CS 5435

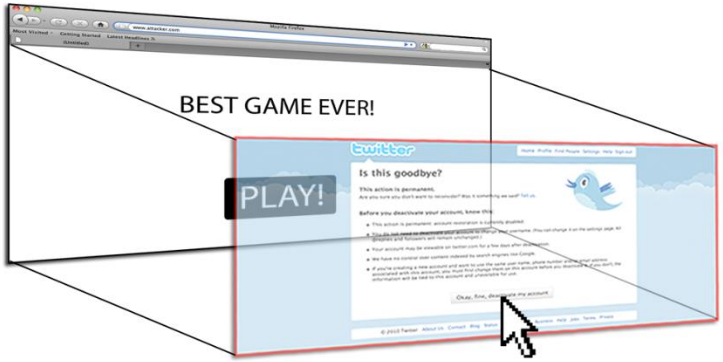
Clickjacking

Vitaly Shmatikov

Clickjacking (UI Redressing)

[Hansen and Grossman 2008]

Attacker overlays multiple transparent or opaque frames to trick a user into clicking on a button or link on another page


www.attacker.com
BEST GAME EVER!
PLAY!
twitter
Home Profile Find People Settings Help Sign out
Is this goodbye?
This action is permanent.
Before you deactivate your account, know this:
Okay, fine, deactivate my account
© 2010 Twitter About Us Contact Blog Status
Business Help Jobs Terms Privacy

Clicks meant for the visible page are hijacked and routed to another, invisible page

Clickjacking in the Wild

Google search for “clickjacking” returns 385,000 results… this is not a hypothetical threat!

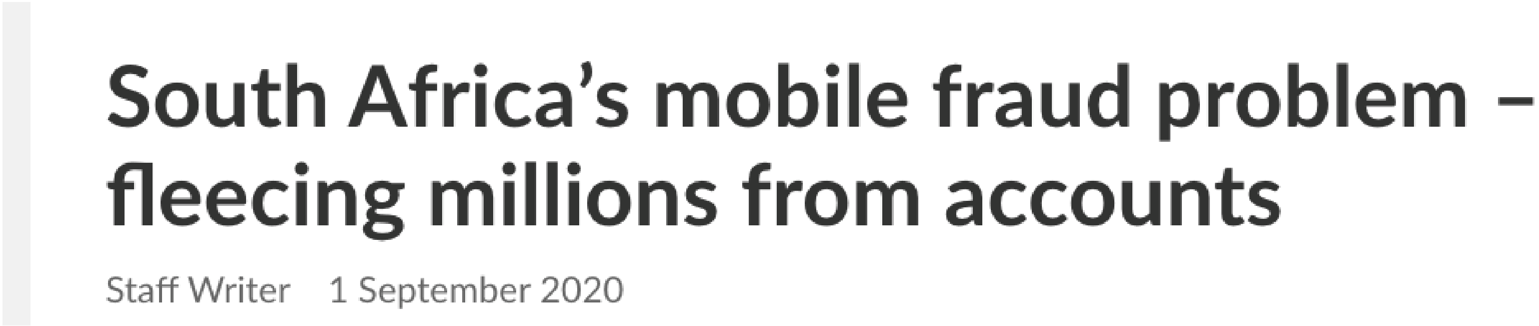
Summer 2010: Facebook worm superimposes an invisible iframe over the entire page that links back to the victim's Facebook page

- If victim is logged in, automatically recommends link to new friends as soon as the page is clicked on

Many clickjacking attacks against Twitter

- Users send out tweets against their will

Clickjacking in the Wild



South Africa's mobile fraud problem – fleecing millions from accounts

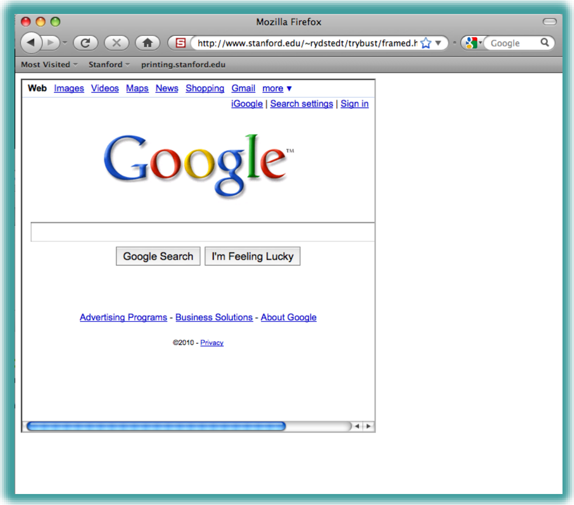
Staff Writer 1 September 2020

Mobile users in South Africa are very often subscribed to mobile services without their consent… South Africans are mostly at risk from a very basic fraudulent mobile activity, clickjacking. "Clickjacking is a type of mobile-based fraud that is more than five years old and could be blocked very quickly if local market players took this threat seriously."

It’s All About iFrame

Any site can frame any other site

```
<iframe
   src=“http://www.google.com/...”>
</iframe>
```



HTML attributes

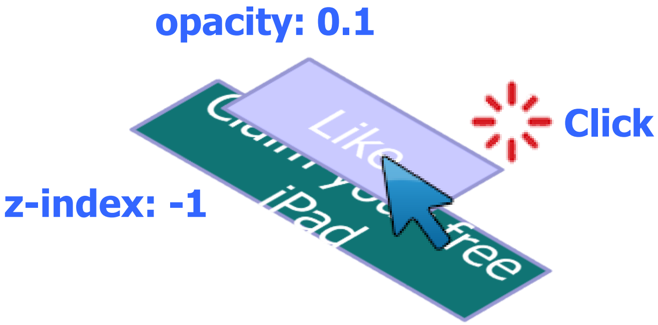
- Style
- Opacity defines visibility percentage of the iframe
  - 1.0: completely visible
  - 0.0: completely invisible

