.NET Core: Developing Cross-Platform Web Apps with ASP.NET Core – Workshop*PLUS*

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v2.1

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  - On the ribbon, click the **View** tab, and then click **Notes Page**
- To navigate through notes, use the Page Up and Page Down keys
  - Zoom in or zoom out, if required
- In the **Notes Page** view, you can:
  - Read any supporting text
    - Terminology List—a list of terms used in this course is provided in the Notes section.
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Module 9: Security

Module Overview

Module 9: Security

Section 1: Security Fundamentals

Lesson: Overview

Security Principles

- Do not trust anything (including user input)
- Know the weakest link
- Multiple layers of security
- Least privilege
- Secure fallback when things go wrong
- Universally check access permissions
- Minimize shared information
- Do not depend on secrecy
- Keep it simple (KISS)

Identity

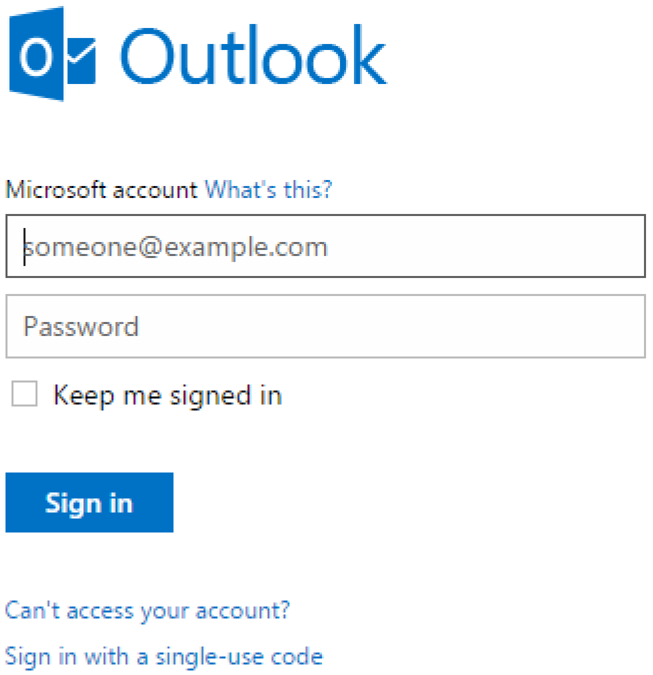
- How do we *represent* a user in our application?
- Typically: A collection of key : value pairs that describe a specific user
  - A pair is referred to as a **claim**
  - The collection of claims makes up an **Identity**
- Represented in code as a model we can create, store, and manipulate
- Can be unique to your app, or shared across apps (Single Sign On)

```
{
  “userID”: “83b6734e”,
  “username”: “SuzyQ”,
  “Name”: “Suzy”,
  “givenName”: “Q”,
  “premiumMember”: true
}
```

```
{
  “userID”: “ba35b637”,
  “username”: “JohnDoe”,
  “Name”: “John”,
  “givenName”: “Doe”,
  “premiumMember”: false
}
```

Authentication

- Verifying the users are who they say they are


Outlook

Microsoft account What's this?

someone@example.com

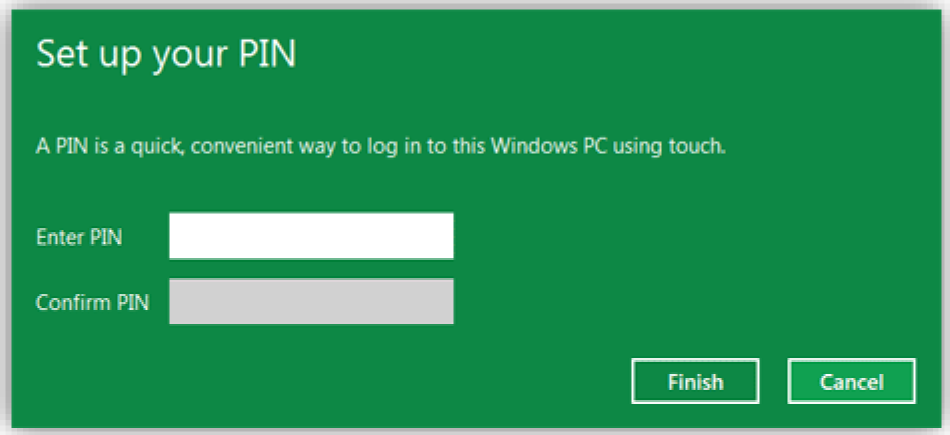
Password

Keep me signed in

Sign in

Can't access your account?

Sign in with a single-use code

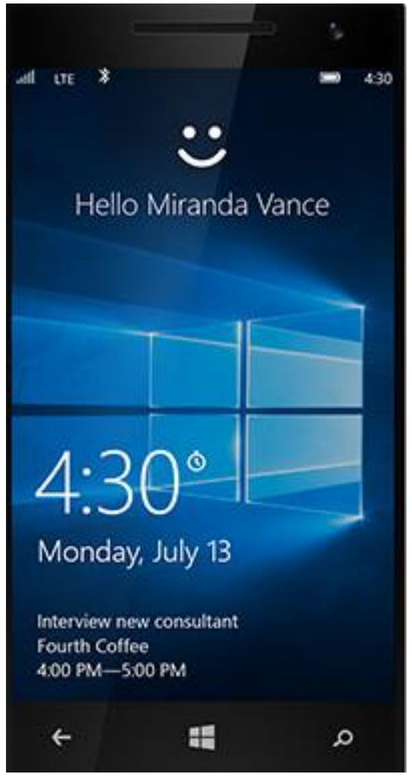

Set up your PIN

A PIN is a quick, convenient way to log in to this Windows PC using touch.

Enter PIN

Confirm PIN

Finish Cancel

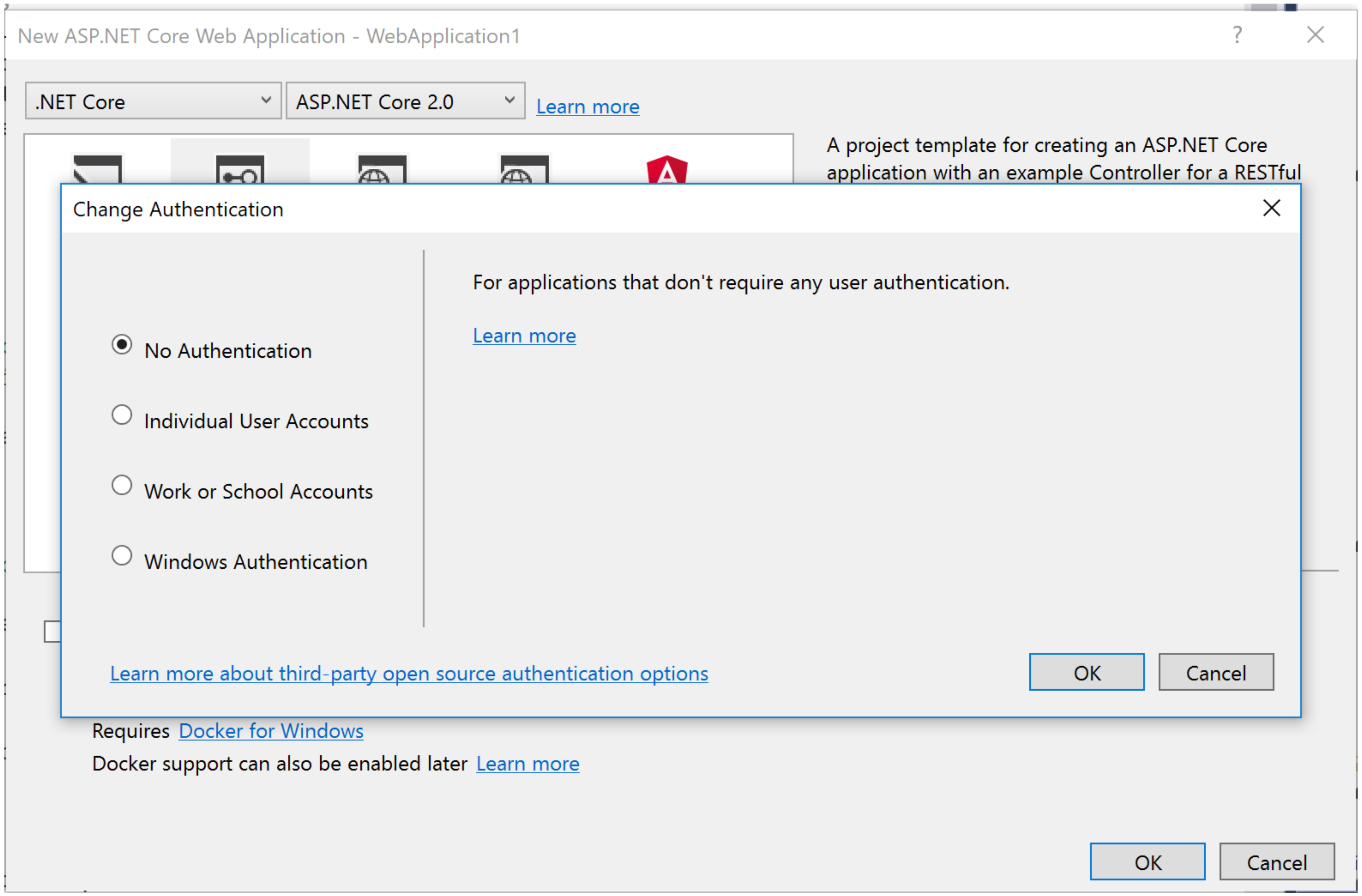

Hello Miranda Vance

4:30

Monday, July 13

Interview new consultant
Fourth Coffee
4:00 PM—5:00 PM

ASP.NET Core Template Authentication Methods



New ASP.NET Core Web Application - WebApplication1

.NET Core | ASP.NET Core 2.0 | Learn more

A project template for creating an ASP.NET Core application with an example Controller for a RESTful

Change Authentication

- [✓ No Authentication]
- Individual User Accounts
- Work or School Accounts
- Windows Authentication

For applications that don't require any user authentication.

