

# Forms Authentication, Authorization, User Accounts, and Roles :: Forms Authentication Configuration and Advanced Topics

## Introduction

In the previous tutorial we looked at the steps necessary for implementing forms authentication in an ASP.NET application, from specifying configuration settings in `Web.config` to creating a log in page to displaying different content for authenticated and anonymous users. Recall that we configured the website to use forms authentication by setting the `mode` attribute of the `<authentication>` element to `Forms`. The `<authentication>` element may optionally include a `<forms>` child element, through which an assortment of forms authentication settings may be specified.

In this tutorial we will examine the various forms authentication settings and see how to modify them through the `<forms>` element. This will entail a detailed look at customizing the forms authentication ticket's timeout value, using a login page with a custom URL (like `SignIn.aspx` instead of `Login.aspx`), and cookieless forms authentication tickets. We will also examine the makeup of the forms authentication ticket more closely and see the precautions ASP.NET takes to ensure that the ticket's data is secure from inspection and tampering. Finally, we will look at how to store extra user data in the forms authentication ticket and how to model this data through a custom principal object.

## Step 1: Examining the `<forms>` Configuration Settings

The forms authentication system in ASP.NET offers a number of configuration settings that can be customized on an application-by-application basis. This includes settings like: the lifetime of the forms authentication ticket; what sort of protection is applied to the ticket; under what conditions cookieless authentication tickets are used; the path to the login page; and other information. To modify the default values, add a [<forms> element](#) as a child of the [<authentication> element](#), specifying those property values you want to customize as XML attributes like so:

```
<authentication mode="Forms">
  <forms
    propertyName1="value1"
    propertyName2="value2"
    ...
  >
</authentication>
```

```

        propertyName="valueN"
    />
</authentication>

```

Table 1 summarizes the properties that can be customized through the <forms> element. Since `Web.config` is an XML file, the attribute names in the left column are case-sensitive.

Attribute	Description
cookieless	This attribute specifies under what conditions the authentication ticket is stored in a cookie versus being embedded in the URL. Allowable values are: <code>UseCookies</code> ; <code>UseUri</code> ; <code>AutoDetect</code> ; and <code>UseDeviceProfile</code> (the default). Step 2 examines this setting in more detail.
defaultUrl	Indicates the URL that users are redirected to after signing in from the login page if there is no <code>RedirectUrl</code> value specified in the querystring. The default value is <code>default.aspx</code> .
domain	When using cookie-based authentication tickets, this setting specifies the cookie's domain value. The default value is an empty string, which causes the browser to use the domain from which it was issued (such as <code>www.yourdomain.com</code> ). In this case, the cookie will <b>not</b> be sent when making requests to subdomains, such as <code>admin.yourdomain.com</code> . If you want the cookie to be passed to all subdomains you need to customize the <code>domain</code> attribute setting it to <code>"yourdomain.com"</code> .
enableCrossAppRedirects	A Boolean value indicating whether authenticated users are remembered when redirected to URLs in other web applications on the same server. The default is <code>false</code> .
loginUrl	The URL of the login page. The default value is <code>login.aspx</code> .
name	When using cookie-based authentication tickets, the name of the cookie. The default is <code>".ASPXAUTH"</code> .
path	When using cookie-based authentication tickets, this setting specifies the cookie's path attribute. The path attribute enables a developer to limit the scope of a cookie to a particular directory hierarchy. The default value is <code>"/"</code> , which informs the browser to send the authentication ticket cookie to any request made to the domain.
protection	Indicates what techniques are used to protect the forms authentication ticket. The allowable values are:

	All (the default); Encryption; None; and Validation. These settings are discussed in detail in Step 3.
<code>requireSSL</code>	A Boolean value that indicates whether an SSL connection is required to transmit the authentication cookie. The default value is <code>false</code> .
<code>slidingExpiration</code>	A Boolean value that indicates whether the authentication cookie's timeout is reset each time the user visits the site during a single session. The default value is <code>false</code> . The authentication ticket timeout policy is discussed in more detail in the "Specifying the Ticket's Timeout Value" section.
<code>timeout</code>	Specifies the time, in minutes, after which the authentication ticket cookie expires. The default value is 30. The authentication ticket timeout policy is discussed in more detail in the "Specifying the Ticket's Timeout Value" section.

**Table 1: A Summary of the <forms> Element's Attributes**

In ASP.NET 2.0 and beyond, the default forms authentication values are hard-coded in the `FormsAuthenticationConfiguration` class in the .NET Framework. Any modifications must be applied on an application-by-application basis in the `Web.config` file. This differs from ASP.NET 1.x, where the default forms authentication values were stored in the `machine.config` file (and could therefore be modified via editing `machine.config`). While on the topic of ASP.NET 1.x, it is worthwhile to mention that a number of the forms authentication system settings have different default values in ASP.NET 2.0 and beyond than in ASP.NET 1.x. If you are migrating your application from an ASP.NET 1.x environment, it is important to be aware of these differences. Consult [the <forms> element technical documentation](#) for a list of the differences.

**Note:** Several forms authentication settings, such as the `timeout`, `domain`, and `path`, specify details for the resulting forms authentication ticket cookie. For more information on cookies, how they work, and their various properties, read [this Cookies tutorial](#).

## Specifying the Ticket's Timeout Value

The forms authentication ticket is a token that represents an identity. With cookie-based authentication tickets, this token is held in the form of a cookie and sent to the web server on each request. Possession of the token, in essence, declares, "I am *username*, I have already logged in," and is used so that a user's identity can be remembered across page visits.

The forms authentication ticket not only includes the user's identity, but also contains information to help ensure the integrity and security of the token. After all,

we don't want a nefarious user to be able to create a counterfeit token, or to modify a legit token in some underhanded way.

One such bit of information included in the ticket is an *expiry*, which is the date and time the ticket is no longer valid. Each time the `FormsAuthenticationModule` inspects an authentication ticket, it ensures that the ticket's expiry has not yet passed. If it has, it disregards the ticket and identifies the user as being anonymous. This safeguard helps protect against replay attacks. Without an expiry, if a hacker was able to get her hands on a user's valid authentication ticket – perhaps by gaining physical access to their computer and rooting through their cookies – they could send a request to the server with this stolen authentication ticket and gain entry. While the expiry doesn't prevent this scenario, it does limit the window during which such an attack can succeed.

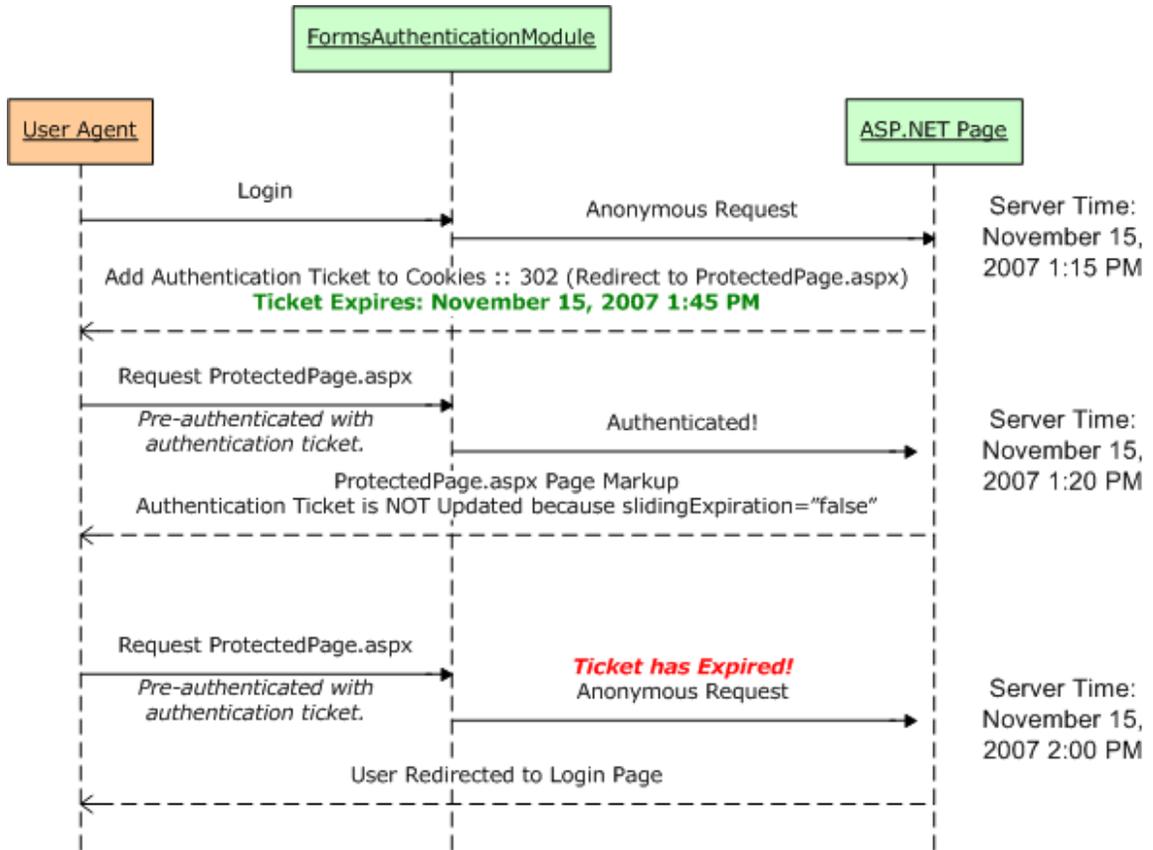
**Note:** Step 3 details additional techniques used by the forms authentication system to protect the authentication ticket.

