



# Security and the .NET Framework



# Code Access Security

- Enforces security policy on code
  - Regardless of user running the code
  - Regardless of whether the code is in the same application with other code
    - Other code can be more, less, or equally privileged
  - When code attempts a restricted action the system throws a `SecurityException`
- Code Access Security is the cornerstone of security on the Framework
- Much of the Framework infrastructure is necessary for CAS to work
  - Managed heap, JIT compilation, Assemblies, etc.

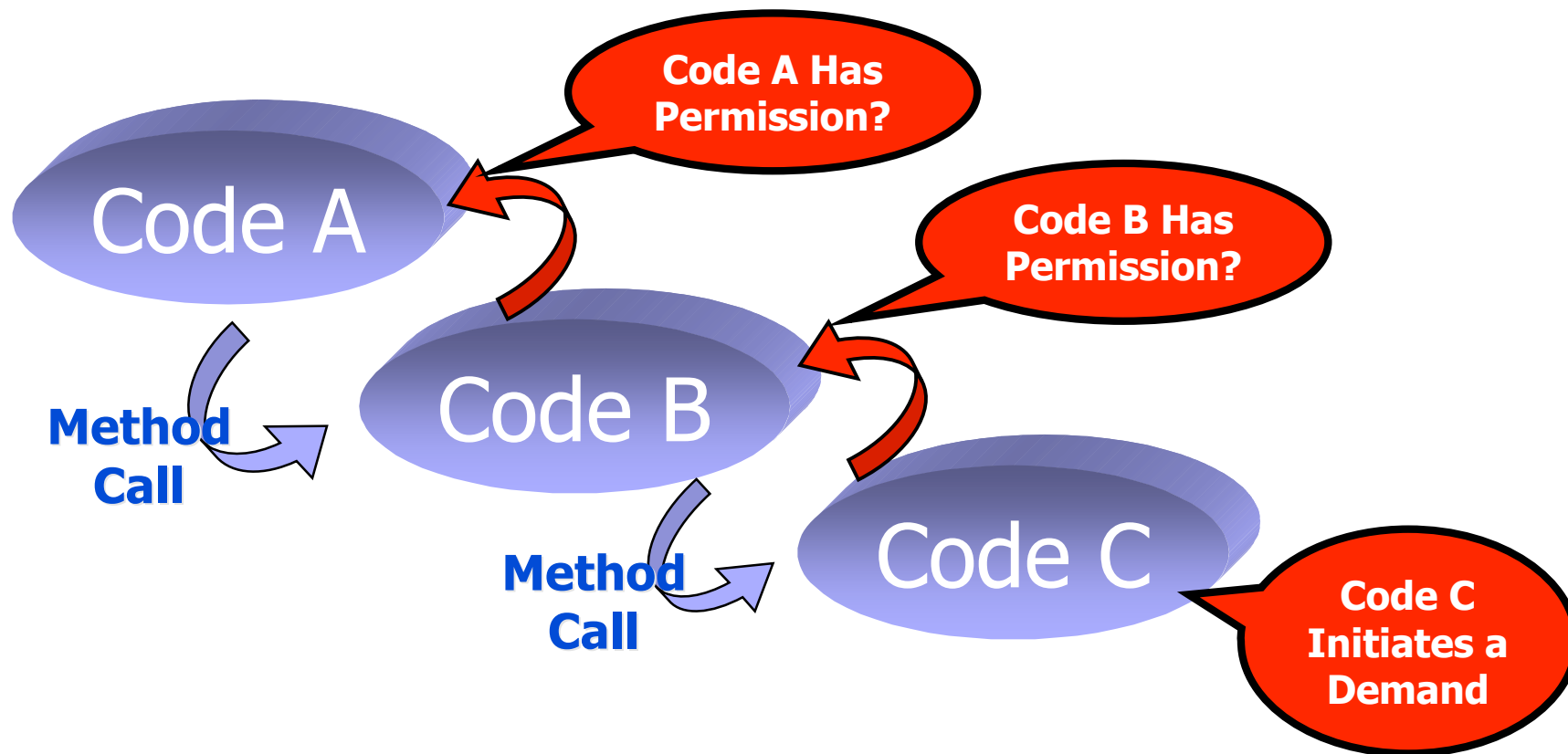


# The Idea Behind CAS

- Assembly == Code in Code Access Security
  - Unit of versioning, deployment and execution
  - Assembly is also a unit of security
  - All code in a single assembly share the same permissions
- Applications are always comprised of code from multiple assemblies
  - The .exe assembly
  - Assemblies in the Framework Class Library
  - Custom libraries, mobile code, etc.
- When a thread crosses an assembly boundary, it also crosses a security boundary
- Before a sensitive action is performed, the CLR walks up the call-stack
  - Assures each assembly in the stack-walk has necessary permissions
  - This stack-walk is called a *Demand*

# Demand

- Demand must be satisfied by all callers
  - Ensures all code in causal chain is authorized
  - Code cannot exploit other code with more privilege





# CAS in Action: A First Look

```
using System;
using System.IO;
using System.Security;

class App{
    public static void Main(string[] args){
        StreamReader reader = new StreamReader(args[0]);
        Console.WriteLine(reader.ReadToEnd());
    }
}
```

- Creates StreamReader object
  - StreamReader reads file internally access file
  - Potentially protected resources



# Rational for CAS

- No longer is all code running in a single user session awarded the same rights
  - Example: User launches a word-processor and it has access to the file system
    - The word-processor loads and runs a script downloaded from a network/Internet -- the script's file system access is limited
  - In this example all code is running natively in the same system process
- Increase granularity of security
  - User-logon no longer the smallest unit of security
  - User does not want to switch logon sessions simply to run partially trusted code