Learn more

Learn more about third-party open source authentication options

OK | Cancel

Requires Docker for Windows

Docker support can also be enabled later Learn more

OK | Cancel

ASP.NET Core Template Authentication Methods

- No authentication
- Individual User Accounts
  - Store user accounts in-app (ASP.NET Identity)
  - Connect to an existing user store in the cloud (OpenID compliant Identity Provider)
    - e.g., Azure AD B2C
- Work or School Accounts
  - Active Directory
  - Azure Active Directory
  - Office 365
- Windows Authentication
  - Internet Information Services (IIS) Windows Authentication module

Authorization

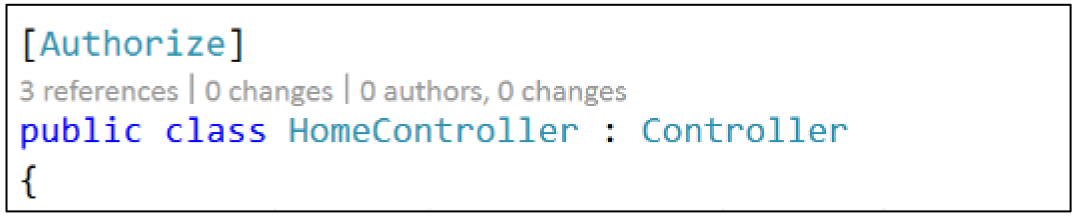
- What can a user *do*?
- Many strategies for approaching this important question:
    - Role-Based Authorization
    - Claims-Based Policy Authorization
    - Manual Custom Authorization

```
{
  “userID”: “83b6734e”,
  ...
  “role”: “SysAdmin”,
  “canEditForm”: true,
  “dob”: “1/1/1985”
}
```

```
{
  “userID”: “ba35b637”,
  ...
  “role”: “SDET2”,
  “canEditCode”: true,
  “dob”: “1/1/1970”
}
```

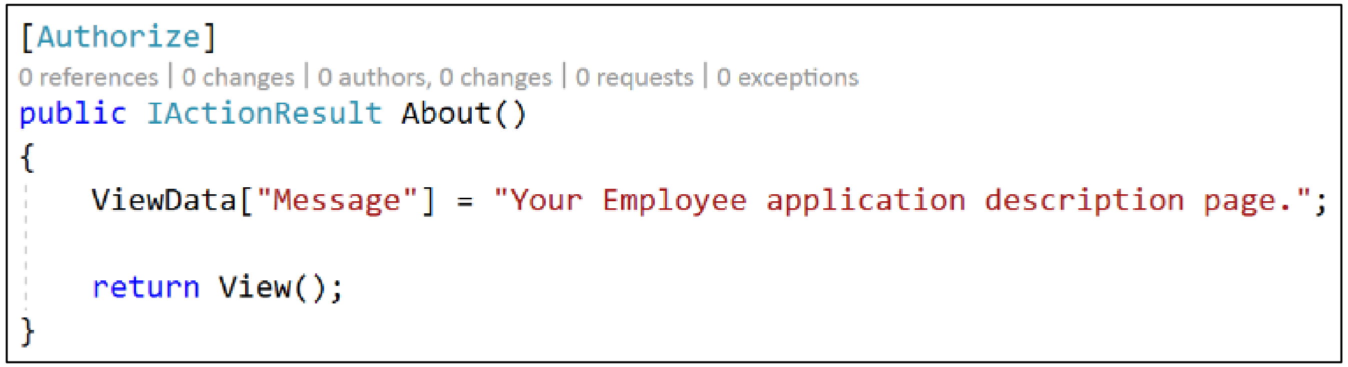
Authentication with [Authorize] Attribute

- `[Authorize]` attribute by itself is used to require an authenticated user
- `[Authorize]` attribute can be used to restrict access to:
  - Specific action methods in a controller
  - Controller ➔ every action method within the controller
- `[Authorize]` should be applied to each controller/action except login/register methods
  - Controller



```
[Authorize]
3 references | 0 changes | 0 authors, 0 changes
public class HomeController : Controller
{
```

  - Action



```
[Authorize]
0 references | 0 changes | 0 authors, 0 changes | 0 requests | 0 exceptions
public IActionResult About()
{
    ViewData["Message"] = "Your Employee application description page.";

    return View();
}
```

Demo: ASP.NET MVC Authentication

Module 9: Security

Section 2: ASP.NET Identity

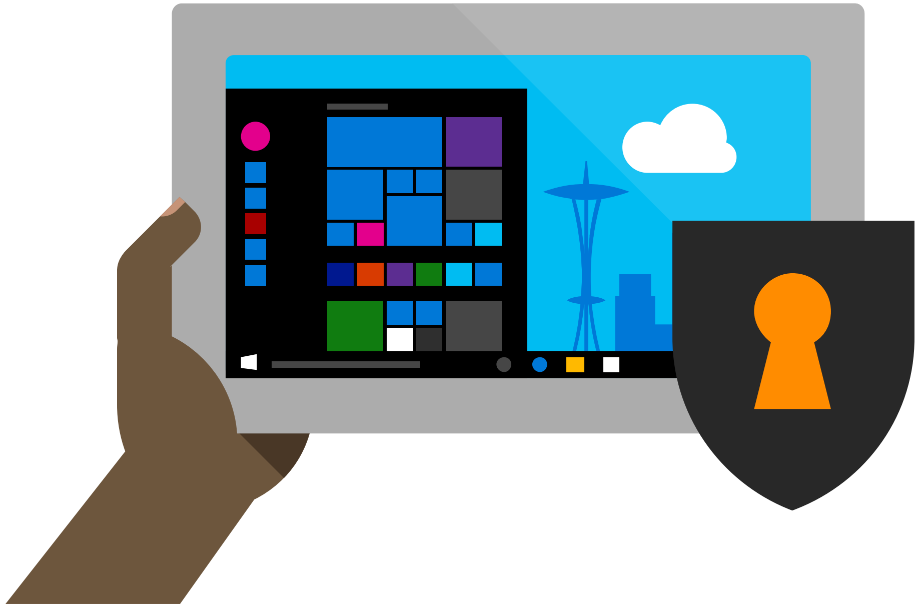
Lesson: Overview

ASP.NET Identity

Seamless and unified experience for enabling authentication in ASP.NET apps on-premises and in the cloud.

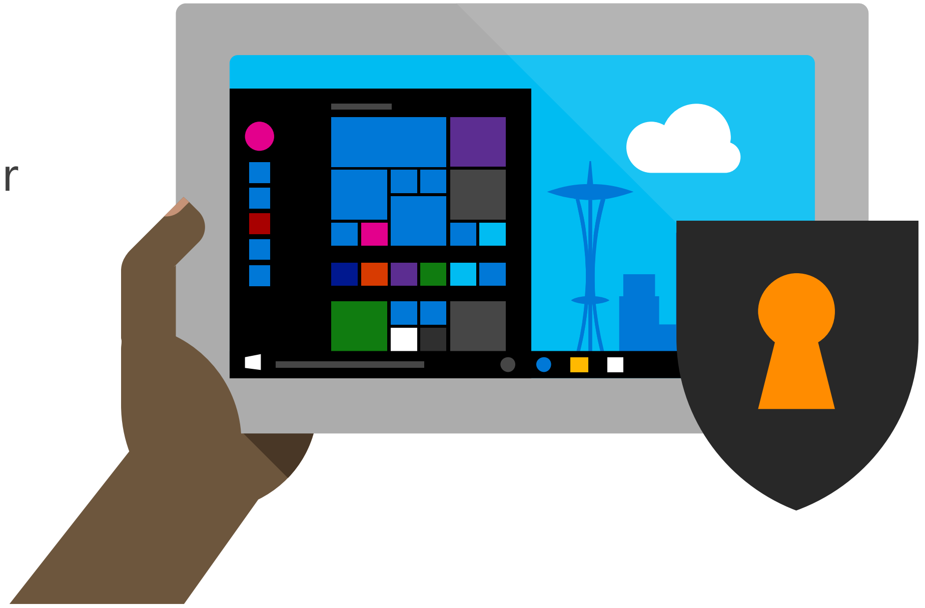
ASP.NET Identity

- **Easily pluggable user profile**
  - Complete control over the schema of user and profile information
- **Persistence control**
  - SQL Server (Default), Microsoft SharePoint, Azure Storage Table Service, NoSQL databases
- **Role Provider**
  - Role-based authorization
- **Claims-based Authentication**
  - Includes rich information about user's identity



