;
6 using System.Linq;
7 using System.Web;
8 using System.Windows.Forms;
9
10 namespace FavoriteTwitterSearches
11 {
12     public partial class FTSForm : Form
13     {
14         private string groupTag; // used to manage group of searches
15
16         CloudStorageAccount storageAccount; // used to access Azure account
17         CloudTableClient tableClient; // gives access to Azure tables
18         CloudTable ftsTable; // used to interact with specific Azure table
19
20         public FTSForm()
21         {
22             InitializeComponent();
23
24             // gives access to the Azure storage emulator
25             storageAccount = CloudStorageAccount.DevelopmentStorageAccount;
26
27             // create Azure table storage client
28             tableClient = storageAccount.CreateCloudTableClient();
29
30             // get reference to Contacts table
31             ftsTable = tableClient.GetTableReference( "FTS" );
32
33             // create the Contacts table if it does not already exist
34             ftsTable.CreateIfNotExists();
35         } // end constructor
36

```

Fig. 31.8 | `FTSForm` instance variables and constructor.

CloudStorageAccount

The `CloudStorageAccount` (line 16) specifies the Azure storage account in which to store the `TaggedSearchEntity` objects. We use the *local storage emulator* in this app for demonstration purposes. To connect to the local storage emulator, line 25 in the constructor ini-

tializes variable `storageAccount` to `CloudStorageAccount.DevelopmentStorageAccount`. The setup to use *online* storage requires additional steps that are discussed in detail at

www.windowsazure.com/en-us/develop/net/how-to-guides/table-services/

CloudTableClient

The **CloudTableClient** (line 17) provides access to the Windows Azure Table Storage service from a client app. Class `CloudStorageAccount`'s **CreateCloudTableClient** method (line 28 in the constructor) returns a `CloudTableClient` that's properly configured for the `CloudStorageAccount` on which it's called. You use the `CloudTableClient` to get the table that the app manipulates.

CloudTable

The **CloudTable** (line 18) provides access to a specific table that's managed by the Windows Azure Table Storage service. Class `CloudTableClient`'s **GetTableReference** method (line 31 in the constructor) returns a `CloudTable` that you can use to interact with a specified table. Class `CloudTable`'s **CreateIfNotExists** method checks whether the table specified in line 31 ("FTS") exists and, if not, creates it.

manageSearchesButton_Click Event Handler

The `manageSearchesButton_Click` event handler (Fig. 31.9) removes the data from the `tagsListBox` (lines 55–56), clears the `webBrowser` control (line 57), stores the group name entered by the user (line 60) and loads the searches for the new group name that was just entered. `WebBrowser` method **Navigate** (line 57) loads the specified web page into the control. Specifying the argument `string.Empty` clears the control's current contents.

```

37      // get group tag, enable capabilities for adding searches
38      // and load existing searches into the app
39      private void manageSearchesButton_Click(
40          object sender, EventArgs e )
41      {

42          // check whether groupTagTextBox is empty
43          if ( string.IsNullOrEmpty( groupTagTextBox.Text ) )
44          {
45              MessageBox.Show( "Enter group tag " );
46          } // end if
47          else
48          {
49              addSearchGroupBox.Enabled = true;
50              taggedSearchesGroupBox.Enabled = true;
51
52              // if new groupTag does not equal previous groupTag
53              if ( !groupTagTextBox.Text.Equals( groupTag ) )
54              {
55                  tagsListBox.DataSource = null; // remove data source
56                  tagsListBox.Items.Clear(); // clear tasListBox
57                  webBrowser.Navigate( string.Empty ); // clear webBrowser
58
59                  // get groupTag for use as Azure PartitionKey

```

Fig. 31.9 | `manageSearchesButton_Click` event handler. (Part I of 2.)