# Important Scenarios

## ■ Mobile Code

- Browser-hosted forms, network installs, distributed applications
- Network scripts run locally
- Email embedded macros and scripts
- Code downloaded and executed locally

## ■ ISP Scenario

- ISP sells web-hosting to many parties
- Web code executes natively on ISP machines
- Code does not require security review



# Scenario #1: Mobile Code

- Advantages of mobile code
  - Executes locally for performance and rich features
  - Not restricted to the limitations of markup or scripts
    - Rich features like animations and drag-and-drop
- Why Code Access Security is necessary
  - Without managed code and CAS mobile code must be scripted or fully trusted
    - Scripted code is slow, limited features
    - Fully trusted code (ActiveX)
      - Bothers users with dialog boxes requesting trust
      - Once established, full trust can be exploited by rogue web-sites
  - CAS enables partial trust of mobile code
    - No dialogs, less exploitable
    - Rich access to GUI API, high performance
    - Best of both worlds



# Scenario #2: ISP Scenario

- Advantages of active server code (CGI, ISAPI, ASP.NET)
  - High performance (improved features/speed over scripted solutions)
  - Dynamic generation of HTML (not restricted to static content)
- With unmanaged code active servers are fully trusted by host (ISP)
  - CGI .exe's or ISAPI DLL's have full access to the system or process
  - One site can undermine the functions of another site
    - Maliciously, or through code error
    - Potentially the whole server can be undermined
  - Security management at the process level is problematic
    - Difficult to administer
    - Doesn't perform well with a minimum of one process per site
  - Result: ISP's disallow active server code
- CAS enables partial trust
  - ASP.NET page can run in proc with other sites
  - Page object for one sight cannot gain access to objects or resources of other sites
  - System resources are not generally available
    - ASP.NET applications can be given access to subsets of system resources such as a directory or registry tree



# Understanding Security Zones

- The system establishes a zone for code (assembly)
  - Happens before code is executed
  - Zones are based on the source location of code
  - Zones are a subset of an advanced CAS feature called *evidence*

Zone	Description
Local	Code executed from the local system. Code in this zone has full trust.
Intranet	Code executed from a share or URL on the enterprise network. Limited access to local resources.
Internet	Code downloaded from the Internet. Minimal access to local resources.
Restricted	Code in the restricted zone is not allowed to execute.



# Practical Zones Programming

- Common .NET developer experience
  - Create an application, test it, fix bugs, code works fine
  - Developer then gives the app to someone who runs it from a network share
    - Application begins crashing inexplicably
    - Reason: The Intranet zone has fewer permissions than the Local zone.
  - Solution: Test your software in different zones
- Running managed software in different zones
  - If your software is an .exe then it is sure to be run in at least two zones
    - Local and Intranet
  - Your software should at least recover gracefully if a security exception is thrown
  - If your software is a reusable control, then it could feasibly be run from any of the zones



# Testing Zones

- You should test your software from the relevant zones
  - Run your software locally
  - Run it from a share
  - Run it from a URL on the internet
- Your software will almost certainly throw some exceptions when first tested in a more restricted zone
  - Handle the exceptions and gracefully shut down
  - Handle the exceptions and work around with restricted features
  - Don't just let security exceptions crash your software!

# Demo Pad.exe

zoner Pad.exe

zoner /z:MyComputer Pad.exe

caspol -rsp Pad.exe



# Permissions

- Permissions are objects that the CLR references when performing a demand
- Permissions are granted to your assembly based on its zone (in addition to other assembly evidence)
- Permission objects themselves play an integral role in the demand process
  - The Demand() method calls virtual functions on the permission object when checking for a match
  - This involvement at the permission level makes the kinds of available permissions very flexible
- It is possible to design custom permissions for your code libraries
  - More on this in the advanced CAS session




# Some Frameworks Permissions

- FileIOPermission
- FileDialogPermission
- IsolatedStoragePermission
- UIPermission
- PrintingPermission
- WebPermission
- SocketPermission
  
- These are Just examples, the FCL defines many permissions



# Your Assembly is Loaded

- The system gathers *evidence* for your assembly
  - Digital signatures, Realm information
  - Zone information
- From evidence, your assembly is assigned one or more *code groups*
- Code groups define the permission sets to apply to your assembly
  - Permission sets are collections of permissions
- Once loaded, the system has a permission grant associated with your assembly



# Your Assembly's Code Executes

- Your code executes, and uses reusable objects
  - FCL, custom objects, etc
- Eventually, a method or constructor of an object will demand a security permission
  - Each assembly in call stack is checked for permission
  - If the demand reaches your assembly, your assembly's grant is checked for permission
    - If you have it, the demand continues up the stack
    - If you do not have the permission in your grant, a SecurityException is thrown
  - If the demand reaches the top of the stack, the demand has succeeded
    - The restricted action is performed



# CAS Applies to All Assemblies

- All assemblies get a grant upon loading
- All assemblies' grants are checked upon demand
- CAS is always aware of who initiates an action



# Rational for CAS: Summary

- Managed code makes CAS possible
  - Unmanaged code, impossible to implement CAS
- CAS enables local execution of code
  - Safe, even if code is not trusted
  - Opens the door to rich features
  - Removes the need for rigid code review
    - Third party code
    - Your software must still be reviewed for security
- CAS permissions based on
  - Code authentication
  - Call stack



# Security and the .NET Framework



The slides following this one contain the figure graphics for the tutorial that goes with this presentation.