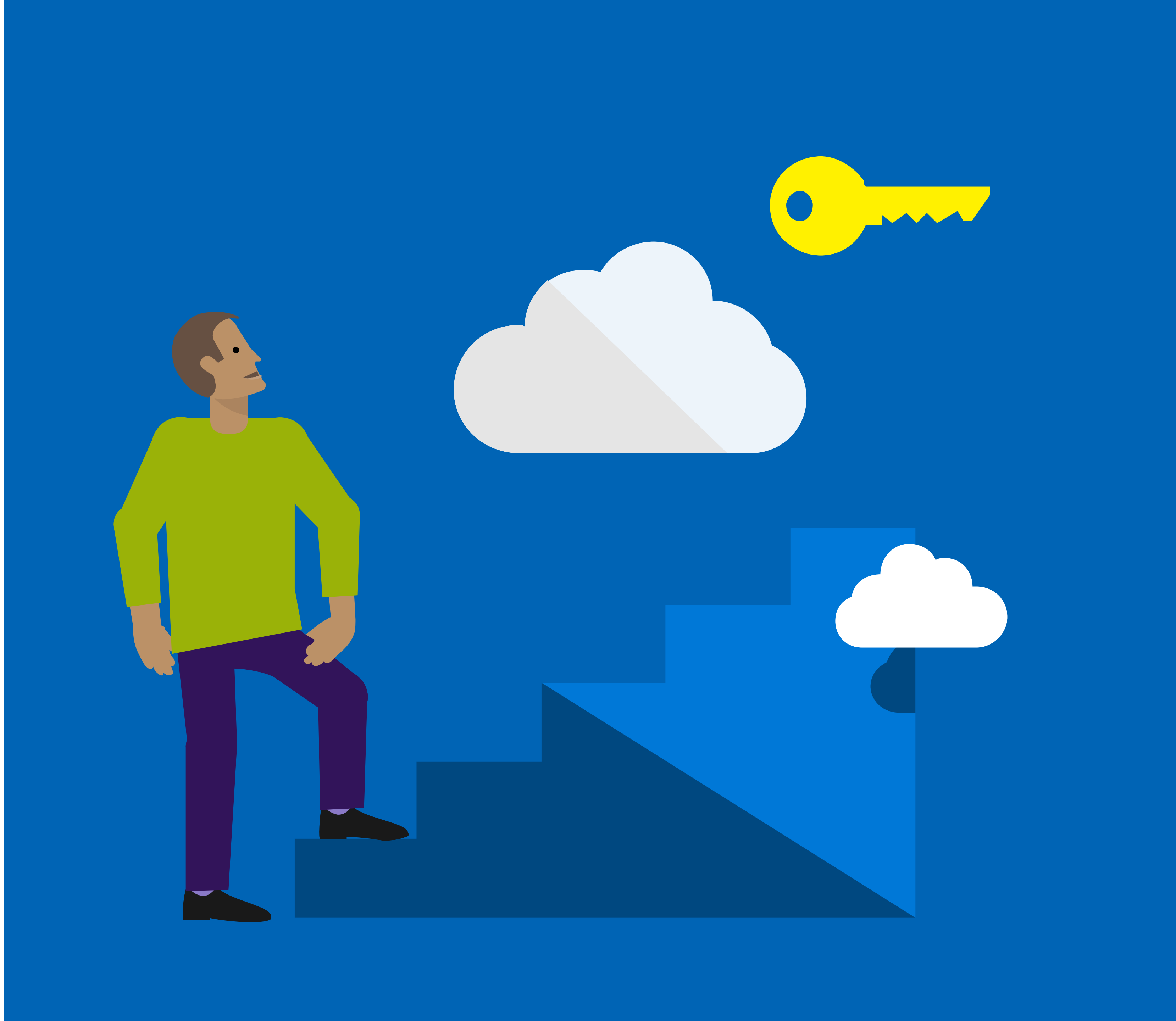
ASP.NET Identity

- **Unit Testability**
  - Authentication/authorization logic independently testable
- **Social Login Providers**
  - Microsoft account, Facebook, Google, Twitter, and others…
- **Azure AD**
  - Single and multi-organization support
- **Azure AD B2C**
  - Managed OAuth/OpenID compliant Identity provider
- **NuGet package**
  - Agility in release of new features and bug fixes

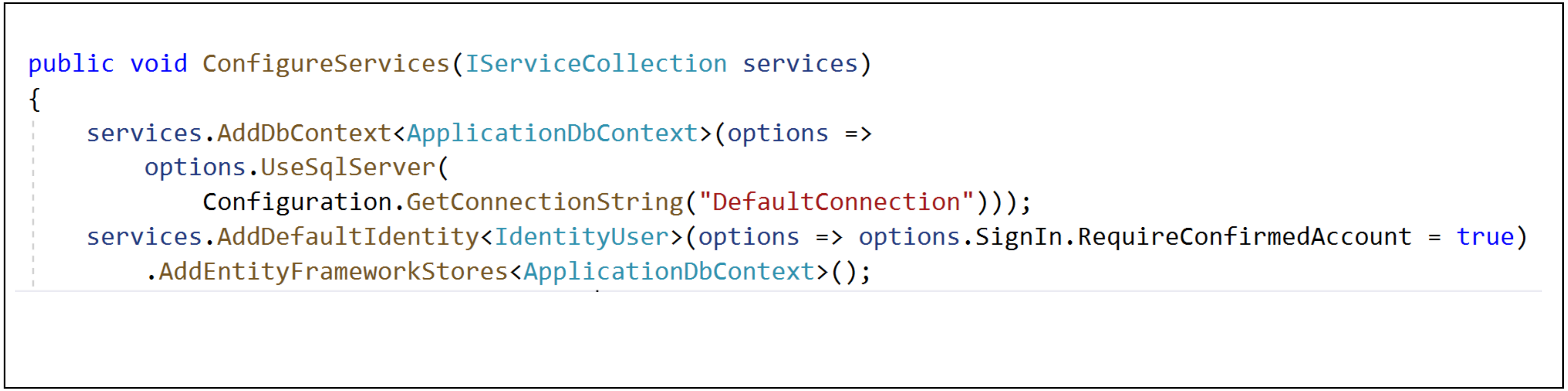


Features

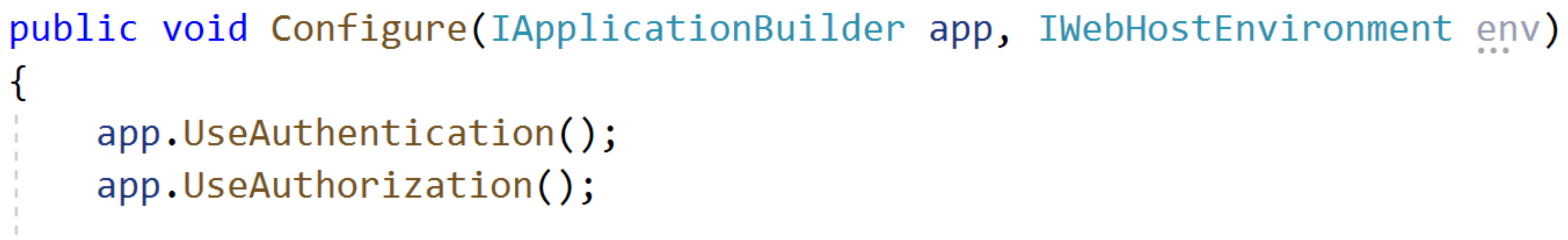
- Two-Factor authentication
- Email/phone verification
- Roles and Claims
- Profile
- User Management
- Role Management
- Password policy enforcement
- User password management
- Account lockout
- Extensibility



ASP.NET Identity Configuration



```
public void ConfigureServices(IServiceCollection services)
{
    services.AddDbContext<ApplicationDbContext>(options =>
        options.UseSqlServer(
            Configuration.GetConnectionString("DefaultConnection")));
    services.AddDefaultIdentity<IdentityUser>(options => options.SignIn.RequireConfirmedAccount = true)
        .AddEntityFrameworkStores<ApplicationDbContext>();
```