When creating the authentication ticket, the forms authentication system determines its expiry by consulting the `timeout` setting. As noted in Table 1, the `timeout` setting defaults to 30 minutes, meaning that when the forms authentication ticket is created its expiry is set to a date and time 30 minutes in the future.

The expiry defines an absolute time in the future when the forms authentication ticket expires. But usually developers want to implement a sliding expiry, one that is reset every time the user revisits the site. This behavior is determined by the `slidingExpiration` settings. If set to `true`, each time the `FormsAuthenticationModule` authenticates a user, it updates the ticket's expiry. If set to `false` (the default), the expiry is not updated on each request, thereby causing the ticket to expire exactly `timeout` number of minutes past when the ticket was first created.

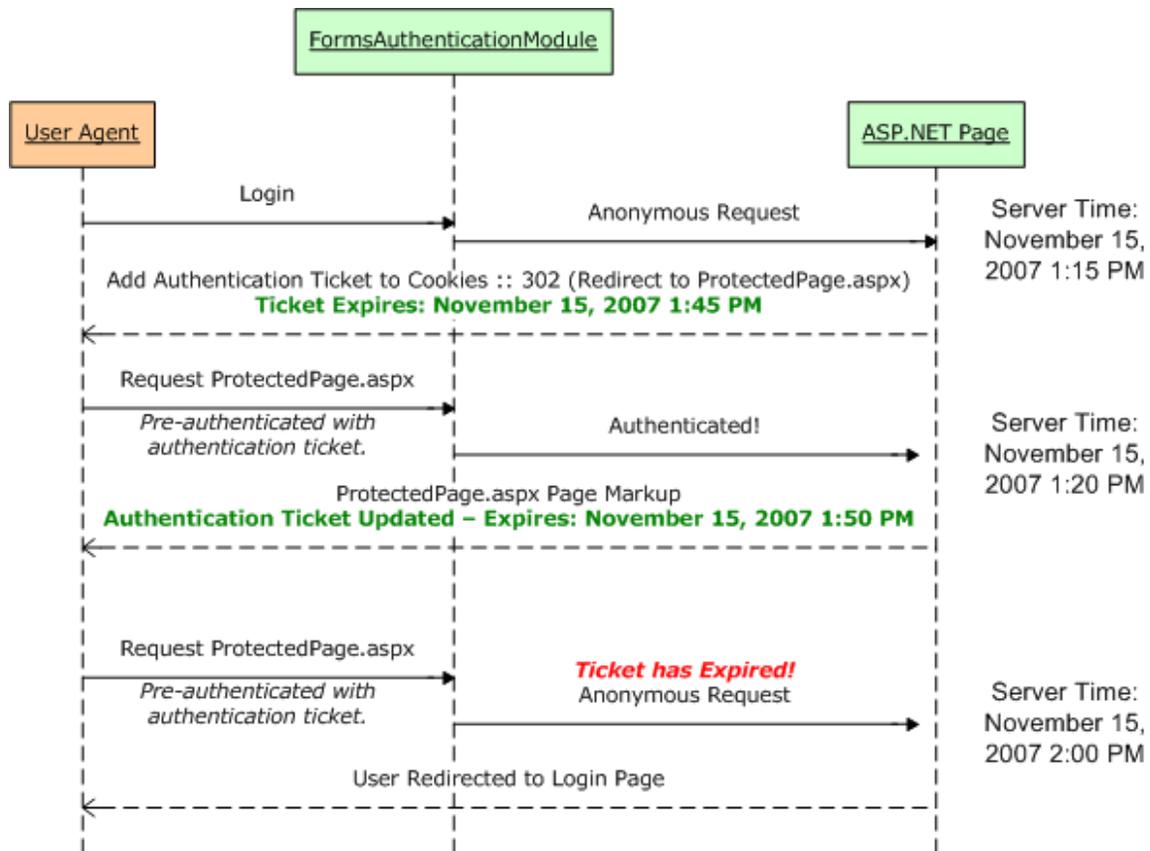
**Note:** The expiry stored in the authentication ticket is an absolute date and time value, like "August 2, 2008 11:34 AM." Moreover, the date and time are relative to the web server's local time. This design decision can have some interesting side effects around Daylight Saving Time (DST), which is when clocks in the United States are moved ahead one hour (assuming the web server is hosted in a locale where Daylight Saving Time is observed). Consider what would happen for an ASP.NET website with a 30 minute expiry near the time that DST begins (which is at 2:00 AM). Imagine a visitor signs on to the site on March 11, 2008 at 1:55 AM. This would generate a forms authentication ticket that expires at March 11, 2008 at 2:25 AM (30 minutes in the future). However, once 2:00 AM rolls around, the clock jumps to 3:00 AM because of DST. When the user loads a new page six minutes after signing in (at 3:01 AM), the `FormsAuthenticationModule` notes that the ticket has expired and redirects the user to the login page. For a more thorough discussion on this and other authentication ticket timeout oddities, as well as workarounds, pick up a copy of Stefan Schackow's *Professional*

Figure 1 illustrates the workflow when `slidingExpiration` is set to `false` and `timeout` is set to 30. Note that the authentication ticket generated at login contains the expiration date, and this value is not updated on subsequent requests. If the `FormsAuthenticationModule` finds that the ticket has expired, it discards it and treats the request as anonymous.



**Figure 1: A Graphical Representation of the Forms Authentication Ticket's Expiry When `slidingExpiration` is false**

Figure 2 shows the workflow when `slidingExpiration` is set to `true` and `timeout` is set to 30. When an authenticated request is received (with a non-expired ticket) its expiry is updated to `timeout` number of minutes in the future.



**Figure 2: A Graphical Representation of the Forms Authentication Ticket's When `slidingExpiration` is true**

When using cookie-based authentication tickets (the default), this discussion becomes a little more confusing because cookies can also have their own expiries specified. A cookie's expiry (or lack thereof) instructs the browser when the cookie should be destroyed. If the cookie lacks an expiry, it is destroyed when the browser shuts down. If an expiry is present, however, the cookie remains stored on the user's computer until the date and time specified in the expiry has passed. When a cookie is destroyed by the browser, it is no longer sent to the web server. Therefore, the destruction of a cookie is analogous to the user logging out of the site.

**Note:** Of course, a user may proactively remove any cookies stored on their computer. In Internet Explorer 7, you would go to Tools, Options, and click the Delete button in the "Browsing history" section. From there, click the "Delete cookies" button.

The forms authentication system creates session-based or expiry-based cookies depending on the value passed in to the `persistCookie` parameter. Recall that the `FormsAuthentication` class's `GetAuthCookie`, `SetAuthCookie`, and `RedirectFromLoginPage` methods take in two input parameters: `username` and `persistCookie`. The login page we created in the preceding tutorial included a

"Remember me" CheckBox, which determined whether a persistent cookie was created. Persistent cookies are expiry-based; non-persistent cookies are session-based.

The `timeout` and `slidingExpiration` concepts already discussed apply the same to both session- and expiry-based cookies. There is only one minor difference in execution: when using expiry-based cookies with `slidingTimeout` set to `true`, the cookie's expiry is only updated when more than half of the specified time has elapsed.

Let's update our website's authentication ticket timeout policies so that tickets timeout after one hour (60 minutes), using a sliding expiration. To effect this change, update the Web.config file, adding a `<forms>` element to the `<authentication>` element with the following markup:

```
<authentication mode="Forms">
  <forms
    slidingExpiration="true"
    timeout="60"
  />
</authentication>
```

## Using an Login Page URL Other than Login.aspx

Since the `FormsAuthenticationModule` automatically redirects unauthorized users to the login page, it needs to know the login page's URL. This URL is specified by the `loginUrl` attribute in the `<forms>` element and defaults to "login.aspx". If you are porting over an existing website, you may already have a login page with a different URL, one that has already been bookmarked and indexed by search engines. Rather than renaming your existing login page to "login.aspx" and breaking links and users' bookmarks, you can instead modify the `loginUrl` attribute to point to your login page.