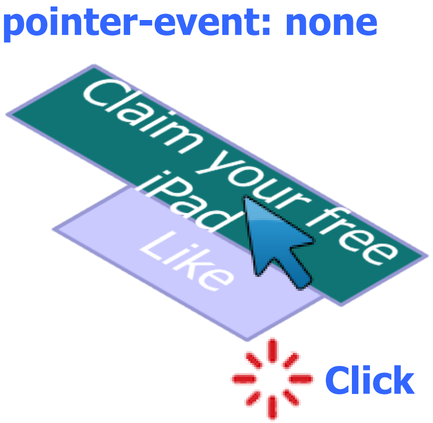
Hiding the Target Element

["Clickjacking: Attacks and Defenses"]

Use CSS `opacity` property and `z-index` property to hide target element and make other element float under the target element

Using CSS `pointer-events: none` property to cover other element over the target element



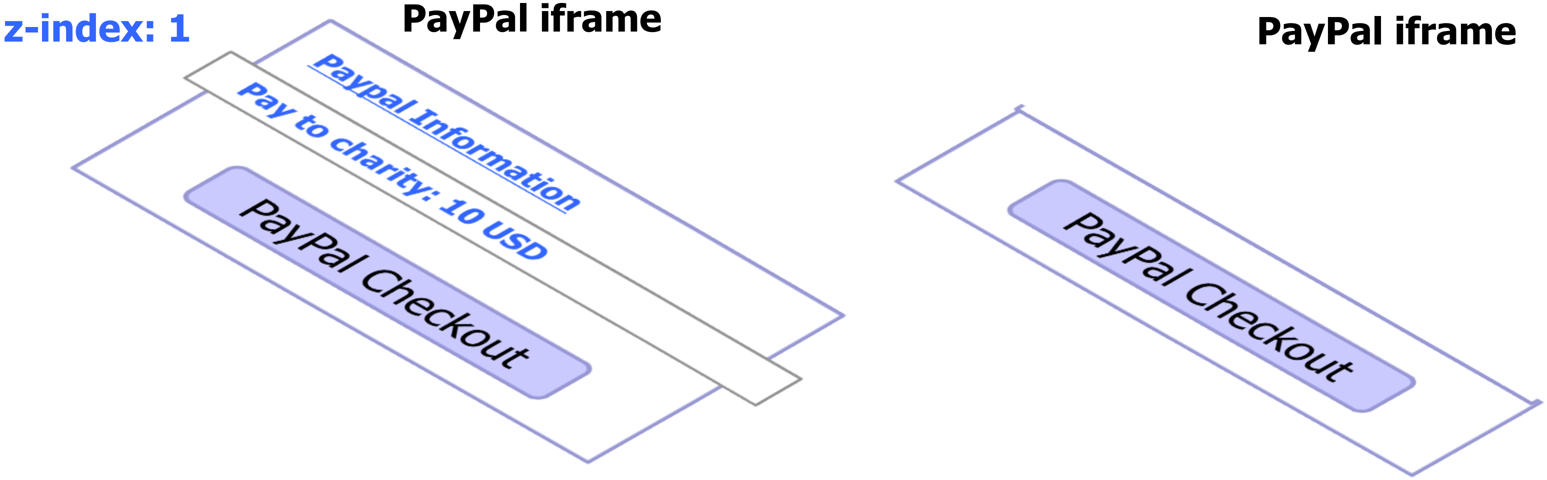


Partial Overlays and Cropping

["Clickjacking: Attacks and Defenses"]

Overlay other elements onto an iframe using CSS `z-index` property or Flash Window Mode `wmode=direct` property

Wrap target element in a new iframe and choose CSS position offset properties



Drag-and-Drop API

["Next Generation Clickjacking"]

Modern browsers support drag-and-drop API

JavaScript can use it to set data being dragged and read it when it's dropped

Not restricted by the same origin policy: data from one origin can be dragged to a frame of another origin

- Reason: drag-and-drop can only be initiated by user's mouse gesture, not by JavaScript on its own