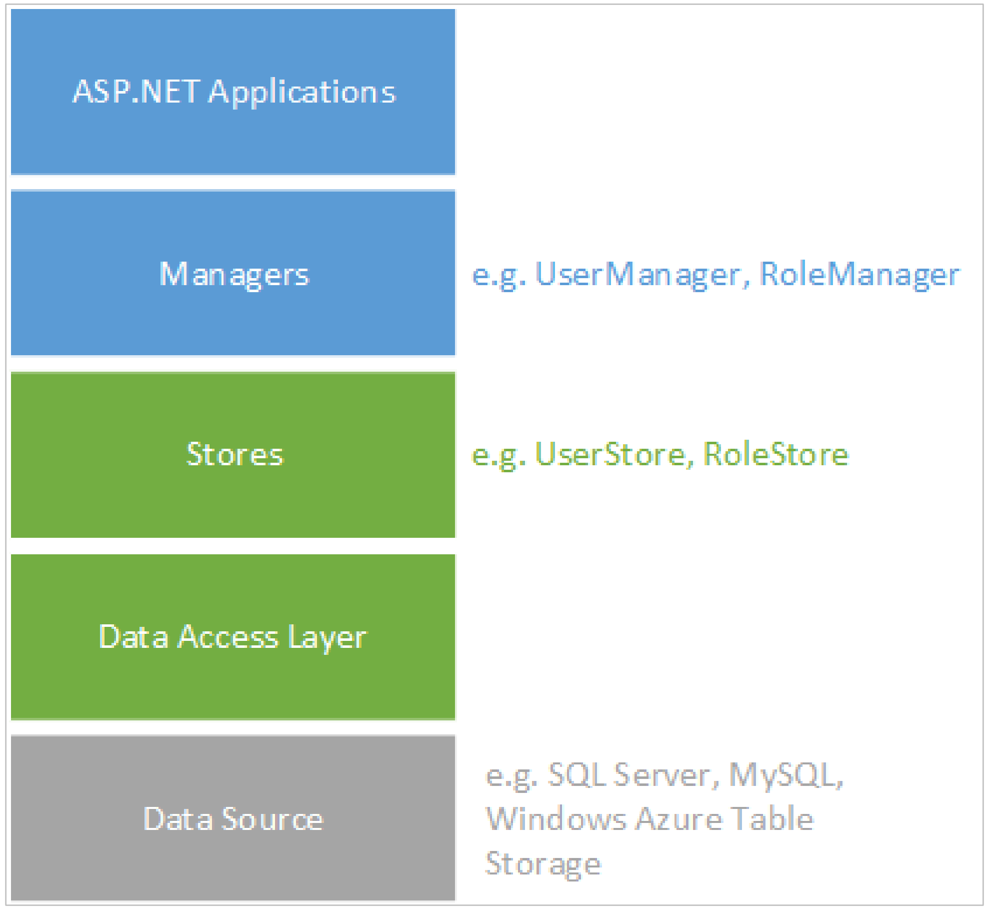
```
public void Configure(IApplicationBuilder app, IWebHostEnvironment env)
{
    app.UseAuthentication();
    app.UseAuthorization();
```

Startup.cs

ASP.NET Identity Architecture

- **Managers**
  - High-level classes
  - Operations such as create user
  - Completely decoupled from stores

- **Stores**
  - Lower-level classes
  - Closely coupled with the persistent mechanism
  - Store users, roles, claims through Data Access Layer (DAL)

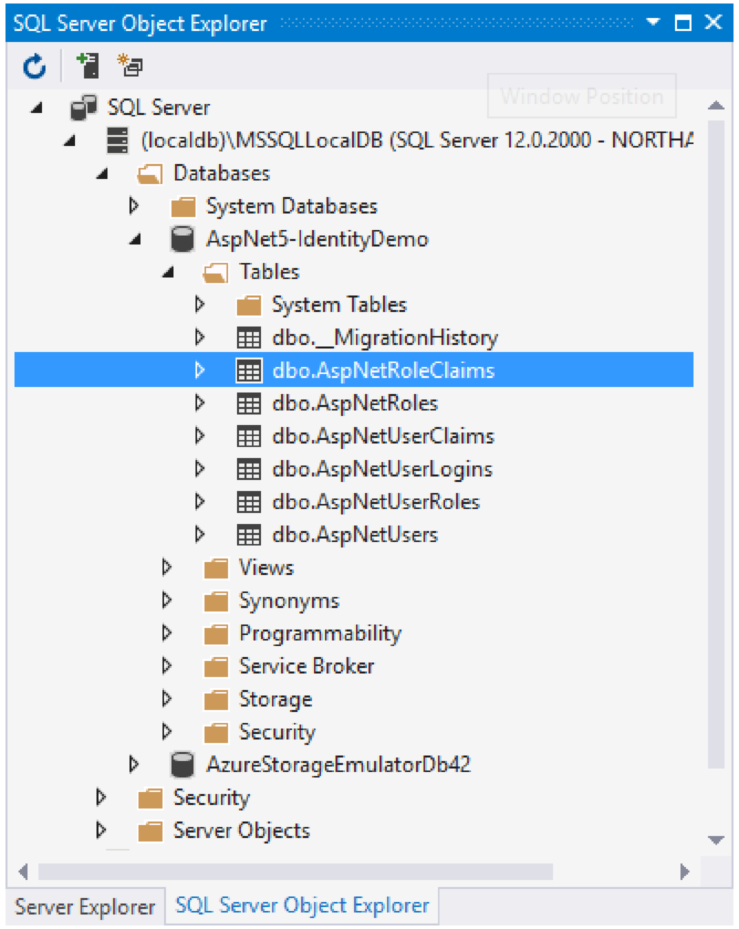

ASP.NET Applications
Managers
e.g. UserManager, RoleManager
Stores
e.g. UserStore, RoleStore
Data Access Layer
Data Source
e.g. SQL Server, MySQL, Windows Azure Table Storage

ASP.NET Identity Key Classes

- **`IdentityUser`** – Represents web application user
- **`EmailService, SmsService`** – Notified during two-factor authentication
- **`UserManager`** – APIs to CRUD (Create, Read, Update, and Delete) user, claim, and auth information via UserStore
- **`RoleManager`** – APIs to CRUD roles via RoleStore
- **`UserStore`** – Talks to data store to store user, user login providers, user claims, user roles,
    - IUserStore, IUserLoginStore, IUserClaimStore, IUserRoleStore
- **`RoleStore`** – Talks to the data store to store roles
- **`SigninManager`** – High level API to sign in (single or two-factor)

ASP.NET Identity Database

Data	Description
Users	Registered users of your web site. Includes the user Id and user name. Might include a hashed password if users log in with credentials that are specific to your site (rather than using credentials from an external site like Facebook), and security stamp to indicate whether anything has changed in the user credentials. Might also include email address, phone number, whether two factor authentication is enabled, the current number of failed logins, and whether an account has been locked.
User Claims	A set of statements (or claims) about the user that represent the user's identity. Can enable greater expression of the user's identity than can be achieved through roles.
User Logins	Information about the external authentication provider (like Facebook) to use when logging in a user.
Roles	Authorization groups for your site. Includes the role Id and role name (like "Admin" or "Employee").


SQL Server Object Explorer

```
SQL Server
  (localdb)\MSSQLLocalDB (SQL Server 12.0.2000 - NORTHA
    Databases
      System Databases
      AspNet5-IdentityDemo
        Tables
          System Tables
          dbo.__MigrationHistory
          dbo.AspNetRoleClaims
          dbo.AspNetRoles
          dbo.AspNetUserClaims
          dbo.AspNetUserLogins
          dbo.AspNetUserRoles
          dbo.AspNetUsers
        Views
        Synonyms
        Programmability
        Service Broker
        Storage
        Security
      AzureStorageEmulatorDb42
    Security
    Server Objects
```

Demo: ASP.NET Identity Setup in Project Template

Module 9: Security

Section 3: Authorization

Lesson: Authorization Methodologies

Roles-Based Authorization

- `[Authorize]` attribute can be used to restrict access to specific users and roles
    - Restricting StoreManagerController to Administrators only

```
[Authorize(Roles = "Administrator")]
public class StoreManagerController : Controller
```

    - Restricting controller/action to **any** of multiple roles (logical OR)

```
[Authorize(Roles = "Administrator, SuperAdmin")]
public class StoreManagerController : Controller
```

    - Restricting controller/action to **all** of multiple roles (logical AND)

```
[Authorize(Roles = "Administrator”), Authorize(Roles = “SuperAdmin")]
public class StoreManagerController : Controller
```

    - Restricting controller/action to multiple users & roles

```
[Authorize(Users = “User1, User2", Roles = "SuperAdmin")]
public IActionResult Create(Album album)
```

Claims-Based Policy Authorization - I

- `[Authorize]` attribute can be used to restrict access to users with specific claims
    - Create a policy for requiring a claim or claim value

```
public void ConfigureServices(IServiceCollection services)
{
    services.AddMvc();

    services.AddAuthorization(options =>
    {
        options.AddPolicy("EmployeeOnly", policy => policy.RequireClaim("EmployeeNumber"));

        options.AddPolicy(“FounderOnly”, policy =>
            policy.RequireClaim(“EmployeeNumber”, “1”, “2”, “3”, “4”, “5”));
    });
}
```

Startup.cs

Claims-Based Policy Authorization - II

- `[Authorize]` attribute can be used to restrict access to users with specific claims
  - Restricting controller/action to **all** of multiple Policies (logical AND)

```
[Authorize(Policy = “EmployeeOnly”), Authorize(Policy = “FounderOnly")]
public class StoreManagerController : Controller
```