For example, if your login page was named `SignIn.aspx` and was located in the `Users` directory, you could point the `loginUrl` configuration setting to `"~/Users/SignIn.aspx"` like so:

```
<authentication mode="Forms">
  <forms
    loginUrl="~/Users/SignIn.aspx"
  />
</authentication>
```

Since our current application already has a login page named `Login.aspx`, there's no need to specify a custom value in the `<forms>` element.

## Step 2: Using Cookieless Forms Authentication Tickets

By default the forms authentication system determines whether to store its authentication tickets in the cookies collection or embed them in the URL based on the user agent visiting the site. All mainstream desktop browsers like Internet Explorer, Firefox, Opera, and Safari, support cookies, but not all mobile devices do.

The cookie policy used by the forms authentication system depends on the `cookieless` setting in the `<forms>` element, which can be assigned one of four values:

- `UseCookies` – specifies that cookie-based authentication tickets will always be used.
- `UseUri` – indicates that cookie-based authentication tickets will never be used.
- `AutoDetect` – if the device profile does not support cookies, cookie-based authentication tickets are not used; if the device profile supports cookies, a probing mechanism is used to determine if cookies are enabled.
- `UseDeviceProfile` – the default; uses cookie-based authentication tickets only if the device profile supports cookies. No probing mechanism is used.

The `AutoDetect` and `UseDeviceProfile` settings rely on a *device profile* in ascertaining whether to use cookie-based or cookieless authentication tickets. ASP.NET maintains a database of various devices and their capabilities, such as whether they support cookies, what version of JavaScript they support, and so on. Each time a device requests a web page from a web server it sends along a *user-agent* HTTP header that identifies the device type. ASP.NET automatically matches the supplied user-agent string with the corresponding profile specified in its database.

**Note:** This database of device capabilities is stored in a number of XML files that adhere to the [Browser Definition File schema](#). The default device profile files are located in

`%WINDIR%\Microsoft.Net\Framework\v2.0.50727\CONFIG\Browsers`. You can also add custom files to your application's `App_Browsers` folder. For more information, see [How To: Detect Browser Types in ASP.NET Web Pages](#).

Because the default setting is `UseDeviceProfile`, cookieless forms authentication tickets will be used when the site is visited by a device whose profile reports that it does not support cookies.

# Encoding the Authentication Ticket in the URL

Cookies are a natural medium for including information from the browser in each request to a particular website, which is why the default forms authentication settings use cookies if the visiting device supports them. If cookies are not supported, an alternate means for passing the authentication ticket from the client to the server must be employed. A common workaround used in cookieless environments is to encode the cookie data in the URL.

The best way to see how such information can be embedded within the URL is to force the site to use cookieless authentication tickets. This can be accomplished by setting the `cookieless` configuration setting to `UseUri`:

```
<authentication mode="Forms">
  <forms
    cookieless="UseUri"
    slidingExpiration="true"
    timeout="60"
  />
</authentication>
```

Once you have made this change, visit the site through a browser. When visiting as an anonymous user, the URLs will look exactly like they did before. For example, when visiting `Default.aspx` page my browser's address bar shows the following URL:

```
http://localhost:2448/ASPNET_Security_Tutorial_03_CS/default.aspx
```

However, upon logging in, the forms authentication ticket is embedded into the URL. For example, after visiting the login page and logging in as Sam, I am returned to the `Default.aspx` page, but the URL this time is:

```
http://localhost:2448/ASPNET_Security_Tutorial_03_CS/(F(jaIOIDTJxIr12xYS-VVgkqKCVAuIoW30Bu0diWi6flQC-FyMaLXJfow_Vd9GZkB2Cv-rfezq0gKadKX0YPZCkA2))/default.aspx
```

The forms authentication ticket has been embedded within the URL. The string `(F(jaIOIDTJxIr12xYS-VVgkqKCVAuIoW30Bu0diWi6flQC-FyMaLXJfow_Vd9GZkB2Cv-rfezq0gKadKX0YPZCkA2))` represents the hex-encoded authentication ticket information, and is the same data that is usually stored within a cookie.

In order for cookieless authentication tickets to work, the system must encode all URLs on the page to include the authentication ticket data, otherwise the authentication ticket will be lost when the user clicks on a link. Thankfully, this embedding logic is performed automatically. To demonstrate this functionality, open the `Default.aspx` page and add a `HyperLink` control, setting its `Text` and `NavigateUrl` properties to "Test Link" and "SomePage.aspx", respectively. It doesn't matter that there really isn't a page in our project named `SomePage.aspx`.

Save the changes to `Default.aspx` and then visit it through a browser. Log on to the site so that the forms authentication ticket is embedded in the URL. Next, from `Default.aspx`, click the "Test Link" link. What happened? If no page named `SomePage.aspx` exists, then a 404 error occurred, but that's not what's important here. Instead, focus on the Address bar in your browser. Note that it includes the forms authentication ticket in the URL!

```
http://localhost:2448/ASPNET_Security_Tutorial_03_CS/(F(jaIOIDTJxIr12xY
S-VVgkqKCVAuIoW30Bu0diWi6flQC-FyMaLXJfow_Vd9GZkB2Cv-
rfezq0gKadKX0YPZCkA2))/SomePage.aspx
```

The URL "SomePage.aspx" in the link was automatically converted into a URL that included the authentication ticket - we didn't have to write a lick of code! The form authentication ticket will automatically be embedded in the URL for any hyperlinks that do not start with "http://" or "/". It doesn't matter if the hyperlink appears in a call to `Response.Redirect`, in a `HyperLink` control, or in an anchor HTML element (i.e., `<a href="...">...</a>`). As long as the URL isn't something like "http://www.someserver.com/SomePage.aspx" or "/SomePage.aspx", the forms authentication ticket will be embedded for us.

**Note:** Cookieless forms authentication tickets adhere to the same timeout policies as cookie-based authentication tickets. However, cookieless authentication tickets are more prone to replay attacks since the authentication ticket is embedded directly in the URL. Imagine a user who visits a website, logs in, and then pastes the URL in an email to a colleague. If the colleague clicks on that link before the expiry is reached, they will be logged in as the user who sent the email!

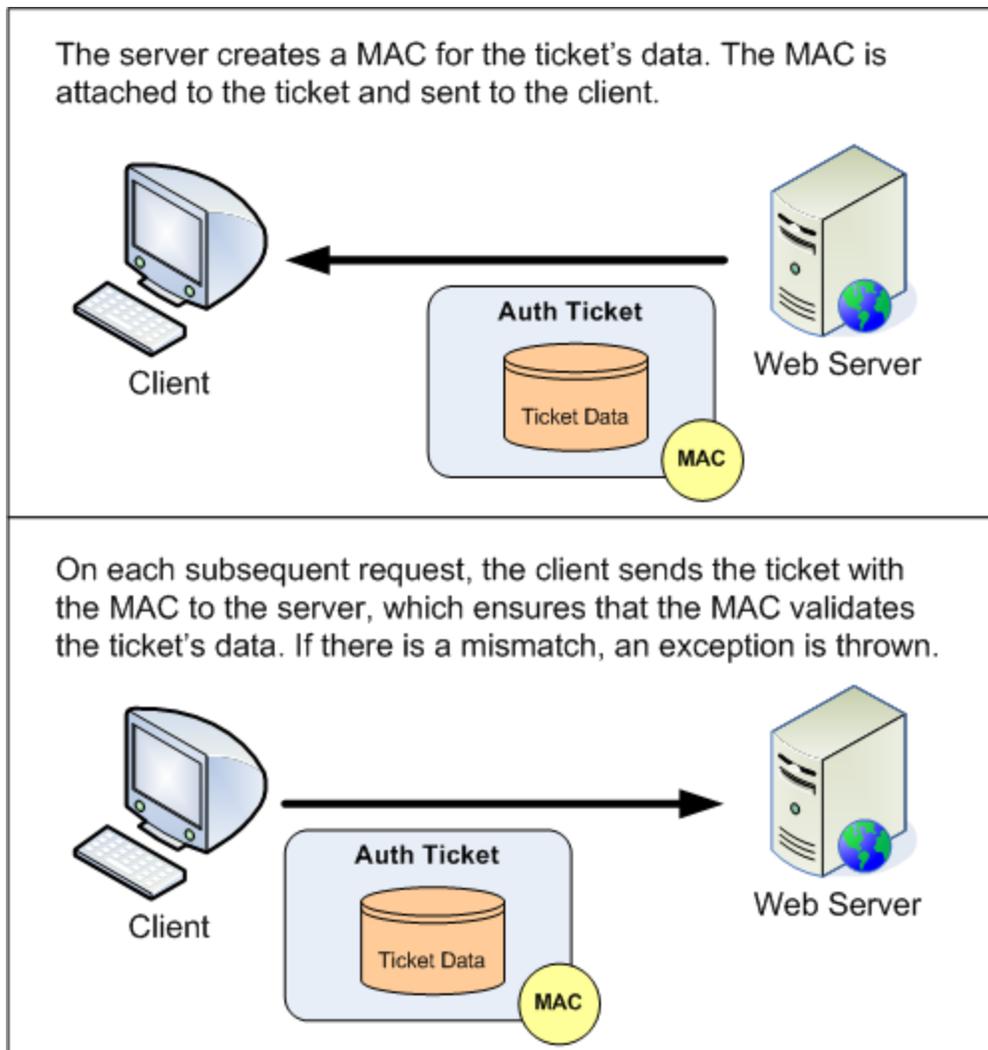
## Step 3: Securing the Authentication Ticket

The forms authentication ticket is transmitted over the wire either in a cookie or embedded directly within the URL. In addition to identity information, the authentication ticket can also include user data (as we will see in Step 4). Consequently, it is important that the ticket's data is encrypted from prying eyes and (even more importantly) that the forms authentication system can guarantee that the ticket was not tampered with.