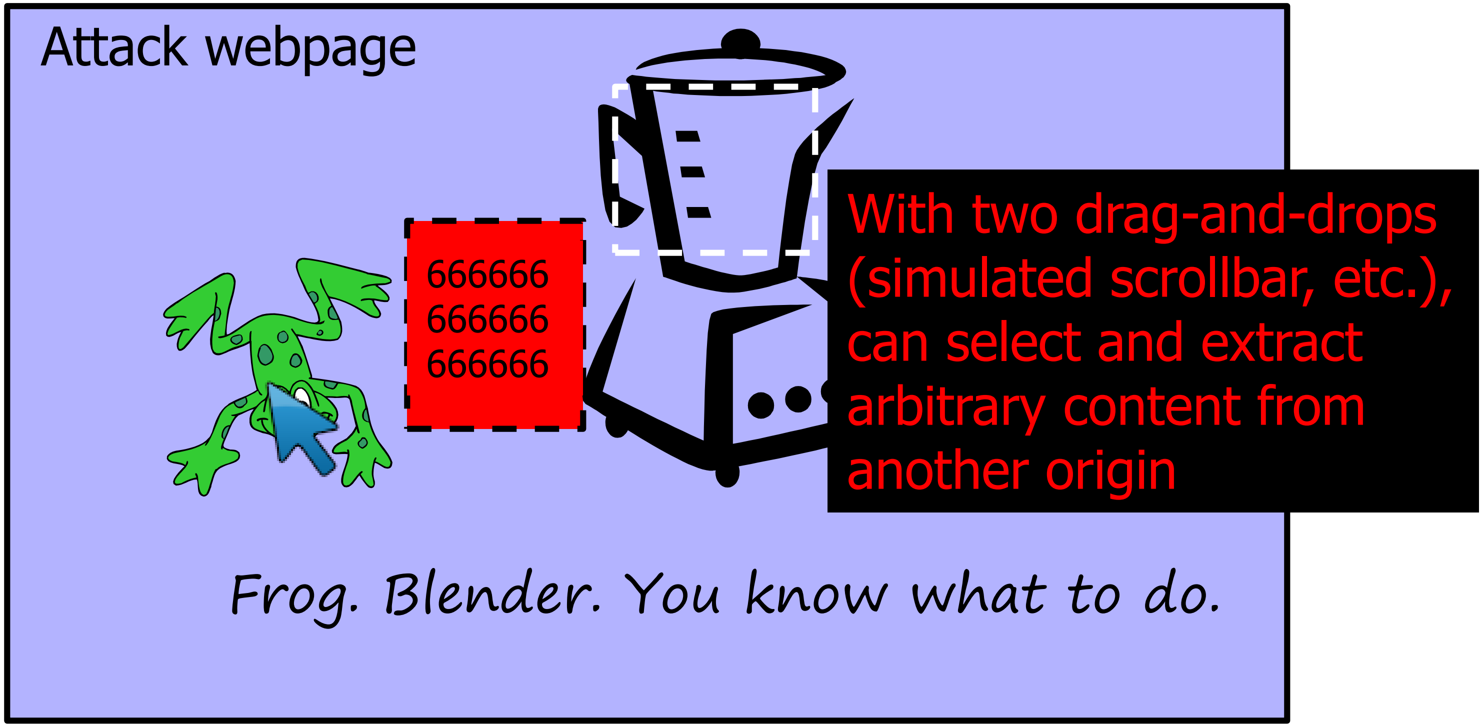
Abusing Drag-and-Drop API

[redacted] ["Next Generation Clickjacking"]

1. Bait the user to click and start dragging

2. Invisible iframe with attacker's text field under mouse cursor, use API to set data being dragged

3. Invisible iframe from another origin with a form field



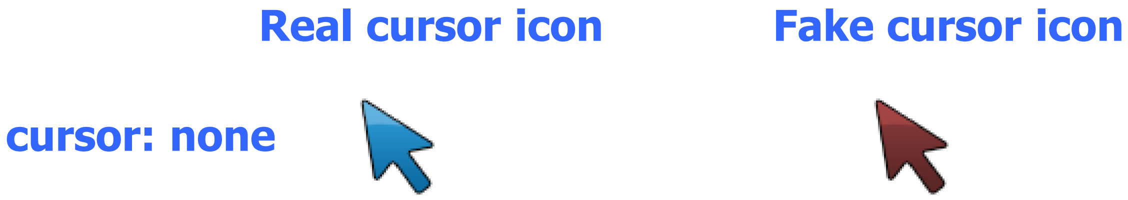
With two drag-and-drops (simulated scrollbar, etc.), can select and extract arbitrary content from another origin

Frog. Blender. You know what to do.

Fake Cursors

[“Clickjacking: Attacks and Defenses”]

Use CSS `cursor` property and JavaScript to simulate a fake cursor icon on the screen



Real cursor icon

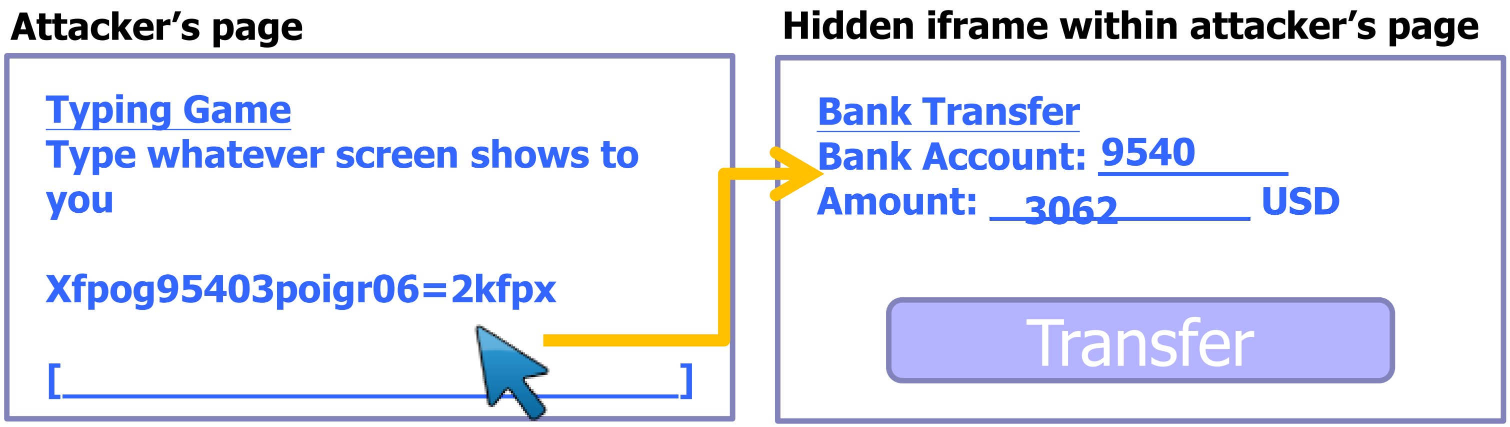
Fake cursor icon

cursor: none

Keyboard “Strokejacking”

[“Clickjacking: Attacks and Defenses”]

Simulate an input field getting focus, but actually the keyboard focus is on target element, forcing user to type some unwanted information into target element



Attacker’s page

Typing Game

Type whatever screen shows to you

Xfpog95403poigr06=2kfpx

[________________________]