  - Restricting controller/action to any of multiple Policies (logical OR)

```
[Authorize(Policy = “EmployeeOnly, FounderOnly")]
public IActionResult Create(Album album)
```

Demo: ASP.NET Core Identity

Tokens

Access Token and ID Token

- OIDC

Access Token

- OAuth 2.0

Refresh Token

- Can be obtained by both OIDC and OAuth 2.0 protocols

Module 9: Security

Section 6: ASP.NET Identity Strategies

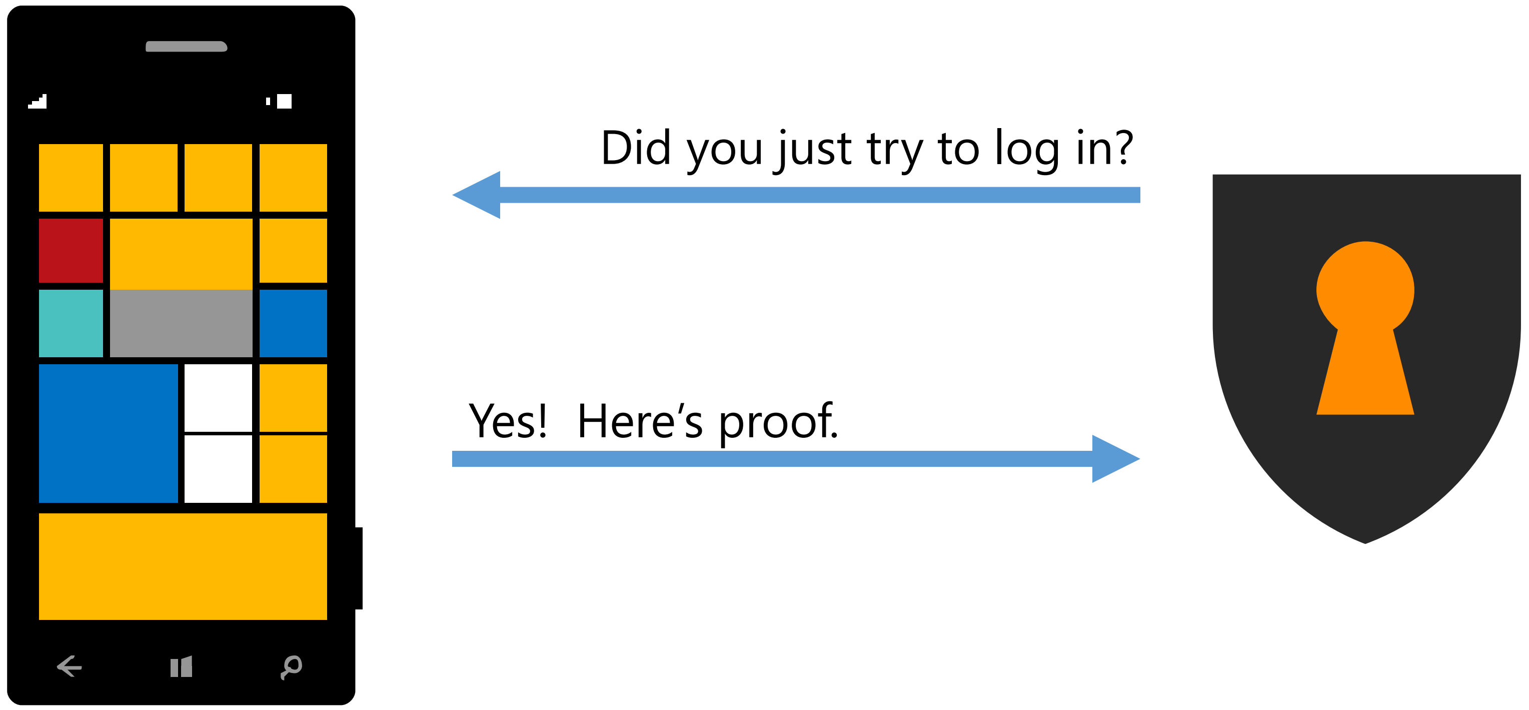
Lesson: ASP.NET Identity Strategies

Recommendations

- Utilize Secure Sockets Layer (TLS/SSL - HTTPS) everywhere
  - Attacker on network can steal your cookies and hijack your session
  - Yes, even login page needs to be protected
  - Any page user can access while logged in should be protected
- Enforce a strong password policy (more an art than a science)
- Use Cross-Site Request Forgery (CSRF) tokens everywhere for post methods
- Do not allow unlimited login attempts
  - Brute forcers dream. Script kiddies abound.

Recommendations (continued)

- **If** security requirements demand it, you can change password hashing method
- Consider shortening OnValidateIdentity times to expire sessions
- Two-Factor authentication is highly recommended for enhanced security



Note that…

- Password expiration is not built-in
    - It is not right for every system, a good policy but consider it carefully
- Identity is not multi-tenant or multi-app by default
    - Use Azure AD or add Tenant IDs to users for multi-tenancy
    - Put Identity in a separate SQL server to share across apps (*not* true SSO)

Module 9: Security

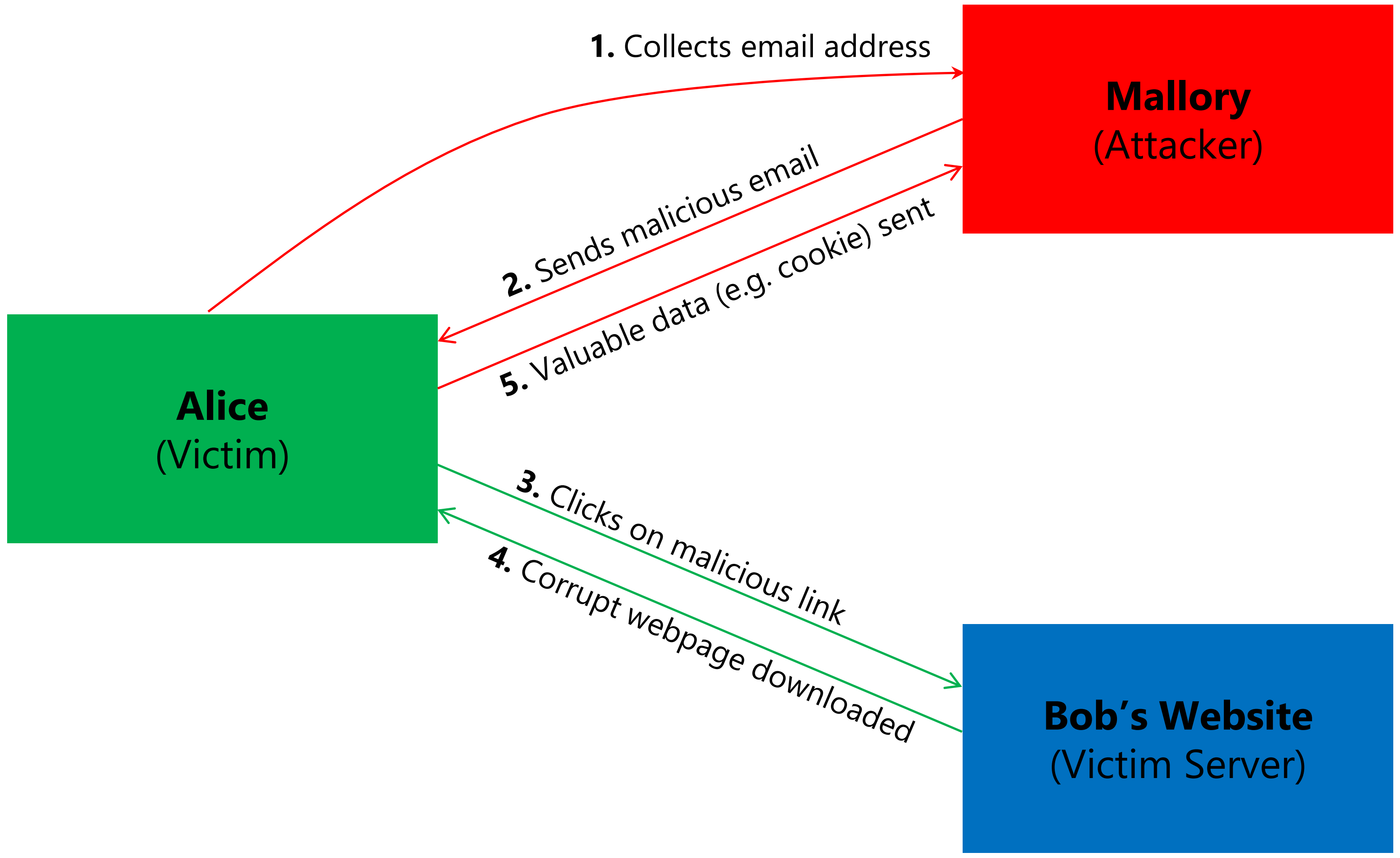
Section 7: Security Threats and Defenses