To ensure the privacy of the ticket's data, the forms authentication system can encrypt the ticket data. Failure to encrypt the ticket data sends potentially sensitive information over the wire in plain-text.

To guarantee a ticket's authenticity, the forms authentication system must *validate* the ticket. Validation is the act of ensuring that a particular piece of data has not been modified, and is accomplished via a [\*message authentication code \(MAC\)\*](#). In a nutshell, the MAC is a small piece of information that identifies the data that needs to be validated (in this case, the ticket). If the data represented by the MAC is modified, then the MAC and the data will not match up. Moreover, it is computationally hard for a hacker to both modify the data and generate his own MAC to correspond with the modified data.

When creating (or modifying) a ticket, the forms authentication system creates a MAC and attaches it to the ticket's data. When a subsequent request arrives, the forms authentication system compares the MAC and ticket data to validate the authenticity of the ticket data. Figure 3 illustrates this workflow graphically.



**Figure 3: The Ticket's Authenticity is Ensured through a MAC**

What security measures are applied to the authentication ticket depends on the `protection` setting in the `<forms>` element. The `protection` setting may be assigned to one of the following three values:

- `All` – the ticket is both encrypted and digitally signed (the default).
- `Encryption` – only encryption is applied – no MAC is generated.
- `None` – the ticket is neither encrypted nor digitally signed.
- `Validation` – a MAC is generated, but the ticket data is sent over the wire in plain-text.

Microsoft strongly recommends using the `All` setting.

# Setting the Validation and Decryption Keys

The encryption and hashing algorithms used by the forms authentication system to encrypt and validate the authentication ticket are customizable through the [<machineKey> element](#) in `Web.config`. Table 2 outlines the `<machineKey>` element's attributes and their possible values.

Attribute	Description
<code>decryption</code>	<p>Indicates the algorithm used for encryption. This attribute can have one of the following four values:</p> <ul style="list-style-type: none"><li>• <code>Auto</code> – the default; determines the algorithm based on the length of the <code>decryptionKey</code> attribute.</li><li>• <code>AES</code> – uses the <a href="#">Advanced Encryption Standard (AES)</a> algorithm.</li><li>• <code>DES</code> – uses the <a href="#">Data Encryption Standard (DES)</a>. <b>This algorithm is considered computationally weak and should not be used.</b></li><li>• <code>3DES</code> – uses the <a href="#">Triple DES</a> algorithm, which works by applying the DES algorithm three times.</li></ul>
<code>decryptionKey</code>	<p>The secret key used by the encryption algorithm. This value must either be a hexadecimal string of the appropriate length (based on the value in <code>decryption</code>), <code>AutoGenerate</code>, or either value appended with <code>,IsolateApps</code>. Adding <code>IsolateApps</code> instructs ASP.NET to use a unique value for each application. The default is <code>AutoGenerate,IsolateApps</code>.</p>
<code>validation</code>	<p>Indicates the algorithm used for validation. This attribute can have one of the following four values:</p> <ul style="list-style-type: none"><li>• <code>AES</code> – uses the <a href="#">Advanced Encryption Standard (AES)</a> algorithm.</li><li>• <code>MD5</code> – uses the <a href="#">Message-Digest 5 (MD5)</a> algorithm.</li><li>• <code>SHA1</code> – uses the <a href="#">SHA1</a> algorithm (the default).</li><li>• <code>3DES</code> – uses the <a href="#">Triple DES</a> algorithm.</li></ul>
<code>validationKey</code>	<p>The secret key used by the validation algorithm. This value must either be a hexadecimal string of the appropriate length (based on the value in <code>validation</code>), <code>AutoGenerate</code>, or either value appended with <code>,IsolateApps</code>. Adding <code>IsolateApps</code> instructs ASP.NET to use a unique value for each application. The default is <code>AutoGenerate,IsolateApps</code>.</p>

**Table 2: The `<machineKey>` Element Attributes**

A thorough discussion of these encryption and validation options, and the pros and cons of the various algorithms, is beyond the scope of this tutorial. For an in-depth look at these issues, including guidance on what encryption and validation algorithms to use, what key lengths to use, and how best to generate these keys, refer to *Professional ASP.NET 2.0 Security, Membership, and Role Management*.

By default, the keys used for encryption and validation are generated automatically for each application, and these keys are stored in the Local Security Authority (LSA). In short, the default settings guarantee unique keys on a web server-by-web server and application-by-application basis. Consequently, this default behavior will not work for the two following scenarios:

- **Web Farms** – in a [web farm](#) scenario, a single web application is hosted on multiple web servers for purposes of scalability and redundancy. Each incoming request is dispatched to a server in the farm, meaning that over the lifetime of a user's session, different servers may be used to handle his various requests. Consequently, each server must use the same encryption and validation keys so that the forms authentication ticket created, encrypted, and validated on one server can be decrypted and validated on a different server in the farm.
- **Cross Application Ticket Sharing** – a single web server may host multiple ASP.NET applications. If you need for these different applications to share a single forms authentication ticket, it is imperative that their encryption and validation keys match up.

When working in a web farm setting or sharing authentication tickets across applications on the same server, you will need to configure the `<machineKey>` element in the affected applications so that their `decryptionKey` and `validationKey` values match up.

While neither of the above scenarios applies to our sample application, we can still specify explicit `decryptionKey` and `validationKey` values and define the algorithms to be used. Add a `<machineKey>` setting to the `Web.config` file:

```
<configuration>
  <system.web>
    ... Some markup was removed for brevity ...

    <machineKey
      decryption="AES"
      validation="SHA1"

decryptionKey="1513F567EE75F7FB5AC0AC4D79E1D9F25430E3E2F1BCDD3370BCFC4E
FC97A541"
```

```
validationKey="32CBA563F26041EE5B5FE9581076C40618DCC1218F5F447634EDE862
4508A129"
    />
</system.web>
</configuration>
```

For more information check out [How To: Configure MachineKey in ASP.NET 2.0](#).

**Note:** The `decryptionKey` and `validationKey` values were taken from [Steve Gibson's Perfect Passwords web page](#), which generates 64 random hexadecimal characters on each page visit. To lessen the likelihood of these keys making their way into your production applications, you are encouraged to replace the above keys with randomly generated ones from the Perfect Passwords page.

## Step 4: Storing Additional User Data in the Ticket

Many web applications display information about or base the page's display on the currently logged on user. For example, a web page might show the user's name and the date she last logged on in the upper corner of every page. The forms authentication ticket stores the currently logged on user's username, but when any other information is needed, the page must go to the user store – typically a database – to lookup the information not stored in the authentication ticket.

With a little bit of code we can store additional user information in the forms authentication ticket. Such data can be expressed through the [FormsAuthenticationTicket class's UserData property](#). This is a useful place to put small amounts of information about the user that is commonly needed. The value specified in the `UserData` property is included as part of the authentication ticket cookie and, like the other ticket fields, is encrypted and validated based on the forms authentication system's configuration. By default, `UserData` is an empty string.

In order to store user data in the authentication ticket, we need to write a bit of code in the login page that grabs the user-specific information and stores it in the ticket. Since `UserData` is a property of type `String`, the data stored in it must be properly serialized as a string. For example, imagine that our user store included each user's date of birth and the name of their employer, and we wanted to store these two property values in the authentication ticket. We could serialize these values into a string by concatenating the user's date of birth's string with a pipe ("`|`"), followed by the employer name. For a user born on August 15, 1974 that works for Northwind Traders, we would assign the `UserData` property the string: "1974-08-15|Northwind Traders".

Whenever we need to access the data stored in the ticket, we can do so by grabbing the current request's `FormsAuthenticationTicket` and deserializing the `UserData` property. In the case of the date of birth and employer name example, we would split the `UserData` string into two substrings based on the delimiter ("|").