```

60         groupTag = groupTagTextBox.Text;
61
62         LoadSearches(); // Load group of searches
63     } // end if
64 } // end else
65 } // end method manageSearchesButton_Click
66

```

Fig. 31.9 | manageSearchesButton_Click event handler. (Part 2 of 2.)

LoadSearches Method—Querying the Table Storage Service

Method `LoadSearches` (Fig. 31.10) creates a **TableQuery** that locates `TaggedSearchEntity` objects with a specified `PartitionKey` value. A `TableQuery` provides capabilities for selecting and filtering table contents. Method `Where` applies a filter condition. `TableQuery` static method `GenerateFilterCondition` requires three arguments:

- A string representing the property to compare—in this case, the `PartitionKey`.
- A constant from the `QueryComparisons` class indicating the type of comparison to perform—in this case, we create a filter that checks whether the value of the property in the first argument is *equal* to the value in the third argument. You can also perform *not equal*, *less than*, *less than or equal to*, *greater than* or *greater than or equal to* comparisons.
- A value to compare to the value of the property in the first argument—in this case the `groupTag` entered by the user.

Lines 80–81 call `CloudTable` method **`ExecuteQuery`** to perform the query. The method returns an `IEnumerable<TaggedSearchEntity>` containing the query results. Lines 84–85 sort the results into ascending alphabetical order. Line 87 specifies that the value of the `TaggedSearchEntity` property `RowKey` will be displayed in the `tagsListBox` and line 88 binds a `List` representation of the sorted `TaggedSearchEntity` objects to the `ListBox`'s `DataSource` property, which displays the tags in the `ListBox`.

```

67      // access Azure table storage to load group of search
68      private void LoadSearches()
69      {
70          try
71          {
72              // create TableQuery to get group of searches
73              TableQuery<TaggedSearchEntity> query =
74                  new TableQuery<TaggedSearchEntity>().
75                      Where( TableQuery.GenerateFilterCondition(
76                          "PartitionKey", QueryComparisons.Equal,
77                          groupTag ) );
78
79              // execute query to get group of searches
80              var searches =
81                  ftsTable.ExecuteQuery<TaggedSearchEntity>( query );
82
83              // Sort tags (RowKeys) alphabetically
84              var sortedSearches =
85                  searches.OrderBy( search => search.RowKey.ToLower() );
86
87              tagsListBox.DisplayMember = "RowKey";
88              tagsListBox.DataSource = sortedSearches.ToList();
89          } // end try
90          catch ( Exception exception )
91          {
92              MessageBox.Show(
93                  String.Format( "Load Failed: {0}", exception ) );
94          } // end catch
95      } // end method LoadSearches
96

```

Fig. 31.10 | LoadSearches method.

saveSearchButton_Click Event Handler

Method `saveSearchButton_Click` (Fig. 31.11) inserts a new `TaggedSearchEntity` into the table. Lines 104–105 create the `TaggedSearchEntity`. `TableOperation` static method **Insert** creates a `TableOperation` that can insert the specified entity. Line 111 calls class `CloudTable`'s **Execute** method to perform the `insertSearch` `TableOperation`. We then reload the saved searches.

```

97      // save a search into the Azure table for this app
98      private void saveSearchButton_Click( object sender, EventArgs e )
99      {
100          // try to save a search
101          try
102          {
103              // create a new TaggedSearchEntity to insert
104              TaggedSearchEntity search = new TaggedSearchEntity(
105                  groupTag, tagTextBox.Text, queryTextBox.Text );
106

```

Fig. 31.11 | `saveSearchButton_Click` event handler. (Part I of 2.)

```

107         // create TableOperation to insert TaggedSearchEntity
108         TableOperation insertSearch = TableOperation.Insert( search );
109
110         // execute the TableOperation to insert the new search
111         ftsTable.Execute( insertSearch );
112
113         LoadSearches(); // Reload searches and select new one
114
115         queryTextBox.Text = string.Empty; // clear queryTextBox
116         tagTextBox.Text = string.Empty; // clear tagTextBox
117     } // end try
118     catch ( Exception exception )
119     {
120         MessageBox.Show(
121             String.Format( "Insert Failed: {0}", exception ) );
122     } // end catch
123 } // end method saveSearchButton_Click
124

```

Fig. 31.11 | saveSearchButton_Click event handler. (Part 2 of 2.)

tagsListBox_SelectedIndexChanged Event Handler

Method tagsListBox_SelectedIndexChanged (Fig. 31.12) performs the selected search. Lines 136–138 create a string representing the Twitter search to perform. Some Twitter search operators use characters that are special in URLs, so line 138 encodes those characters in the selected search's Query property by calling static method **UrlEncode** of class **HttpUtility** (namespace **System.Web**). Line 140 calls **WebBrowser** method **Navigate** to load the search results into the webBrowser control.