Lesson: Web Attacks and Defenses

Cross-Site Scripting (XSS) Attack

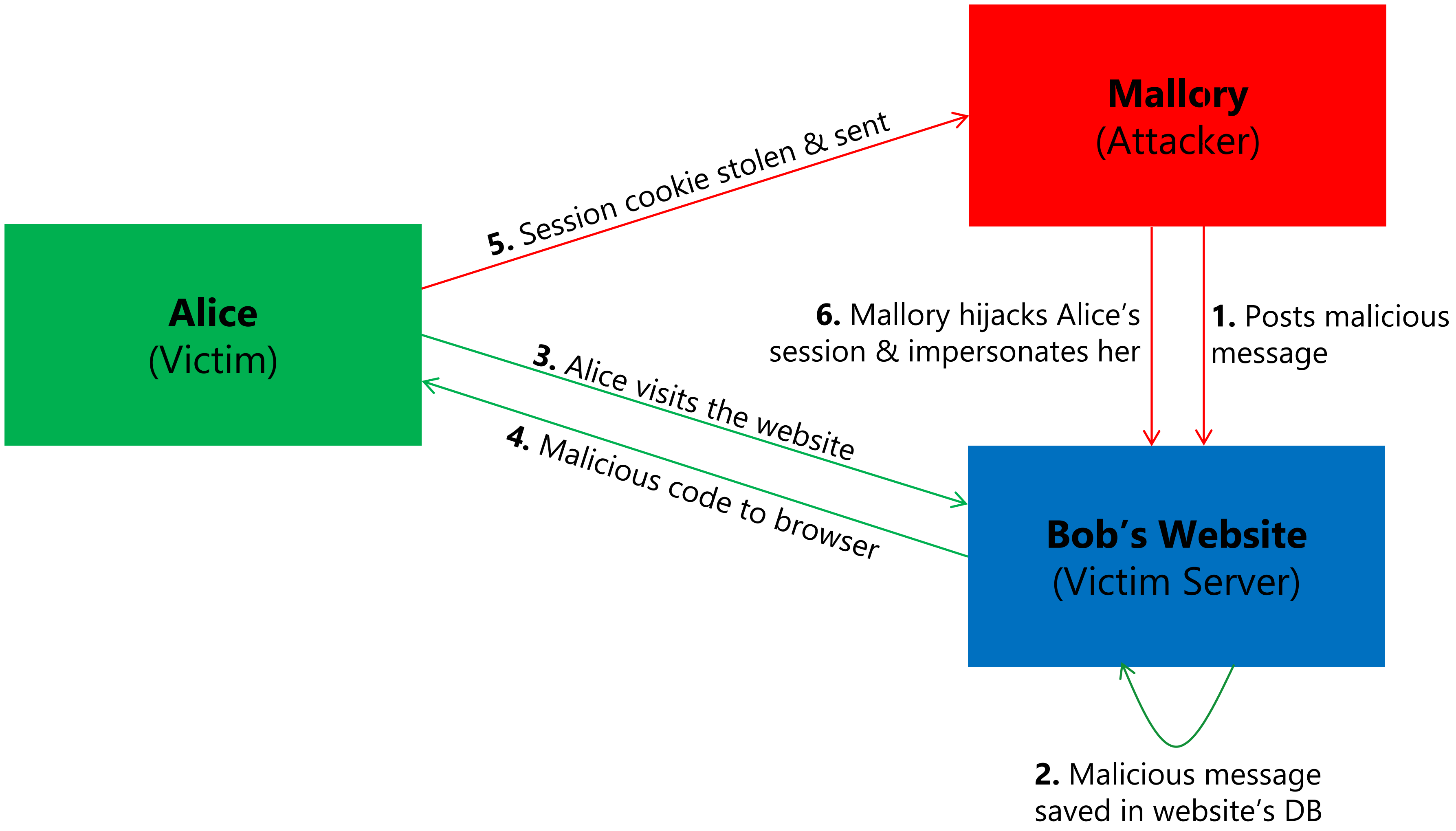
- XSS vulnerability allows an attacker to inject malicious JavaScript into pages generated by a web application
- Malicious script executes in victim client's browser
    - To gain access to sensitive webpage content, session cookies, etc.
- Methods for injecting malicious code:
    - **Active or Reflected Injection**
        - Attack script directly reflected back to the user from the victim site
        - Victim user participates directly in the attack
        - Often done through social engineering tricks, such as malicious email
    - **Passive or Stored Injection**
        - Malicious code is saved in the backend database using user input
        - Potentially more dangerous because all users of the web application may be compromised

XSS Reflected Attack



1. Collects email address
Mallory
(Attacker)
2. Sends malicious email
5. Valuable data (e.g. cookie) sent
Alice
(Victim)
3. Clicks on malicious link
4. Corrupt webpage downloaded
Bob's Website
(Victim Server)

XSS Stored Attack



Mallory
(Attacker)
Alice
(Victim)
Bob's Website
(Victim Server)
1. Posts malicious message
2. Malicious message saved in website's DB
3. Alice visits the website
4. Malicious code to browser
5. Session cookie stolen & sent
6. Mallory hijacks Alice's session & impersonates her

XSS Defense

- Never trust any input to your website
- Ensure that your app validates all user input, form values, query strings, cookies, information received from third-party sources, for example, OpenID
- Use whitelist approach instead of trying to imagine all possible hacks
  - It is not possible to know all permutations
- Remove/encode special characters
  - HTML encoding
  - JavaScript encoding

HTML Encoding

- All output on your pages should be HTML-encoded or HTML-attribute-encoded
  - `@Html.Encode(Model.FirstName)`
  - `@Model.FirstName`
- URL Encoding:
  - `@Url.Encode(Url.Action(“index”, “home”, new {name=ViewData[“name”]}))`
- Razor View Engine automatically HTML-encodes output

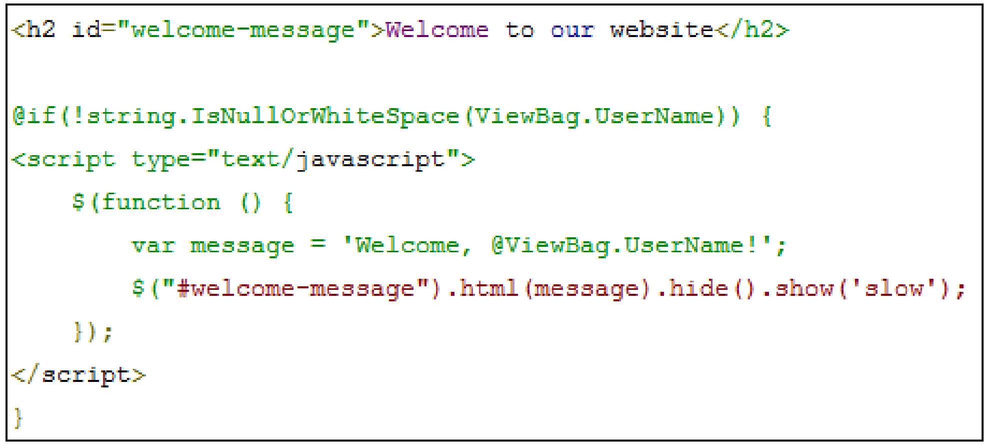
Malicious User Input (without encoding)

<script>alert(“XSS!”)</script>

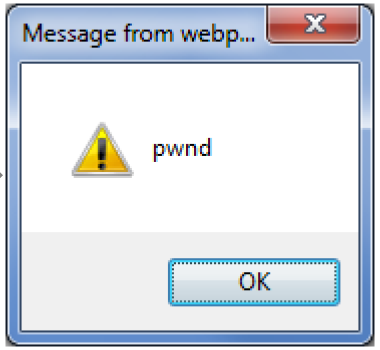
HTML-Encoded User Input

&lt;script&gt;alert(‘XSS!’)&lt;/script&gt;

JavaScript Encoding



```
<h2 id="welcome-message">Welcome to our website</h2>

@if(!string.IsNullOrWhiteSpace(ViewBag.UserName)) {
<script type="text/javascript">
    $(function () {
        var message = 'Welcome, @ViewBag.UserName!';
        $("#welcome-message").html(message).hide().show('slow');
    });
</script>
}
```

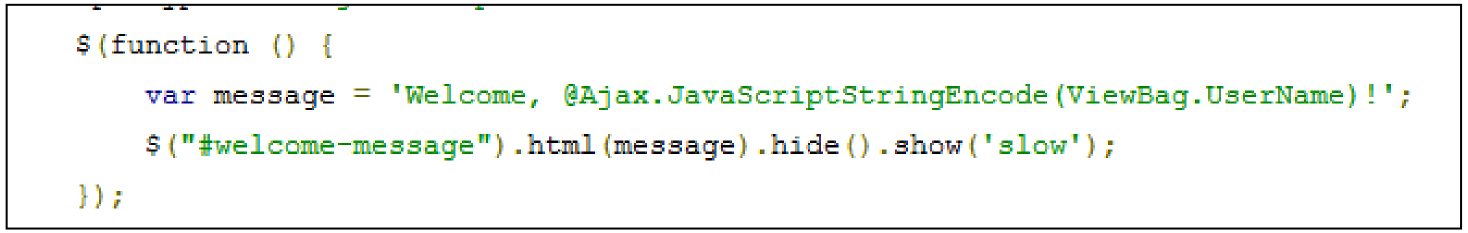


Message from webp...