The authentication ticket contains various bits of information, such as the username, the issue and expiry dates, and the `UserData`, among others. `UserData` is simply a string, so we need to serialize the information into a single string.

The following examples show authentication tickets for Scott, Jisun, and Sam, who work at Northwind Traders, Adventure Works, and Contoso, respectively. Scott is a Janitor, Jisun a scientist, and Sam a mascot.

**Auth Ticket**

**Name:** Scott  
**IssueDate:** November 15, 2007 1:45 PM  
**ExpireDate:** November 15, 2007 2:15 PM  
**IsPersistent:** True  
...  
**UserData:** Northwind Traders|Janitor

**Auth Ticket**

**Name:** Jisun  
**IssueDate:** November 16, 2007 3:05 PM  
**ExpireDate:** November 16, 2007 3:35 PM  
**IsPersistent:** True  
...  
**UserData:** Adventure Works|Scientist

**Auth Ticket**

**Name:** Sam  
**IssueDate:** November 25, 2007 6:33 AM  
**ExpireDate:** November 25, 2007 7:03 AM  
**IsPersistent:** True  
...  
**UserData:** Contoso|Mascot

**Figure 4: Additional User Information Can Be Stored in the Authentication Ticket**

## Writing Information to `UserData`

Unfortunately, adding user-specific information to a forms authentication ticket is not as straightforward as one might expect. The `UserData` property of the `FormsAuthenticationTicket` class is read-only and can only be specified through the `FormsAuthenticationTicket` class constructor. When specifying the `UserData` property in the constructor, we also need to provide the ticket's other values: the username, the issue date, the expiration, and so on. When we created the login page in the preceding tutorial, this was all handled for us by the `FormsAuthentication` class. When adding `UserData` to the `FormsAuthenticationTicket`, we will need to write code to replicate much of the functionality already provided by the `FormsAuthentication` class.

Let's explore the necessary code for working with `UserData` by updating the `Login.aspx` page to record additional information about the user to the authentication ticket. Pretend that our user store contains information about the company the user works for and their title, and that we want to capture this information in the authentication ticket. Update the `Login.aspx` page's `LoginButton` `Click` event handler so that the code looks like the following:

```
Protected Sub LoginButton_Click(ByVal sender As Object, ByVal e As
System.EventArgs) Handles LoginButton.Click
    ' Three valid username/password pairs: Scott/password,
    Jisun/password, and Sam/password.
    Dim users() As String = {"Scott", "Jisun", "Sam"}
    Dim passwords() As String = {"password", "password", "password"}
    Dim companyName() As String = {"Northwind Traders", "Adventure
Works", "Contoso"}
    Dim titleAtCompany() As String = {"Janitor", "Scientist", "Mascot"}

    For i As Integer = 0 To users.Length - 1
        Dim validUsername As Boolean = (String.Compare(Username.Text,
users(i), True) = 0)
        Dim validPassword As Boolean = (String.Compare>Password.Text,
passwords(i), False) = 0)

        If validUsername AndAlso validPassword Then
            ' Query the user store to get this user's User Data
            Dim userDataString As String =
String.Concat(companyName(i), "|", titleAtCompany(i))

            ' Create the cookie that contains the forms authentication
ticket
            Dim authCookie As HttpCookie =
FormsAuthentication.GetAuthCookie(Username.Text, RememberMe.Checked)

            ' Get the FormsAuthenticationTicket out of the encrypted
cookie
            Dim ticket As FormsAuthenticationTicket =
FormsAuthentication.Decrypt(authCookie.Value)

            ' Create a new FormsAuthenticationTicket that includes our
custom User Data
            Dim newTicket As FormsAuthenticationTicket = New
FormsAuthenticationTicket(ticket.Version, ticket.Name,
```

```

ticket.IssueDate, ticket.Expiration, ticket.IsPersistent,
userDataString)

        ' Update the authCookie's Value to use the encrypted
version of newTicket
        authCookie.Value = FormsAuthentication.Encrypt(newTicket)

        ' Manually add the authCookie to the Cookies collection
Response.Cookies.Add(authCookie)

        ' Determine redirect URL and send user there
        Dim redirectUrl As String =
FormsAuthentication.GetRedirectUrl(UserName.Text, RememberMe.Checked)
        Response.Redirect(redirectUrl)
    End If
Next

    ' If we reach here, the user's credentials were invalid
InvalidCredentialsMessage.Visible = True
End Sub

```

Let's step through this code one line at a time. The method starts by defining four string arrays: `users`, `passwords`, `companyName`, and `titleAtCompany`. These arrays hold the usernames, passwords, company names, and titles for the user accounts in the system, of which there are three: Scott, Jisun, and Sam. In a real application, these values would be queried from the user store, not hard-coded in the page's source code.

In the previous tutorial, if the supplied credentials were valid we simply called `FormsAuthentication.RedirectFromLoginPage(UserName.Text, RememberMe.Checked)`, which performed the following steps:

1. Created the forms authentication ticket
2. Wrote the ticket to the appropriate store. For cookies-based authentication tickets, the browser's cookies collection is used; for cookieless authentication tickets, the ticket data is serialized into the URL
3. Redirected the user to the appropriate page

These steps are replicated in the code above. First, the string we will eventually store in the `UserData` property is formed by combining the company name and the title, delimiting the two values with a pipe character (`"|"`).

```
Dim userDataString As String = String.Concat(companyName(i), "|",  
titleAtCompany(i))
```

Next, the `FormsAuthentication.GetAuthCookie` method is invoked, which creates the authentication ticket, encrypts and validates it according to the configuration settings, and places it in an `HttpCookie` object.

```
Dim authCookie As HttpCookie =  
FormsAuthentication.GetAuthCookie(UserName.Text, RememberMe.Checked)
```

In order to work with the `FormAuthenticationTicket` embedded within the cookie, we need to call the `FormAuthentication` class's [Decrypt method](#), passing in the cookie value.

```
Dim ticket As FormsAuthenticationTicket =  
FormsAuthentication.Decrypt(authCookie.Value)
```

We then create a *new* `FormsAuthenticationTicket` instance based on the existing `FormsAuthenticationTicket`'s values. However, this new ticket includes the user-specific information (`userDataString`).

```
Dim newTicket As FormsAuthenticationTicket = New  
FormsAuthenticationTicket(ticket.Version, ticket.Name,  
ticket.IssueDate, ticket.Expiration, ticket.IsPersistent,  
userDataString)
```

We then encrypt (and validate) the new `FormsAuthenticationTicket` instance by calling the [Encrypt method](#), and put this encrypted (and validated) data back into `authCookie`.

```
authCookie.Value = FormsAuthentication.Encrypt(newTicket)
```

Finally, `authCookie` is added to the `Response.Cookies` collection and the `GetRedirectUrl` method is called to determine the appropriate page to send the user.

```
Response.Cookies.Add(authCookie)
```

```
Dim redirUrl As String =  
FormsAuthentication.GetRedirectUrl(UserName.Text, RememberMe.Checked)  
Response.Redirect(redirUrl)
```

All of this code is needed because the `UserData` property is read-only and the `FormsAuthentication` class does not provide any methods for specifying `UserData` information in its `GetAuthCookie`, `SetAuthCookie`, or `RedirectFromLoginPage` methods.

**Note:** The code we just examined stores user-specific information in a cookies-based authentication ticket. The classes responsible for serializing the forms authentication ticket to the URL are internal to the .NET Framework. Long story short, you cannot store user data in a cookieless forms authentication ticket.

## Accessing the UserData Information

At this point each user's company name and title is stored in the forms authentication ticket's `UserData` property when they log in. This information can be accessed from the authentication ticket on any page without requiring a trip to the user store. To illustrate how this information can be retrieved from the `UserData` property, let's update `Default.aspx` so that its welcome message includes not only the user's name, but also the company they work for and their title.