Hidden iframe within attacker’s page

Bank Transfer

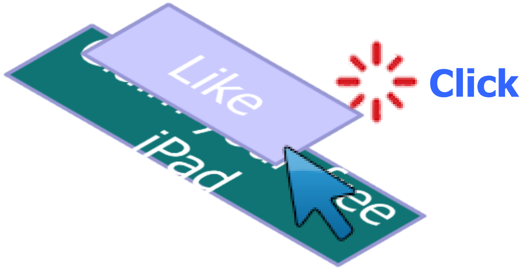
Bank Account: 9540

Amount: 3062 USD

Compromising Temporal Integrity

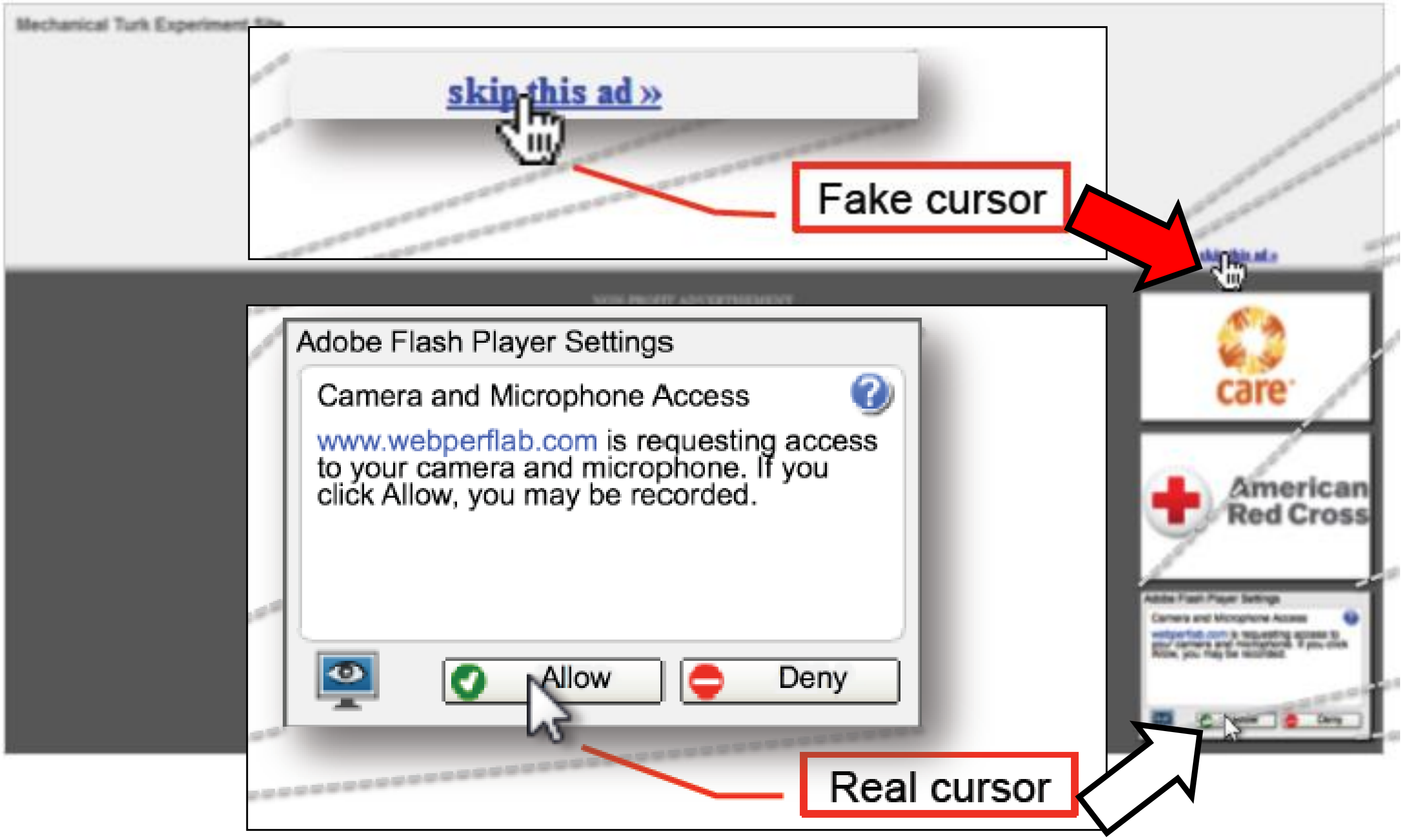
[“Clickjacking: Attacks and Defenses”]

Manipulate UI elements after the user has decided to click, but before the actual click occurs



Cursor Spoofing

[“Clickjacking: Attacks and Defenses”]



Adobe Flash Player Settings

Camera and Microphone Access

www.webperflab.com is requesting access to your camera and microphone. If you click Allow, you may be recorded.

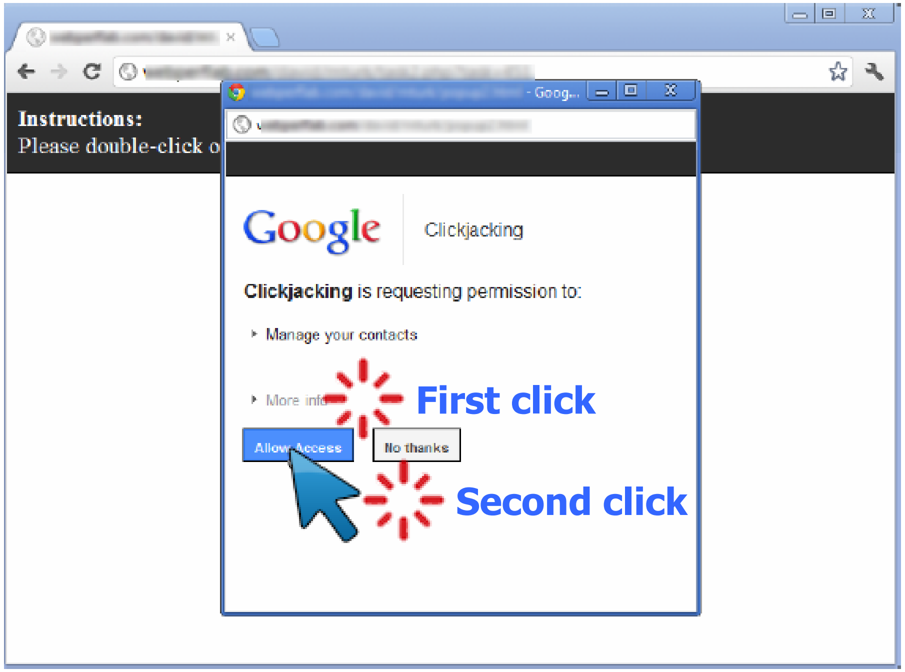
Fake cursor

Real cursor

Double-Click Attack

[redacted] ["Clickjacking: Attacks and Defenses"]