```

125         // display search results in the webBrowser control
126     private void tagsListBox_SelectedIndexChanged(
127         object sender, EventArgs e )
128     {
129         // get selected item from tagsListBox
130         TaggedSearchEntity selectedSearch =
131             ( TaggedSearchEntity ) tagsListBox.SelectedItem;
132
133         if ( selectedSearch != null )
134         {
135             // create URL representing search
136             String urlString = String.Format(
137                 "https://twitter.com/search?q={0}",
138                 HttpUtility.UrlEncode( selectedSearch.Query ) );
139
140             webBrowser.Navigate( urlString ); // show results
141         } // end if
142     } // end method tagsListBox_SelectedIndexChanged
143 } // end class
144 } // end namespace FavoriteTwitterSearches

```

Fig. 31.12 | tagsListBox_SelectedIndexChanged event handler.

31.8 Security, Privacy and Reliability

Cloud services can be vulnerable to denial-of-service (DoS) attacks and security breaches. Many of the largest cloud computing services have been the targets of cyber attacks that have interrupted service to users or compromised their data. Much of the security and reliability burden is on the service provider; however, there are steps you can take to ensure the privacy and security of your data—particularly protecting identity and access (Fig. 31.13). Microsoft's *Windows Azure Security Guidance* guide (www.windowsazure.com/en-us/develop/net/best-practices/security) lists several identity and access scenarios and provides best practices for handling each.

Microsoft Global Foundation Services (GFS) manages data centers for Windows Azure which comply with industry standards for security (see www.iso.org/iso/catalogue_detail?csnumber=42103). Microsoft uses internal checks and third-party auditors to ensure that Windows Azure is compliant with the security, privacy and reliability standards and policies.

Visit the Windows Azure Trust Center (www.windowsazure.com/en-us/support/trust-center/) to learn more about Azure security, privacy and compliance. For additional cloud security information and research, check out the Cloud Security Alliance (cloudsecurityalliance.org).

| Solution | Description |
|---|---|
| Windows Identity Foundation (WIF) | Verify identity and grant access rather than programming your own solution. |
| Windows Azure AD Access Control Active Directory Federation Services | Single sign on across multiple applications. Allows the user's organization to verify identity so the user can access web apps from trusted business partners. |
| Windows Azure Shared Access Signatures | Allow restricted access to blobs, tables, containers and queues for a set time period. |

Fig. 31.13 | Windows Azure identity access mechanisms (www.windowsazure.com/en-us/develop/net/best-practices/security).

31.9 Microsoft Windows Azure Resources

Figure 31.14 lists some of the key Microsoft Windows Azure resources.

| Resource | URL | Description |
|-------------------------|--|--|
| <i>Reference</i> | | |
| Windows Azure home page | www.windowsazure.com/en-us/documentation | Includes links to Windows Azure news, blogs, videos and documentation. |

Fig. 31.14 | Some key Microsoft Windows Azure resources. (Part 1 of 3.)

| Resource | URL | Description |
|--|--|--|
| Introducing Windows Azure | www.windowsazure.com/en-us/develop/net/fundamentals/intro-to-windows-azure | Discusses the fundamentals of Windows Azure including the components, execution models, data management, networking, business analytics, messaging, caching, identity, high-performance computing, media, commerce and SDKs. |
| Windows Azure Execution Models | www.windowsazure.com/en-us/develop/net/fundamentals/compute | Discusses three execution models for running Windows Azure apps—virtual machines, web sites and cloud services—and provides examples of when to use each. |
| <i>Videos</i> | | |
| Windows Azure Developer Experience Videos | channel9.msdn.com/Blogs/Windows-Azure-Developer-Experience-Videos | Several introductory Windows Azure videos that demonstrate how to build a simple app. |
| Official YouTube Channel for Windows Azure | www.youtube.com/user/windowsazure | Microsoft's Windows Azure channel includes numerous video tutorials and presentations. |
| <i>Code samples, labs and demos</i> | | |
| Windows Azure code samples | code.msdn.microsoft.com/windowsazure | Hundreds of code samples from Windows Azure team members and from the community. |
| Windows Azure Training Kit | www.windowsazure.com/en-us/develop/net/other-resources/training-kit | Presentations, demos, labs and code samples that show you how to build Windows Azure apps. |