Currently, `Default.aspx` contains an `AuthenticatedMessagePanel` Panel with a Label control named `WelcomeBackMessage`. This Panel is only displayed to authenticated users. Update the code in `Default.aspx`'s `Page_Load` event handler so that it looks like the following:

```
Protected Sub Page_Load(ByVal sender As Object, ByVal e As
System.EventArgs) Handles Me.Load
    If Request.IsAuthenticated Then
        WelcomeBackMessage.Text = "Welcome back, " & User.Identity.Name
        & "!"

        ' Get User Data from FormsAuthenticationTicket and show it in
WelcomeBackMessage
        Dim ident As FormsIdentity = CType(User.Identity,
FormsIdentity)
        If ident IsNot Nothing Then
            Dim ticket As FormsAuthenticationTicket = ident.Ticket
            Dim userDataString As String = ticket.UserData

            ' Split on the |
            Dim userDataPieces() As String =
userDataString.Split("|".ToCharArray())
            Dim companyName As String = userDataPieces(0)
```

```

        Dim titleAtCompany As String = userDataPieces(1)

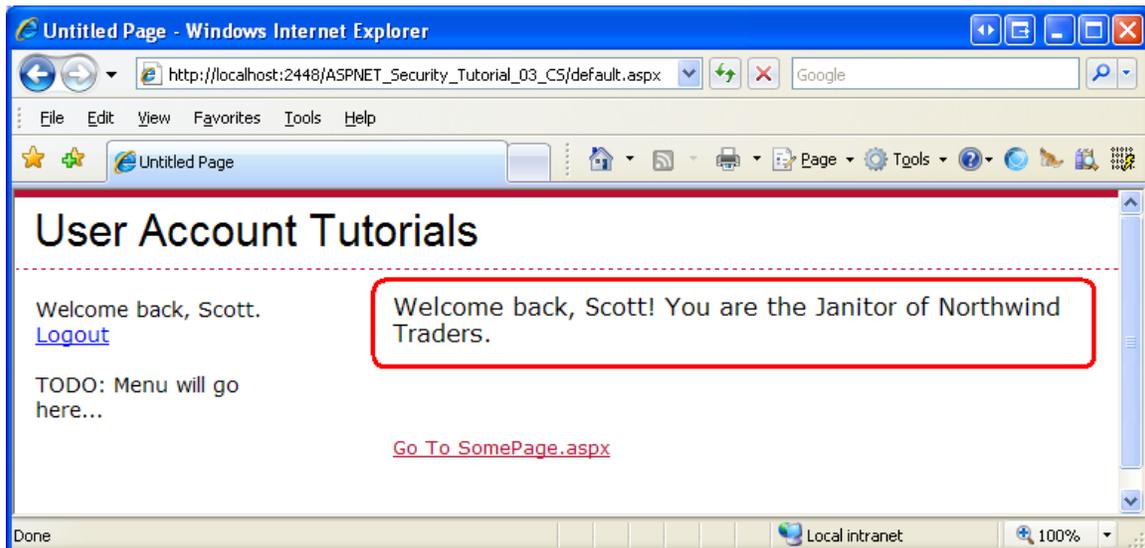
        WelcomeBackMessage.Text &= String.Format(" You are the {0}
of {1}.", titleAtCompany, companyName)
    End If

    AuthenticatedMessagePanel.Visible = True
    AnonymousMessagePanel.Visible = False
Else
    AuthenticatedMessagePanel.Visible = False
    AnonymousMessagePanel.Visible = True
End If
End Sub

```

If `Request.IsAuthenticated` is `True`, then the `WelcomeBackMessage`'s `Text` property is first set to "Welcome back, *username*." Then, the `User.Identity` property is cast to a `FormsIdentity` object so that we can access the underlying `FormsAuthenticationTicket`. Once we have the `FormsAuthenticationTicket`, we deserialize the `UserData` property into the company name and title. This is accomplished by splitting the string on the pipe character. The company name and title are then displayed in the `WelcomeBackMessage` Label.

Figure 5 shows a screenshot of this display in action. Logging in as Scott displays a welcome back message that includes Scott's company and title.



**Figure 5: The Currently Logged On User's Company and Title are Displayed**

**Note:** The authentication ticket's `UserData` property serves as a cache for the user store. Like any cache, it needs to be updated when the underlying data is modified. For example, if there is a web page from which users can update their profile, the fields cached in the `UserData` property must be refreshed to reflect the changes made by the user.

## Step 5: Using a Custom Principal

On each incoming request the `FormsAuthenticationModule` attempts to authenticate the user. If a non-expired authentication ticket is present, the `FormsAuthenticationModule` assigns the `HttpContext.User` property to a new `GenericPrincipal` object. This `GenericPrincipal` object has an `Identity` of type `FormsIdentity`, which includes a reference to the forms authentication ticket. The `GenericPrincipal` class contains the bare minimum functionality needed by a class that implements `IPrincipal` – it just has an `Identity` property and an `IsInRole` method.

The principal object has two responsibilities: to indicate what roles the user belongs to and to provide identity information. This is accomplished through the `IPrincipal` interface's `IsInRole(roleName)` method and `Identity` property, respectively. The `GenericPrincipal` class allows for a string array of role names to be specified via its constructor; its `IsInRole(roleName)` method merely checks to see if the passed in *roleName* exists within the string array. When the `FormsAuthenticationModule` creates the `GenericPrincipal`, it passes in an empty string array to the `GenericPrincipal`'s constructor. Consequently, any call to `IsInRole` will always return `False`.

The `GenericPrincipal` class meets the needs for most forms based authentication scenarios where roles are not used. For those situations where the default role handling is insufficient or when you need to associate a custom `IIIdentity` object with the user, you can create a custom `IPrincipal` object during the authentication workflow and assign it to the `HttpContext.User` property.

**Note:** As we will see in future tutorials, when ASP.NET's Roles framework is enabled it creates a custom principal object of type [RolePrincipal](#) and overwrites the forms authentication-created `GenericPrincipal` object. It does this in order to customize the principal's `IsInRole` method to interface with the Roles framework's API.

Since we have not concerned ourselves with roles yet, the only reason we would have for creating a custom principal at this juncture would be to associate a custom `IIIdentity` object to the principal. In Step 4 we looked at storing additional user information in the authentication ticket's `UserData` property, in particular the user's company name and their title. However, the `UserData` information is only accessible through the authentication ticket and only then as a serialized string, meaning that

anytime we want to view the user information stored in the ticket we need to parse the `UserData` property.

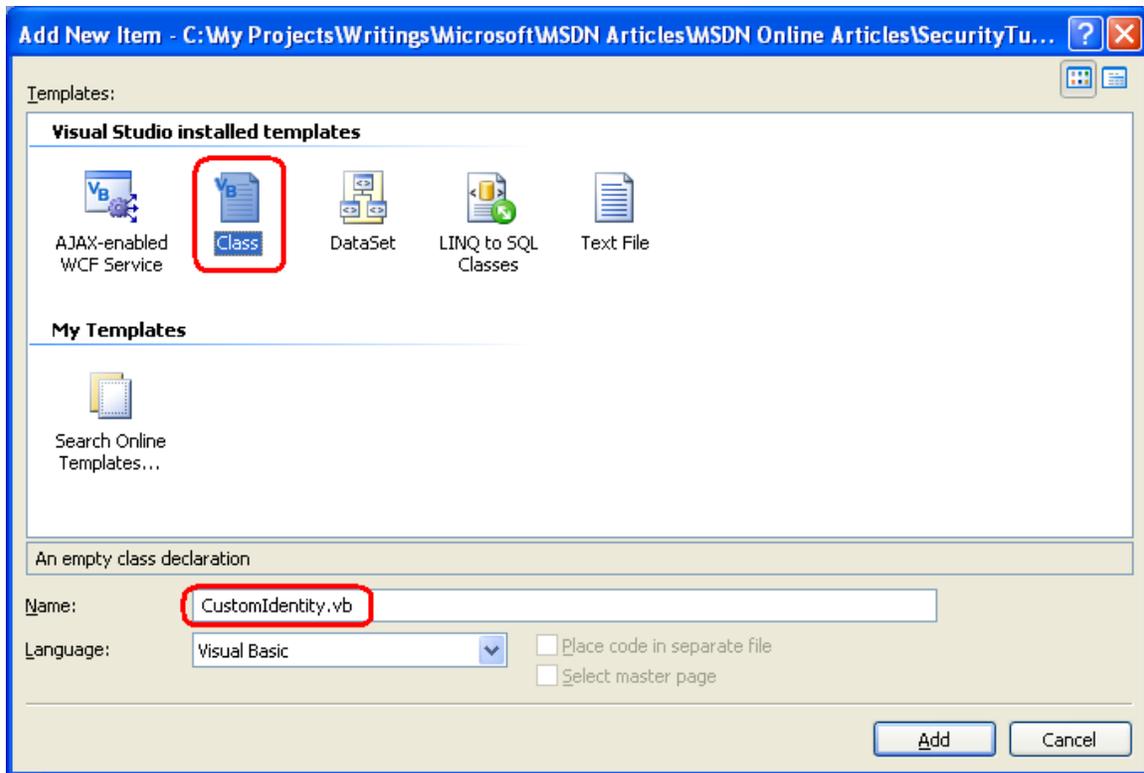
We can improve the developer experience by creating a class that implements `IIdentity` and includes `CompanyName` and `Title` properties. That way, a developer can access the currently logged on user's company name and title directly through the `CompanyName` and `Title` properties without needed to know how to parse the `UserData` property.