Bait the user to perform a double-click, switch focus to a popup window under the cursor right between the two clicks



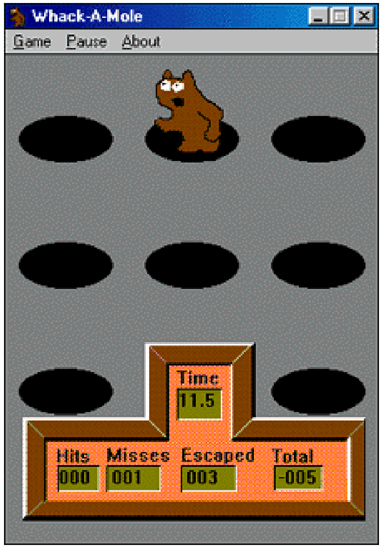
Instructions:
Please double-click o

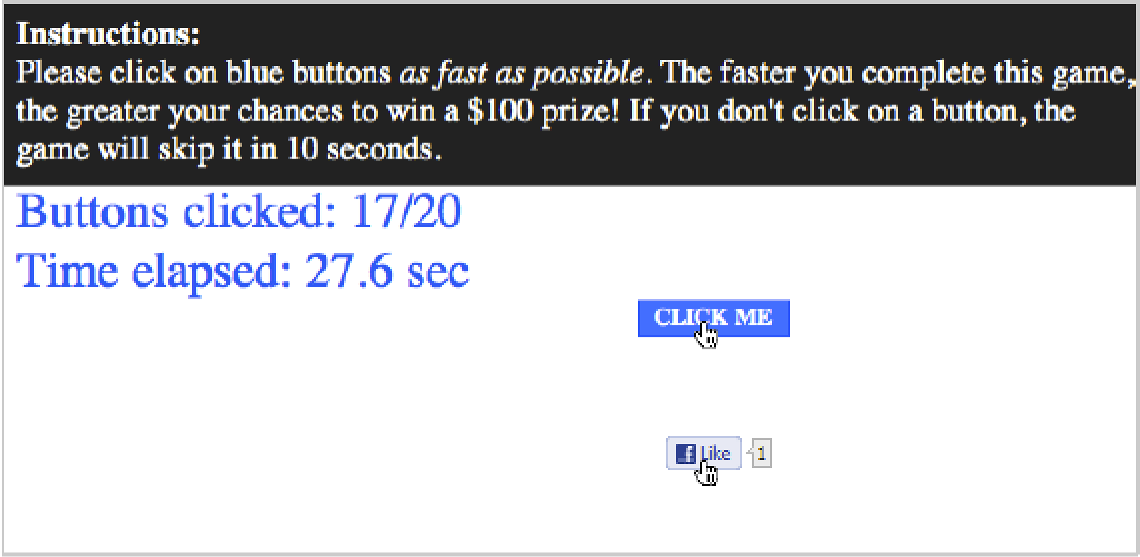
Clickjacking is requesting permission to:

Whack-A-Mole Attack

[redacted] [“Clickjacking: Attacks and Defenses”]

Ask the user to click as fast as possible, suddently switch Facebook Like button





Instructions:
Please click on blue buttons *as fast as possible*. The faster you complete this game, the greater your chances to win a $100 prize! If you don't click on a button, the game will skip it in 10 seconds.

Buttons clicked: 17/20

Time elapsed: 27.6 sec

Solution: Frame Busting

I am a page owner

All I need to do is make sure that my web page is not loaded in an enclosing frame …

Clickjacking: solved!

- Does not work for FB “Like” buttons and such, but Ok

How hard can this be?

```
if  (top != self)
    top.location.href = location.href
```

Frame Busting in the Wild

Survey by Gustav Rydstedt, Elie Burzstein, Dan Boneh, Collin Jackson

Following slides shamelessly jacked from Rydstedt

If My Frame Is Not On Top …

Conditional Statements
if (top != self)
if (top.location != self.location)
if (top.location != location)
if (parent.frames.length > 0)
if (window != top)
if (window.top !== window.self)
if (window.self != window.top)
if (parent && parent != window)
if (parent && parent.frames && parent.frames.length>0)
if((self.parent&& !(self.parent===self))&& (self.parent.frames.length!=

… Move It To Top

Counter-Action Statements
top.location = self.location
top.location.href = document.location.href
top.location.href = self.location.href
top.location.replace(self.location)
top.location.href = window.location.href
top.location.replace(document.location)
top.location.href = window.location.href
top.location.href = "URL"
document.write(’’)
top.location = location
top.location.replace(document.location)
top.location.replace(’URL’)
top.location.href = document.location
top.location.replace(window.location.href)
top.location.href = location.href
self.parent.location = document.location
parent.location.href = self.document.location
top.location.href = self.location
top.location = window.location
top.location.replace(window.location.pathname)

What About My Own iFrames?

Check: is the enclosing frame one of my own?

How hard can this be?