| <i>Documentation</i> | | |
| Reference | www.windowsazure.com/en-us/develop/net/reference | Includes links to the various cloud computing feature guides and the .NET and REST API references. |
| Guidance (best practices) | www.windowsazure.com/en-us/develop/net/guidance | Best practices for designing, deployment, troubleshooting, security, and performance. |
| App Services | www.windowsazure.com/en-us/develop/net/app-services | Guides and tutorials for Windows Azure app services. |
| Data Services | www.windowsazure.com/en-us/develop/net/data | Guides and tutorials for Windows Azure data services. |
| Mobile Services | www.windowsazure.com/en-us/develop/mobile/ | Documentation, tutorials, forums and code samples for Windows Azure mobile services. |

Fig. 31.14 | Some key Microsoft Windows Azure resources. (Part 2 of 3.)

| Resource | URL | Description |
|--------------------------|--|---|
| <i>News and forums</i> | | |
| Windows Azure Blog | www.windowsazure.com/en-us/community/blog | News and tutorials from Microsoft Windows Azure team members and the Azure community. |
| Windows Azure Newsletter | www.windowsazure.com/en-us/community/newsletter | Stay up-to-date with the latest Windows Azure developments and events. |
| Forums | www.windowsazure.com/en-us/support/forums | Ask questions and get answers from other Windows Azure developers. |

Fig. 31.14 | Some key Microsoft Windows Azure resources. (Part 3 of 3.)

31.10 Microsoft Windows Azure Code Samples

Microsoft's All-In-One Code Framework (blogs.msdn.com/b/onecode) is a library of free sample apps designed to help developers address real-world issues. Developers can use the samples available on the website and submit requests for new solutions to be posted. Figure 31.15 lists some of the Microsoft sample apps. Visit the websites for each to find the source code and a tutorial that shows you how to build the app.

| Code Example | URL |
|---|--|
| Windows Azure Access Control for Single Sign-On | code.msdn.microsoft.com/windowsazure/Windows-Azure-Access-d01d282b |
| Azure + Bing Map Sample Application | code.msdn.microsoft.com/windowsazure/CSAzureBingMaps-bab92df1 |
| Access Azure Table Storage via WCF Data Services | code.msdn.microsoft.com/windowsazure/CSAzureTableStorageWCFDS-2355159b |
| Host and use WCF Services in Windows Azure | code.msdn.microsoft.com/windowsazure/CSAzureWCFServices-20c7d9c5 |
| Geolocation Sample End-to-End using Windows Azure Mobile Services | code.msdn.microsoft.com/windowsapps/Geolocation-sample-end-to-5d9ee245 |
| Windows Azure Mobile Services—Doto Sample (to do list app) | code.msdn.microsoft.com/windowsapps/doto-a-simple-social-todo-7e6ba464 |
| Create a Game Leaderboard using Windows Azure Mobile Services | code.msdn.microsoft.com/windowsapps/Adding-a-Leaderboard-to-1f9d216d |
| Authenticate Microsoft Account, Facebook, Twitter and Google with Mobile Services | code.msdn.microsoft.com/windowsapps/Authenticate-Account-827dd37b |
| How to use Bing Search API | code.msdn.microsoft.com/windowsazure/How-to-use-bing-search-API-4c8b287e |

Fig. 31.15 | A few Microsoft Windows Azure sample apps.

31.11 Additional Web Resources

Web-Based Training

channel9.msdn.com/Series/Windows-Azure-Cloud-Services-Tutorials

A series of eight short online courses that introduce you to Windows Azure Cloud Services, ending with a tutorial that shows you how to build a Windows Azure trivia game.

www.microsoftvirtualacademy.com/training-courses/introduction-to-windows-azure

The Microsoft Virtual Academy training course, “Introduction to Windows Azure Training.” The course provides an introduction to Windows Azure and discusses deploying, managing and monitoring Azure apps.

Feature Overviews

msdn.microsoft.com/en-us/library/windowsazure/gg441573.aspx

“What's New in Windows Azure,” from Microsoft. Discusses the Management Portal, infrastructure as a service (IaaS) support, platform as a service (PaaS) support, high-density hosting of websites, health monitoring for apps and services, linked resources, scaling, single portal for all key workloads, in-portal help and information, easy transitions, integrated developer experience, and more.

weblogs.asp.net/scottgu/archive/2012/06/07/meet-the-new-windows-azure.aspx

Blog: “Meet the New Windows Azure,” by Scott Guthrie. Discusses the new Admin portal and command line tools, virtual machines, websites, cloud services and distributed caching, and the new SDKs and tooling support.

hwww.windowsazure.com/en-us/overview/what-is-windows-azure/

Windows Azure features including mobile services, web sites, virtual machines, cloud services, data management, business analytics, caching, networking, identity, messaging, media services and marketplace.