## Creating the Custom Identity and Principal Classes

For this tutorial, let's create the custom principal and identity objects in the `App_Code` folder. Start by adding an `App_Code` folder to your project – right-click on the project name in Solution Explorer, select the Add ASP.NET Folder option, and choose `App_Code`. The `App_Code` folder is a special ASP.NET folder that holds class files specific to the website.

**Note:** The `App_Code` folder should only be used when managing your project through the Website Project Model. If you are using the [Web Application Project Model](#), create a standard folder and add the classes to that. For example, you could add a new folder named `Classes`, and place your code there.

Next, add two new class files to the `App_Code` folder, one named `CustomIdentity.vb` and one named `CustomPrincipal.vb`.



**Figure 6: Add the CustomIdentity and CustomPrincipal Classes to Your Project**

The `CustomIdentity` class is responsible for implementing the `IIdentity` interface, which defines the `AuthenticationType`, `IsAuthenticated`, and `Name` properties. In addition to those required properties, we are interested in exposing the underlying forms authentication ticket as well as properties for the user's company name and title. Enter the following code into the `CustomIdentity` class.

```
Imports Microsoft.VisualBasic
```

```
Public Class CustomIdentity
```

```
    Implements System.Security.Principal.IIdentity
```

```
    Private _ticket As FormsAuthenticationTicket
```

```
    Public Sub New (ByVal ticket As FormsAuthenticationTicket)
```

```
        _ticket = ticket
```

```
    End Sub
```

```
    Public ReadOnly Property AuthenticationType () As String Implements  
System.Security.Principal.IIdentity.AuthenticationType
```

```

        Get
            Return "Custom"
        End Get
    End Property

    Public ReadOnly Property IsAuthenticated() As Boolean Implements
System.Security.Principal.IIdentity.IsAuthenticated
        Get
            Return True
        End Get
    End Property

    Public ReadOnly Property Name() As String Implements
System.Security.Principal.IIdentity.Name
        Get
            Return _ticket.Name
        End Get
    End Property

    Public ReadOnly Property Ticket() As FormsAuthenticationTicket
        Get
            Return _ticket
        End Get
    End Property

    Public ReadOnly Property CompanyName() As String
        Get
            Dim userDataPieces() As String =
_ticket.UserData.Split("|".ToCharArray())
            Return userDataPieces(0)
        End Get
    End Property

    Public ReadOnly Property Title() As String
        Get
            Dim userDataPieces() As String =
_ticket.UserData.Split("|".ToCharArray())
            Return userDataPieces(1)
        End Get
    End Property
End Class

```

Note that the class includes a `FormsAuthenticationTicket` member variable (`_ticket`) and that this ticket information must be supplied through the constructor. This ticket data is used in returning the identity's `Name`; its `UserData` property is parsed to return the values for the `CompanyName` and `Title` properties.

Next, create the `CustomPrincipal` class. Since we are not concerned with roles at this juncture, the `CustomPrincipal` class's constructor accepts only a `CustomIdentity` object; its `IsInRole` method always returns `False`.

```
Imports Microsoft.VisualBasic
```

```
Public Class CustomPrincipal
```

```
    Implements System.Security.Principal.IPrincipal
```

```
    Private _identity As CustomIdentity
```

```
    Public Sub New(ByVal identity As CustomIdentity)
```

```
        _identity = identity
```

```
    End Sub
```

```
    Public ReadOnly Property Identity() As  
System.Security.Principal.IIdentity Implements  
System.Security.Principal.IPrincipal.Identity
```

```
        Get
```

```
            Return _identity
```

```
        End Get
```

```
    End Property
```

```
    Public Function IsInRole(ByVal role As String) As Boolean  
Implements System.Security.Principal.IPrincipal.IsInRole
```

```
        Return False
```

```
    End Function
```

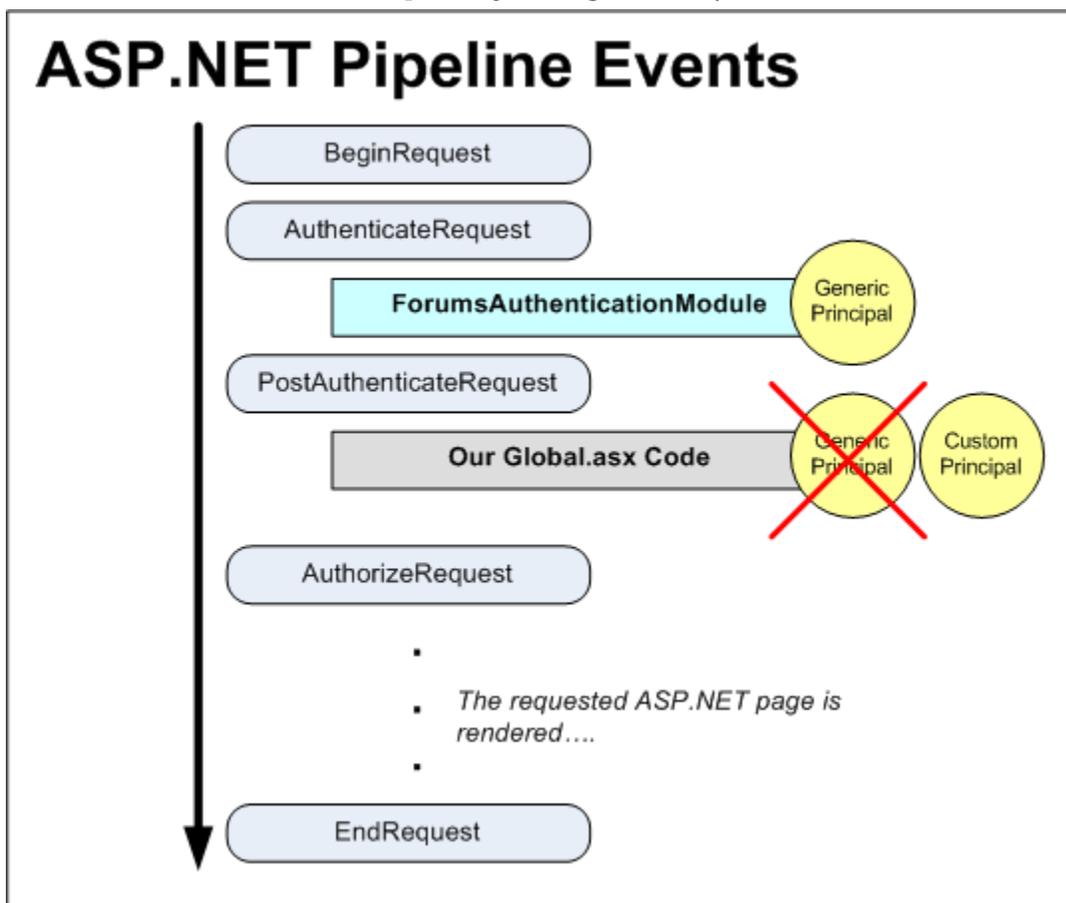
```
End Class
```

## Assigning a CustomPrincipal Object to the Incoming Request's Security Context

We now have a class that extends the default `IIdentity` specification to include `CompanyName` and `Title` properties, as well as a custom principal class that uses the custom identity. We are ready to step into the ASP.NET pipeline and assign our custom principal object to the incoming request's security context.

The ASP.NET pipeline takes an incoming request and processes it through a number of steps. At each step, a particular event is raised, making it possible for developers to tap into the ASP.NET pipeline and modify the request at certain points in its lifecycle. The `FormsAuthenticationModule`, for example, waits for ASP.NET to raise the [AuthenticateRequest event](#), at which point it inspects the incoming request for an authentication ticket. If an authentication ticket is found, a `GenericPrincipal` object is created and assigned to the `HttpContext.User` property.