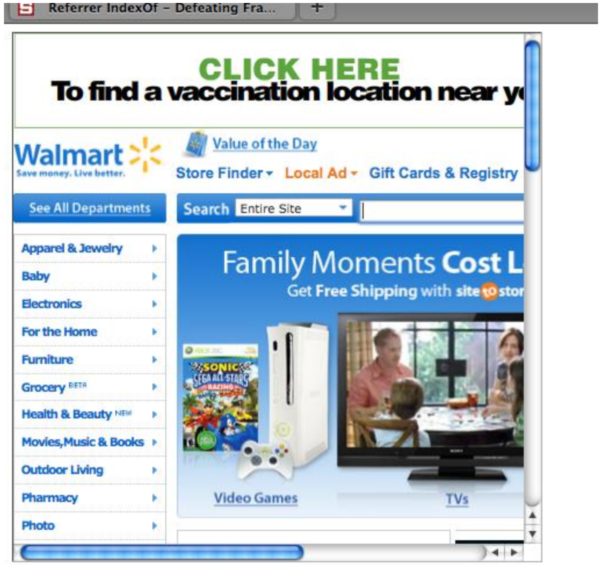
Survey of several hundred top websites …

… all frame busting code is broken!

Courtesy of **Walmart**

```
if (top.location != location) {
  if(document.referer &&
    document.referer.indexOf("walmart.com") == -1)
    {
        top.location.replace(document.location.href);
    }
}
```

Error in Referer Checking



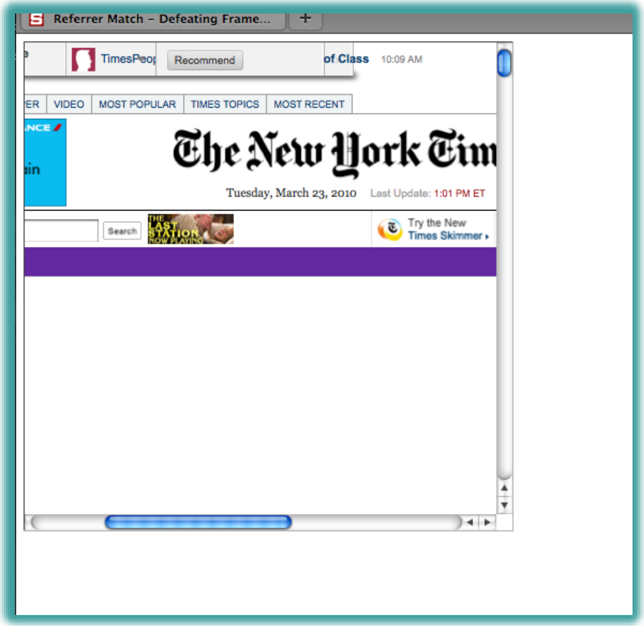
From http://www.attacker.com/walmart.com.html

<iframe src=“http://www.walmart.com”>

Courtesy of The New York Times

```
if (window.self != window.top &&
   !document.referer.match(
   /https?:\/\/[^?\/]+\.nytimes\.com\//))
{
   self.location = top.location;
}
```

Error in Referer Checking



From http://www.attacker.com/a.html?b=https://www.nytimes.com/

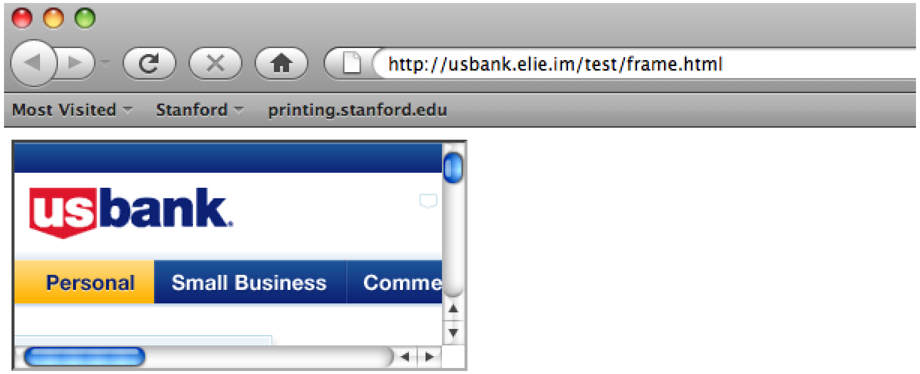
<iframe src="http://www.nytimes.com">

Courtesy of usbank

```
if (self != top) {
   var domain = getDomain(document.referer);
   var okDomains = /usbank|localhost|usbnet/;
   var matchDomain = domain.search(okDomains);

   if (matchDomain == -1) {
       // frame bust
     }
}
```

Error in Referer Checking



http://usbank.elie.im/test/frame.html

From http://usbank.attacker.com/

<iframe src="http://www.usbank.com">

Strategic Relationship?

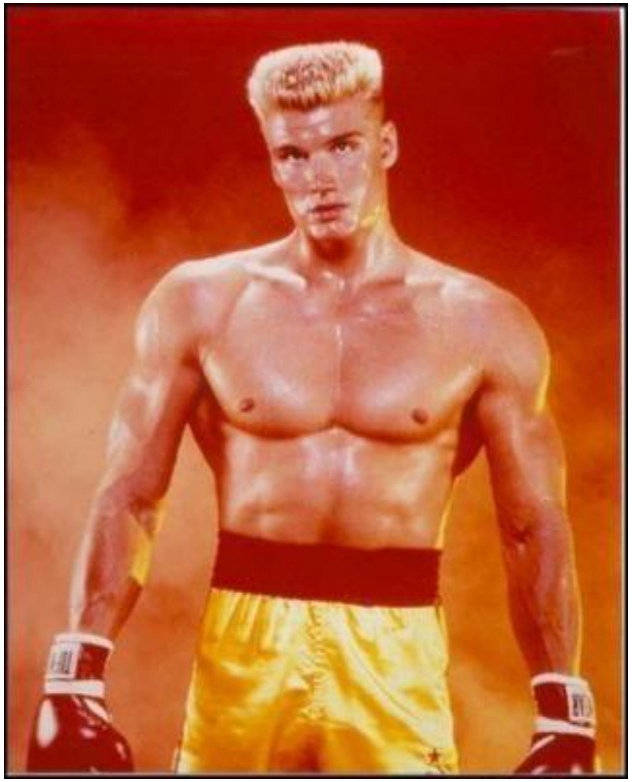
Norwegian State House Bank

http://www.husbanken.no

Strategic Relationship?