www.windowsazure.com/en-us/home/features/mobile-services/

Azure Mobile Services include creating a backend for Windows 8 client apps, saving data to the cloud, adding users to an app, and quickly integrating push notifications.

How-To Articles

msdn.microsoft.com/en-us/library/windowsazure/gg433055.aspx

“Use the Windows Azure SDK Tools to Package, Run, and Deploy an Application,” from Microsoft. Discusses the Windows Azure Compute Emulator for running your app locally, the Windows Azure Storage Emulator for storage services, packaging a Windows Azure application, uploading certificates and encrypting passwords for remote desktop connections, testing applications in the Compute Emulator, reducing the number of running instances for testing, debugging and collecting diagnostic data.

www.windowsazure.com/en-us/manage/services/cloud-services/how-to-create-and-deploy-a-cloud-service/

“How to Create and Deploy a Cloud Service,” from Microsoft’s Windows Azure documentation. Topics include how to create a cloud service using Quick Create, upload a certificate for a cloud service, deploy a cloud service

Fundamentals

blogs.msdn.com/b/acoat/archive/2012/06/03/excellent-windows-azure-intro-videos.aspx

The blog post, “Excellent Windows Azure Intro Videos,” by Andrew Coates of Microsoft. The post includes four short, animated videos that explain the basics of Windows Azure, SQL Azure, Access Control and Service Bus.

www.windowsazure.com/en-us/develop/net/fundamentals/identity/

“Windows Azure Identity,” discusses running and using Windows Server Active Directory to manage identities in Windows Azure.

www.windowsazure.com/en-us/develop/net/fundamentals/cloud-storage/

“Data Management and Business Analytics,” from Microsoft. Discusses storing data in blobs and tables, running a database management system in a virtual machine and SQL database data sync and reporting.

www.windowsazure.com/en-us/develop/net/fundamentals/networking/

“Windows Azure Networking,” from Microsoft. Discusses the Windows Azure Virtual Network, Windows Azure Connect and Windows Azure Traffic Manager.

www.windowsazure.com/en-us/develop/net/fundamentals/hybrid-solutions/

Discusses the benefits of hybrid, service bus relay, service bus queries and topics, SQL data sync, access control services (ACS) paired with Active Directory Federation Services (AD FS), and Windows Azure Connect.

Reference Guides

msdn.microsoft.com/en-us/library/windowsazure/ee460799.aspx

“Windows Azure Service Management REST API Reference,” from Microsoft. Discusses the Service Management API, versioning, addressing service management resources, authenticating requests, tracking asynchronous requests, status and error codes, operations on storage accounts, operations on hosted services, operations on service certificates, operations on affinity groups, operations on locations, operations on tracking asynchronous requests, retrieving operating systems information, retrieving subscription history, management certificates, the traffic manager, virtual machines, virtual machine images, virtual machine disks, virtual networks, and virtual network gateways.

Tutorials

www.windowsazure.com/en-us/develop/net/tutorials/get-started/

The Microsoft tutorial, “Deploying an ASP.NET Web Application to a Windows Azure Web Site,” shows you build a simple web app that runs in the cloud using Visual Studio ASP.NET MVC 4 and Windows Azure.

www.windowsazure.com/en-us/develop/net/how-to-guides/twilio-voice-and-sms-service/

The Microsoft tutorial, “How to Use Twilio for Voice and SMS Capabilities from Windows Azure,” shows you how to use the Twilio API on Windows Azure to make phone calls and send an SMS (Short Message Service) text message. Includes sample code.

www.windowsazure.com/en-us/develop/net/tutorials/web-site-with-sql-database/

The tutorial, “Deploy a Secure ASP.NET MVC App with Membership, OAuth, and SQL Database to a Windows Azure Web Site,” by Rick Anderson and Tom Dykstra.

www.windowsazure.com/en-us/manage/services/hdinsight/get-started-hdinsight/

The tutorial, “Getting Started with Windows Azure HDInsight Service,” by Microsoft shows you how to start using HDInsight to manage and store your data in Windows Azure.

Tools and Resources

vmdepot.msopentech.com/List/Index

VM Depot includes open-source virtual machine images for use with Windows Azure.

31.12 Wrap-Up

In this chapter, we introduced cloud computing and Windows Azure. We discussed some popular cloud computing apps. We discussed how to sign up for a free Windows Azure trial and download the tools you'll need to build Windows Azure apps.