pwnd

http://localhost:XXXXX/?**UserName=Waqar\x3cscript\x3e%20alert(\x27pwnd\x27)%20\x3c/script\x3e**

JavaScript Encoding Fix



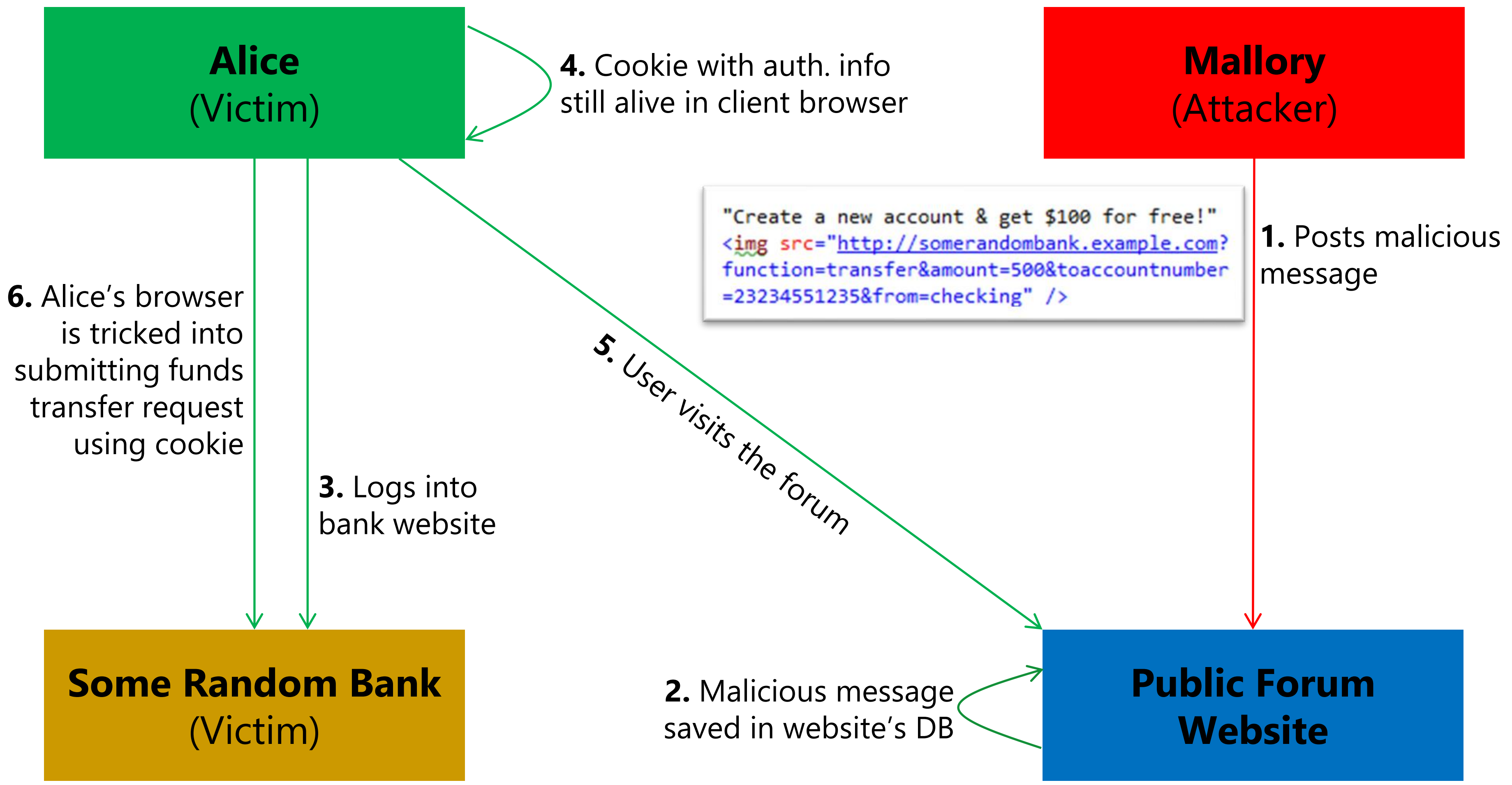
```
    $(function () {
        var message = 'Welcome, @Ajax.JavaScriptStringEncode(ViewBag.UserName)!';
        $("#welcome-message").html(message).hide().show('slow');
    });
```

Demo: Cross-Site Scripting Attack

CSRF Attack

- CSRF attack tricks a browser into misusing its authority to represent a user to remote website
- CSRF exploits user’s trust in a browser
  - Confused Deputy Attack against a web browser
- Characteristics of “at-risk” sites:
  - Reliance on user identity
  - Perform actions on input from authenticated user *without* requiring explicit authorization

CSRF Attack (continued)


Alice
(Victim)
4. Cookie with auth. info still alive in client browser
Mallory
(Attacker)
1. Posts malicious message
6. Alice's browser is tricked into submitting funds transfer request using cookie
3. Logs into bank website
5. User visits the forum
Some Random Bank
(Victim)
2. Malicious message saved in website's DB
Public Forum Website

```
"Create a new account & get $100 for free!"
<img src="http://somerandombank.example.com?
function=transfer&amount=500&toaccountnumber
=23234551235&from=checking" />
```

CSRF Defense

- **AntiForgery token**: A hidden form field that is validated when the form is submitted
  - Both Html Helper and Tag Helper based forms will *automatically* create an AntiForgery token and include it as a hidden field

```
<form asp-controller="Manage" asp-action="ChangePassword" method="post">

</form>
```

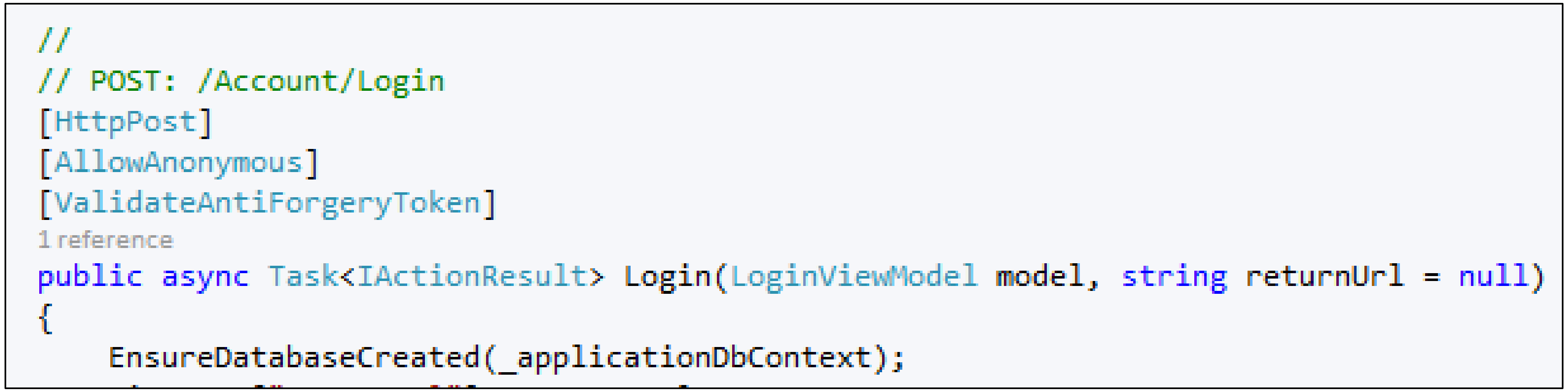
```
@using (Html.BeginForm("ChangePassword", "Manage"))
{

}
```

Syntax of the Anti-Forgery Token

```
<% using(Html.Form("UserProfile", "SubmitUpdate")) { %>
    <%= Html.AntiForgeryToken() %>
    <!-- rest of form goes here -->
<% } %>
```