Bank of Moscow

http://www.rusbank.org



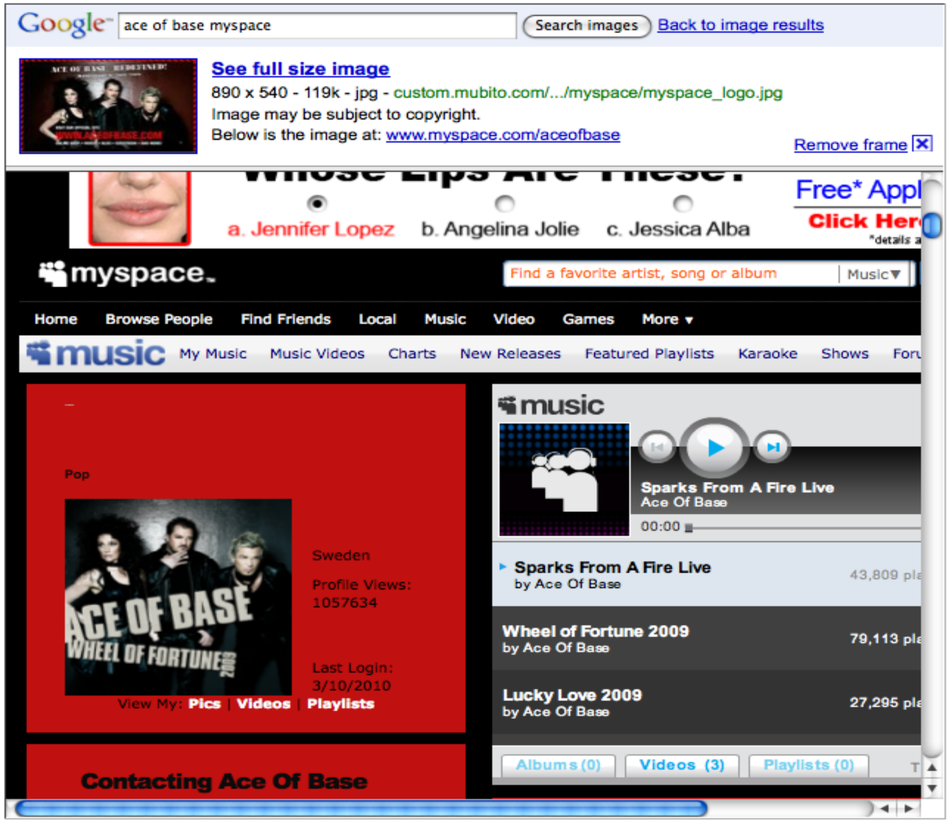
Courtesy of myspace

a place for freedom

```
try{
   A=!top.location.href
} catch(B){}
A=A&&
      !(document.referer.match(/^https?:\/\/[-az09.]
      *\.google\.(co\.|com\.)? [a-z] +\/imgres/i))&&
       !(document.referer.match(/^https?:\/\/([^\/]*\.)?
       (myspace\.com|
        myspace\.cn|
        simsidekick\.com|
        levisawards\.com|
        digg\.com)\//i));

if(A){  // Frame bust }
```

Do Your Trusted Sites Frame Bust?



Google ace of base myspace Search images Back to image results

See full size image

890 x 540 - 119k - jpg - custom.mubito.com/.../myspace/myspace_logo.jpg

Image may be subject to copyright.

Below is the image at: www.myspace.com/aceofbase

Remove frame

Google Images does not frame bust

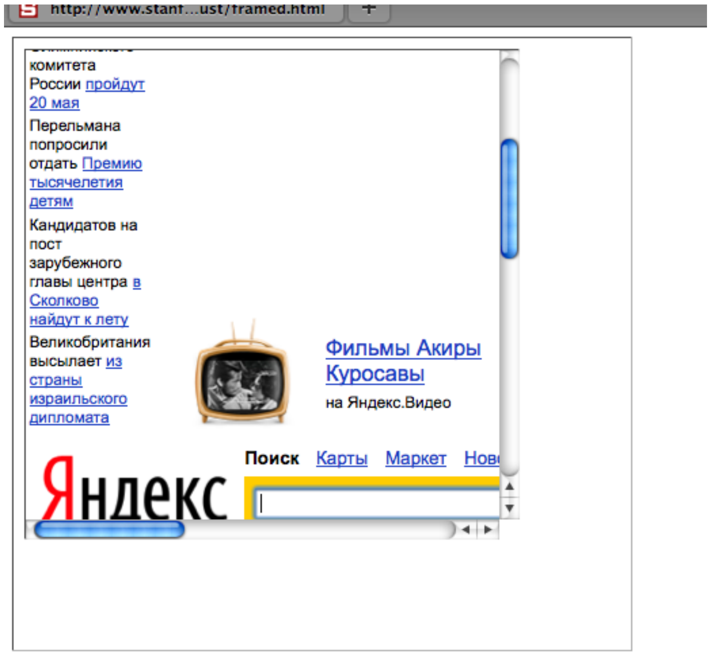
Many Attacks on Referer Header

- Open redirect referer changer
- HTTPS->HTTP redirect changes the header
- Apparently, hard to get regular expression right
- Trust other sites to frame your pages, but what if those trusted sites can be framed themselves?