You created the **Favorite Twitter Searches** app to demonstrate Windows Azure Table Storage. We overviewed the app's capabilities, then you test-drove it. Next, we presented the app's code implementation, which showed the features you needed to create a table, insert items into the table and query the table's contents.

Self-Review Exercises

- 31.1** Specify whether each of the following is *true* or *false*. If *false*, explain why.
- a) Cloud computing allows you to use software and data stored on your desktop, notebook computer and mobile device.
 - b) Cloud computing allows you to instantaneously scale your storage and processing power to meet their occasional peak levels.
 - c) Windows Azure allows your apps to store their data on your local servers.
 - d) When building real Azure-based apps, you'll need both the Windows Azure SDK and access to the Windows Azure cloud services.
 - e) Unlike your personal computer, cloud services are not vulnerable to security breaches.
 - f) Microsoft is completely responsible for the security and privacy of your data.
 - g) Windows Azure Shared Access Signatures is a mechanism for enabling single sign on across multiple apps.
- 31.2** Fill in the blanks in each of the following:
- a) _____ is a cloud computing platform that allows you to develop, manage and distribute your apps in the cloud.
 - b) The example that you'll build in this chapter uses the _____ on your local computer rather than connecting to the fee-based Windows Azure cloud services.
 - c) You can use _____ to verify identity and grant access to your data in Windows Azure rather than programming your own solution.
- 31.3** List three use cases for Windows Azure cloud computing and include an example of how you can use each.

Answers to Self Review Exercises

31.1 a) False. Cloud computing allows you to use software and data stored in the "cloud"—i.e., accessed on remote computers (or servers) via the Internet and available on demand—rather than having it stored on your desktop, notebook computer or mobile device. b) True. c) False. Windows Azure allows your apps to store their data in the cloud so that the data is available at all times from any of your desktop computers and mobile devices. d) True. e) False. Cloud services can be vulnerable to denial-of-service (DoS) attacks and security breaches, and when there's a problem, it's experienced by a massive number of people. f) False. There are steps you can take to ensure the privacy

and security or your data—particularly protecting identity and access. g) False. Windows Azure AD Access Control is a mechanism for enabling single sign on across multiple apps.

31.2 a) Windows Azure. b) Windows Azure Storage Emulator. c) Windows Identity Foundation (WIF).

31.3 Any of three of the following are valid responses:

- a) Big data. Scale your computing and storage capacity as needed rather than buying hardware that's needed only occasionally. You can also use the additional computing power to process the data (e.g., performing analytics to track customer behavior and find trends).
- b) Testing and development. Use multiple virtual machines to develop and test your apps in a variety of scenarios rather than buying additional hardware and software and setting up a variety of platforms.
- c) Websites and web apps. Host your websites and web apps on Windows Azure which can handle varying demand and shifts the administrative burden (e.g., security and reliability) to Microsoft.
- d) Mobile apps. Use Windows Azure to support your mobile apps across a variety of platforms (e.g., Windows Phone 8, iOS, Android)—for example, authenticating app users, storing data and sending push notifications to users' devices.
- e) Infrastructure. Set up servers in the cloud and scale your infrastructure (e.g., processor cycles, memory and secondary storage) as needed, paying for only what you use rather than purchasing additional costly hardware.
- f) Storage, Backup and Recovery. Use Windows Azure's secure, reliable storage space to back-up your data. The data is stored on servers in multiple locations worldwide to ensure that it's safe and accessible even in the case of a local disaster.
- g) Identity and access management. Enable single sign-on to authenticate users just once to access multiple apps. Control access to apps or other data by setting up rules.
- h) Media. Distribute media (e.g., stream video on demand) to several devices and platforms such as Windows, Android, iOS and others. You can also use Windows Azure to manage and protect your media content.

Exercise

31.4 (*Favorite Flickr Searches App*) Investigate the Flickr (flickr.com) search mechanism, then reimplement this chapter's **Favorite Twitter Searches** app as a **Favorite Flickr Searches** app.