CSRF Defense

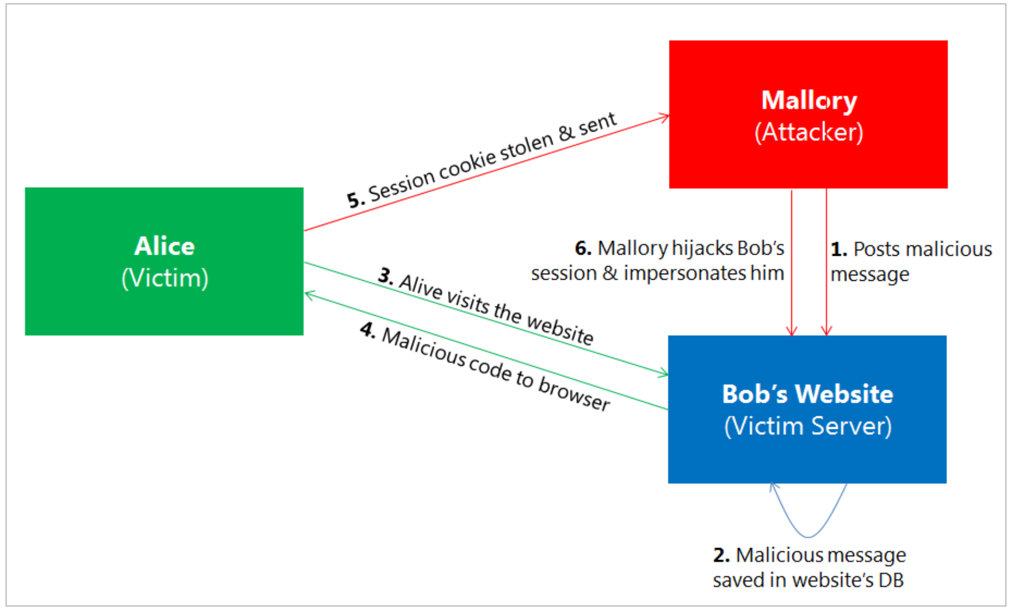
- **AntiForgery token**: A hidden form field that is validated when the form is submitted
  - Validate the token on the server side via the `[ValidateAntiForgeryToken]`



```
//
// POST: /Account/Login
[HttpPost]
[AllowAnonymous]
[ValidateAntiForgeryToken]
1 reference
public async Task<IActionResult> Login(LoginViewModel model, string returnUrl = null)
{
    EnsureDatabaseCreated(_applicationDbContext);
```

Cookie Stealing Attack

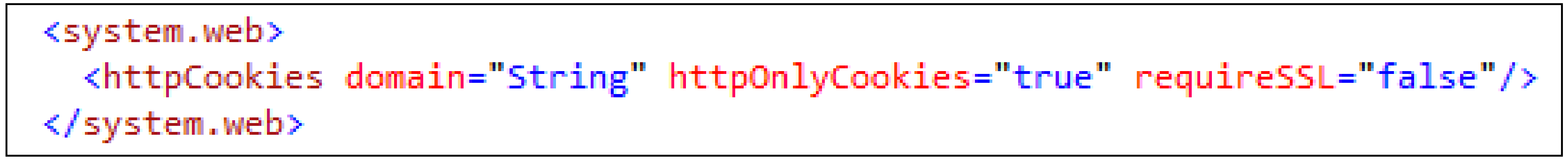
- Attacker steals user's authentication cookie for a website to impersonate user and carry out actions on user's behalf
- Dependent on XSS attack
  - Attacker must be able to inject script on the target site
  - Script sends user’s authentication cookie to attacker’s remote server


Mallory
(Attacker)
Alice
(Victim)
Bob’s Website
(Victim Server)
1. Posts malicious message
2. Malicious message saved in website’s DB
3. Alive visits the website
4. Malicious code to browser
5. Session cookie stolen & sent
6. Mallory hijacks Bob’s session & impersonates him

Cookie Stealing Defense

- Prevent XSS attack on the website
- Disallow changes to the cookie from the client’s browser
  - Browser will invalidate the cookie unless the server sets/changes it

  - Can be done from web.config if using IIS



```
<system.web>
  <httpCookies domain="String" httpOnlyCookies="true" requireSSL="false"/>
</system.web>
```

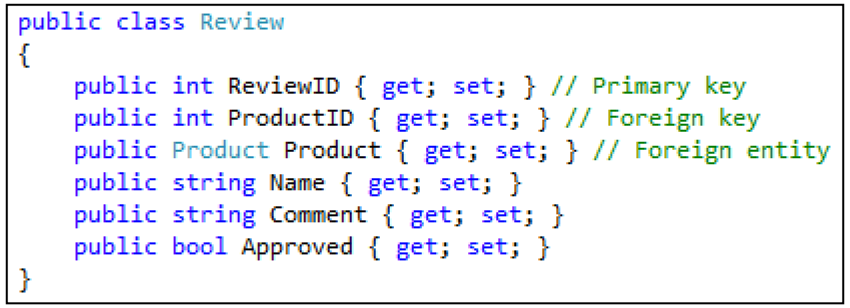
  - Can also be set when configuring Cookies in Startup.cs

```
.AddCookie(opts => opts.Cookie.HttpOnly = true );
```

Over-Posting Attack

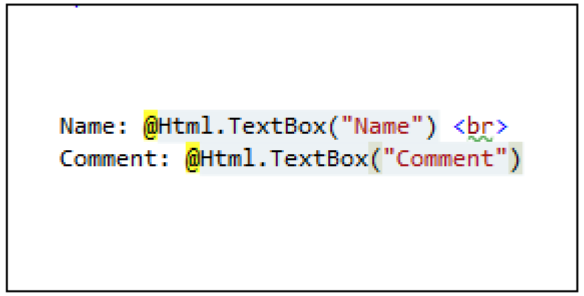
- An attacker can populate model properties that are not included in the View.

Model



```
public class Review
{
    public int ReviewID { get; set; } // Primary key
    public int ProductID { get; set; } // Foreign key
    public Product Product { get; set; } // Foreign entity
    public string Name { get; set; }
    public string Comment { get; set; }
    public bool Approved { get; set; }
}
```

View

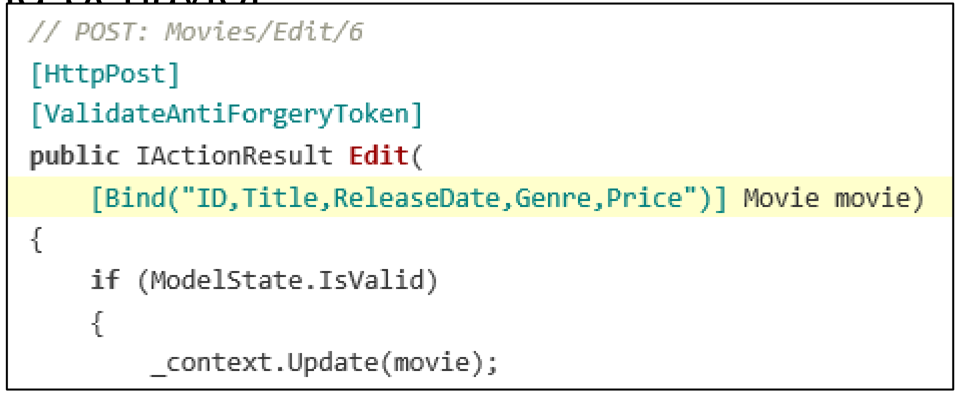


```
Name: @Html.TextBox("Name") <br>
Comment: @Html.TextBox("Comment")
```

- Attacker can add “Approved=true” to form post.
- Attacker can post values for Product, such as Product.Price, to change values in the persistent storage.

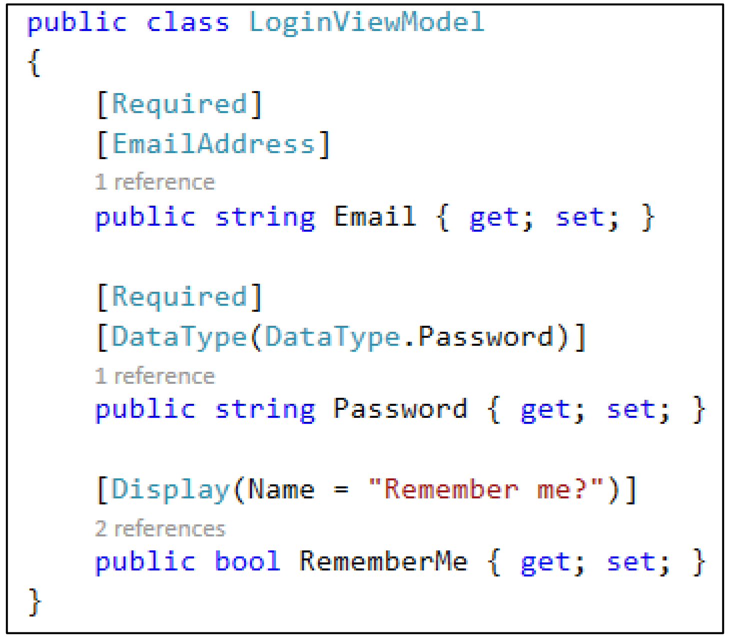
Over-Posting Defense

- Use [bind] attribute to explicitly control the binding behavior
  - Specifically list permitted properties
- Use View Model [recommended]



```
// POST: Movies/Edit/6
[HttpPost]
[ValidateAntiForgeryToken]
public IActionResult Edit(
    [Bind("ID,Title,ReleaseDate,Genre,Price")] Movie movie)
{
    if (ModelState.IsValid)
    {
        _context.Update(movie);
```

[Bind]



```
public class LoginViewModel
{
    [Required]
    [EmailAddress]
    1 reference
    public string Email { get; set; }

    [Required]
    [DataType(DataType.Password)]
    1 reference
    public string Password { get; set; }

    [Display(Name = "Remember me?")]
    2 references
    public bool RememberMe { get; set; }
}
```

View Model

Lab: Security

Microsoft