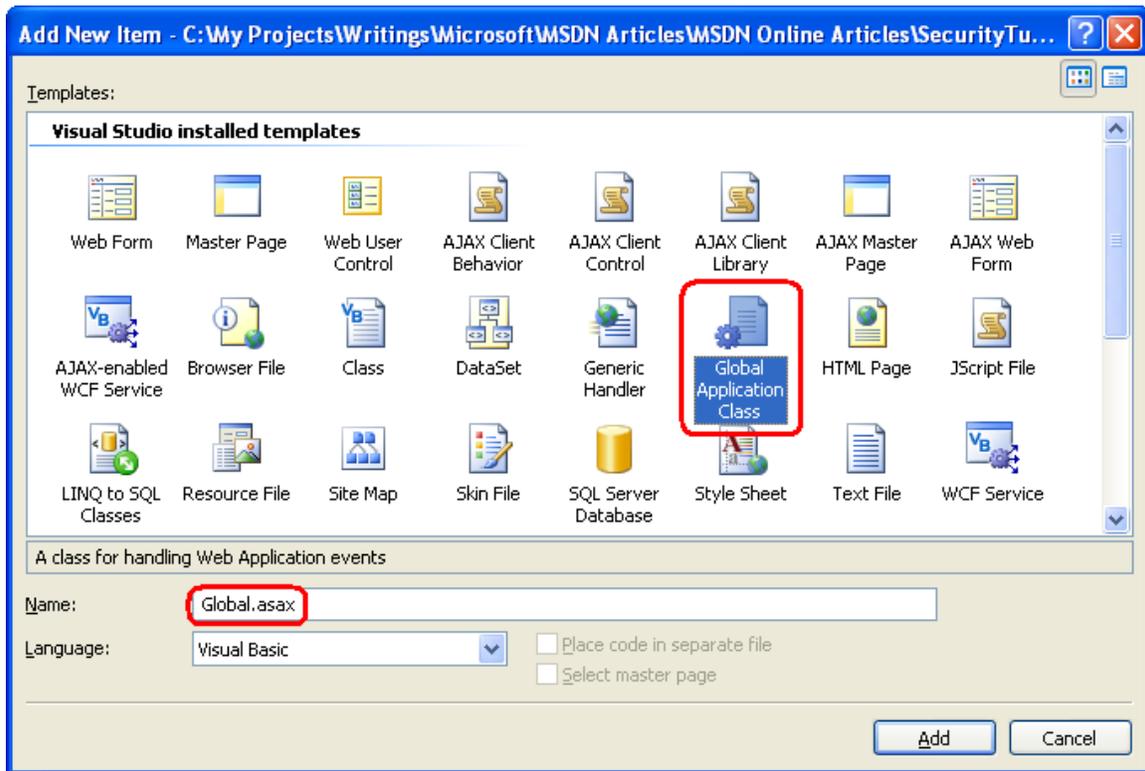
After the `AuthenticateRequest` event, the ASP.NET pipeline raises the [PostAuthenticateRequest event](#), which is where we can replace the `GenericPrincipal` object created by the `FormsAuthenticationModule` with an instance of our `CustomPrincipal` object. Figure 7 depicts this workflow.



**Figure 7: The `GenericPrincipal` is Replaced by a `CustomPrincipal` in the `PostAuthenticateRequest` Event**

In order to execute code in response to an ASP.NET pipeline event, we can either create the appropriate event handler in `Global.asax` or create our own HTTP Module. For this tutorial let's create the event handler in `Global.asax`. Start by

adding `Global.asax` to your website. Right-click on the project name in Solution Explorer and add an item of type Global Application Class named `Global.asax`.



**Figure 8: Add a Global.asax File to Your Website**

The default `Global.asax` template includes event handlers for a number of the ASP.NET pipeline events, including the `Start`, `End` and [Error event](#), among others. Feel free to remove these event handlers, as we do not need them for this application. The event we are interested in is `PostAuthenticateRequest`. Update your `Global.asax` file so its markup looks similar to the following:

```
<%@ Application Language="VB" %>
<%@ Import Namespace="System.Security.Principal" %>
<%@ Import Namespace="System.Threading" %>

<script runat="server">

    Sub Application_OnPostAuthenticateRequest(ByVal sender As Object,
ByVal e As EventArgs)
        ' Get a reference to the current User
        Dim usr As IPrincipal = HttpContext.Current.User
```

```

    ' If we are dealing with an authenticated forms authentication
request
    If usr.Identity.IsAuthenticated AndAlso
usr.Identity.AuthenticationType = "Forms" Then
        Dim fIdent As FormsIdentity = CType(usr.Identity,
FormsIdentity)

        ' Create a CustomIdentity based on the
FormsAuthenticationTicket
        Dim ci As New CustomIdentity(fIdent.Ticket)

        ' Create the CustomPrincipal
        Dim p As New CustomPrincipal(ci)

        ' Attach the CustomPrincipal to HttpContext.User and
Thread.CurrentPrincipal
        HttpContext.Current.User = p
        Thread.CurrentPrincipal = p
    End If
End Sub

</script>

```

The `Application_OnPostAuthenticateRequest` method executes each time the ASP.NET runtime raises the `PostAuthenticateRequest` event, which happens once on each incoming page request. The event handler starts by checking to see if the user is authenticated and was authenticated via forms authentication. If so, a new `CustomIdentity` object is created and passed the current request's authentication ticket in its constructor. Following that, a `CustomPrincipal` object is created and passed the just-created `CustomIdentity` object in its constructor. Finally, the current request's security context is assigned to the newly created `CustomPrincipal` object.

Note that the last step – associating the `CustomPrincipal` object with the request's security context – assigns the principal to two properties: `HttpContext.User` and `Thread.CurrentPrincipal`. These two assignments are necessary because of the way security contexts are handled in ASP.NET. The .NET Framework associates a security context with each running thread; this information is available as an `IPrincipal` object through the [Thread object's CurrentPrincipal property](#). What is a confusing is that ASP.NET has its own security context information (`HttpContext.User`).

In certain scenarios, the `Thread.CurrentPrincipal` property is examined when determining the security context; in other scenarios, `HttpContext.User` is used. For example, there are security features in .NET that allow developers to declaratively

state what users or roles can instantiate a class or invoke specific methods (see [Adding Authorization Rules to Business and Data Layers Using PrincipalPermissionAttributes](#)). Underneath the covers, these declarative techniques determine the security context via the `Thread.CurrentPrincipal` property.

In other scenarios, the `HttpContext.User` property is used. For example, in the previous tutorial we used this property to display the currently logged on user's username. Clearly, then, it is imperative that the security context information in the `Thread.CurrentPrincipal` and `HttpContext.User` properties match up.

The ASP.NET runtime automatically syncs these property values for us. However, this synchronization occurs after the `AuthenticateRequest` event, but *before* the `PostAuthenticateRequest` event. Consequently, when adding a custom principal in the `PostAuthenticateRequest` event we need to be certain to manually assign the `Thread.CurrentPrincipal` or else `Thread.CurrentPrincipal` and `HttpContext.User` will be out of sync. See [Context.User VS. Thread.CurrentPrincipal](#) for a more detailed discussion on this issue.

## Accessing the `CompanyName` and `Title` Properties

Whenever a request arrives and is dispatched to the ASP.NET engine, the `Application_OnPostAuthenticateRequest` event handler in `Global.asax` will fire. If the request has been successfully authenticated by the `FormsAuthenticationModule`, the event handler will create a new `CustomPrincipal` object with a `CustomIdentity` object based on the forms authentication ticket. With this logic in place, accessing information about the currently logged on user's company name and title is incredibly straightforward.

Return to the `Page_Load` event handler in `Default.aspx`, where in Step 4 we wrote code to retrieve the form authentication ticket and parse the `UserData` property in order to display the user's company name and title. With the `CustomPrincipal` and `CustomIdentity` objects in use now, there's no need to parse the values out of the ticket's `UserData` property. Instead, simply get a reference to the `CustomIdentity` object and use its `CompanyName` and `Title` properties:

```
Dim ident As CustomIdentity = CType(User.Identity, CustomIdentity)
If ident IsNot Nothing Then
    WelcomeBackMessage.Text &= String.Format(" You are the {0} of {1}.", ident.Title, ident.CompanyName)
End If
```

## Summary

In this tutorial we examined how to customize the forms authentication system's settings via `Web.config`. We looked at how the authentication ticket's expiration is handled and how the encryption and validation safeguards are used to protect the ticket from inspection and modification. Finally, we discussed using the authentication ticket's `UserData` property to store additional user information in the ticket itself, and how to use custom principal and identity objects to expose this information in a more developer-friendly manner.

This tutorial concludes our examination of forms authentication in ASP.NET. The next tutorial starts our journey into the Membership framework.

Happy Programming!

## Further Reading

For more information on the topics discussed in this tutorial, refer to the following resources:

- [Dissecting Forms Authentication](#)
- [Explained: Forms Authentication in ASP.NET 2.0](#)
- [How To: Protect Forms Authentication in ASP.NET 2.0](#)
- [Professional ASP.NET 2.0 Security, Membership, and Role Management](#) (ISBN: 978-0-7645-9698-8)
- [Securing Login Controls](#)
- [The <authentication> Element](#)
- [The <forms> Element for <authentication>](#)
- [The <machineKey> Element](#)
- [Understanding the Forms Authentication Ticket and Cookie](#)

## About the Author

Scott Mitchell, author of multiple ASP/ASP.NET books and founder of 4GuysFromRolla.com, has been working with Microsoft Web technologies since 1998. Scott works as an independent consultant, trainer, and writer. His latest book is [Sams Teach Yourself ASP.NET 2.0 in 24 Hours](#). Scott can be reached at [mitchell@4guysfromrolla.com](mailto:mitchell@4guysfromrolla.com) or via his blog at <http://ScottOnWriting.NET>.

## Special Thanks To...

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