Typical Frame Busting Code

```
if(top.location != self.location) {
    parent.location = self.location;
 }
```

Who Is Your ~~Daddy~~ Parent?



комитета России пройдут 20 мая

Перельмана попросили отдать Премию тысячелетия детям

Кандидатов на пост зарубежного главы центра в Сколково найдут к лету

Великобритания высылает из страны израильского дипломата

Фильмы Акиры Куросавы

на Яндекс.Видео

Double framing!!

framed1.html
<iframe src="framed2.html">

framed2.html
<iframe src="victim.com">

Who Is On Top?

```
if  (top.location != self.location)
     top.location = self.location
```

If top.location can be changed or disabled, this code is useless

Location Clobbering

IE 7

```
var location=“clobbered”;
```

Safari

```
window.__defineSetter__("location", function(){});
```

- top.location now undefined

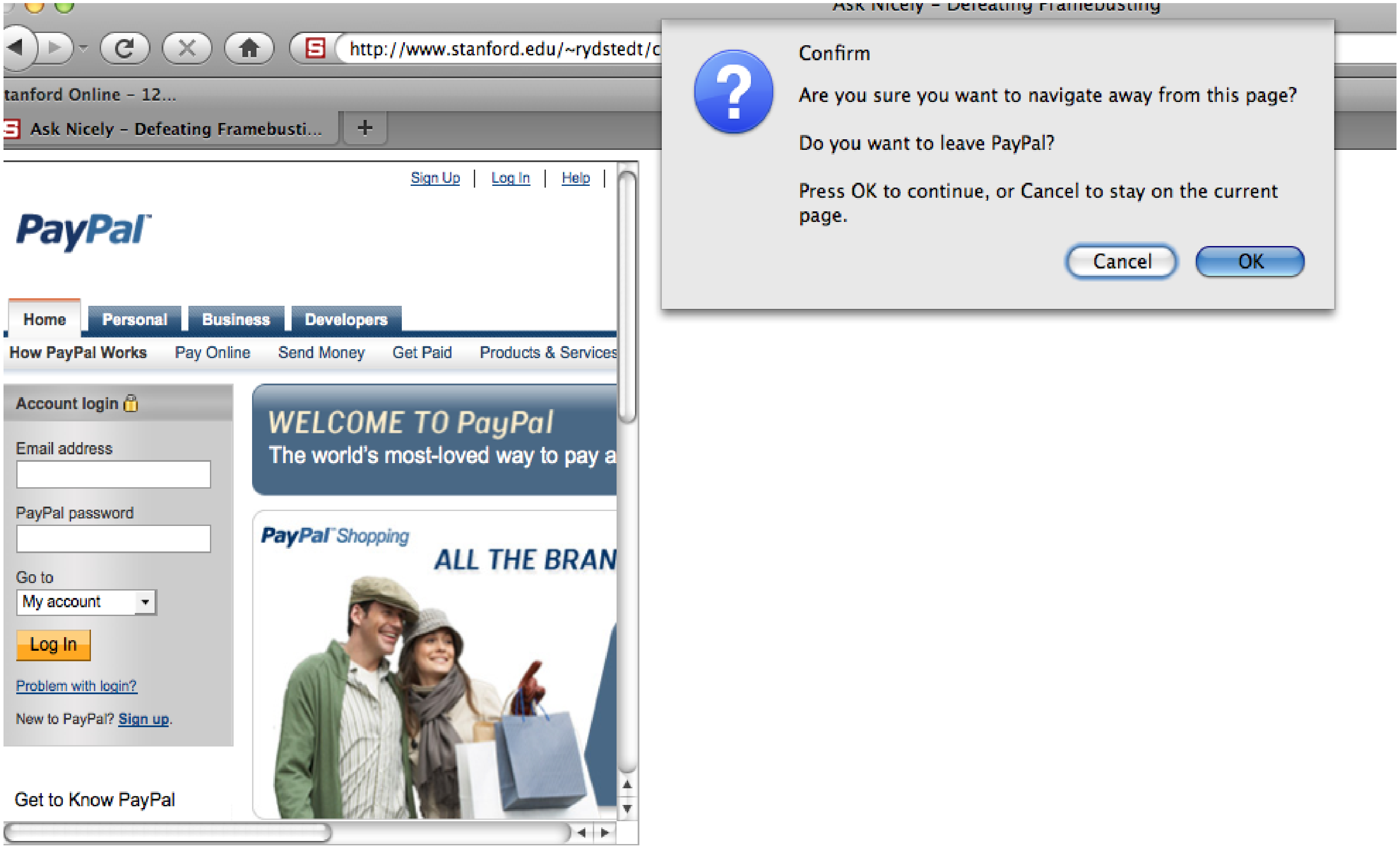
User Can Stop Frame Busting

User can manually cancel any redirection attempt made by frame busting code

Attacker just needs to ask…

```
<script>
  window.onbeforeunload = function() {
    return ”Do you want to leave PayPal?";
  }
</script>
<iframe src="http://www.paypal.com">
```

Ask Nicely



Confirm

Are you sure you want to navigate away from this page?

Do you want to leave PayPal?

Press OK to continue, or Cancel to stay on the current page.

… Or Don’t Even Ask

Most browsers let attacker cancel the relocation programmatically

```
var prevent_bust = 0
window.onbeforeunload = function() {kill_bust++ }
setInterval(function() {
    if (kill_bust > 0) {
            kill_bust -= 2;
            window.top.location = 'http://no-content-204.com'
    }
}, 1);
<iframe src="http://www.victim.com">
```

X-Frame-Options

HTTP header sent with the page

Two possible values: DENY and SAMEORIGIN

DENY: page will not render if framed

SAMEORIGIN: page will only render if top frame has the same origin

Adoption of X-Frame-Options

Good adoption by browsers

Worse adoption by sites

Limitations

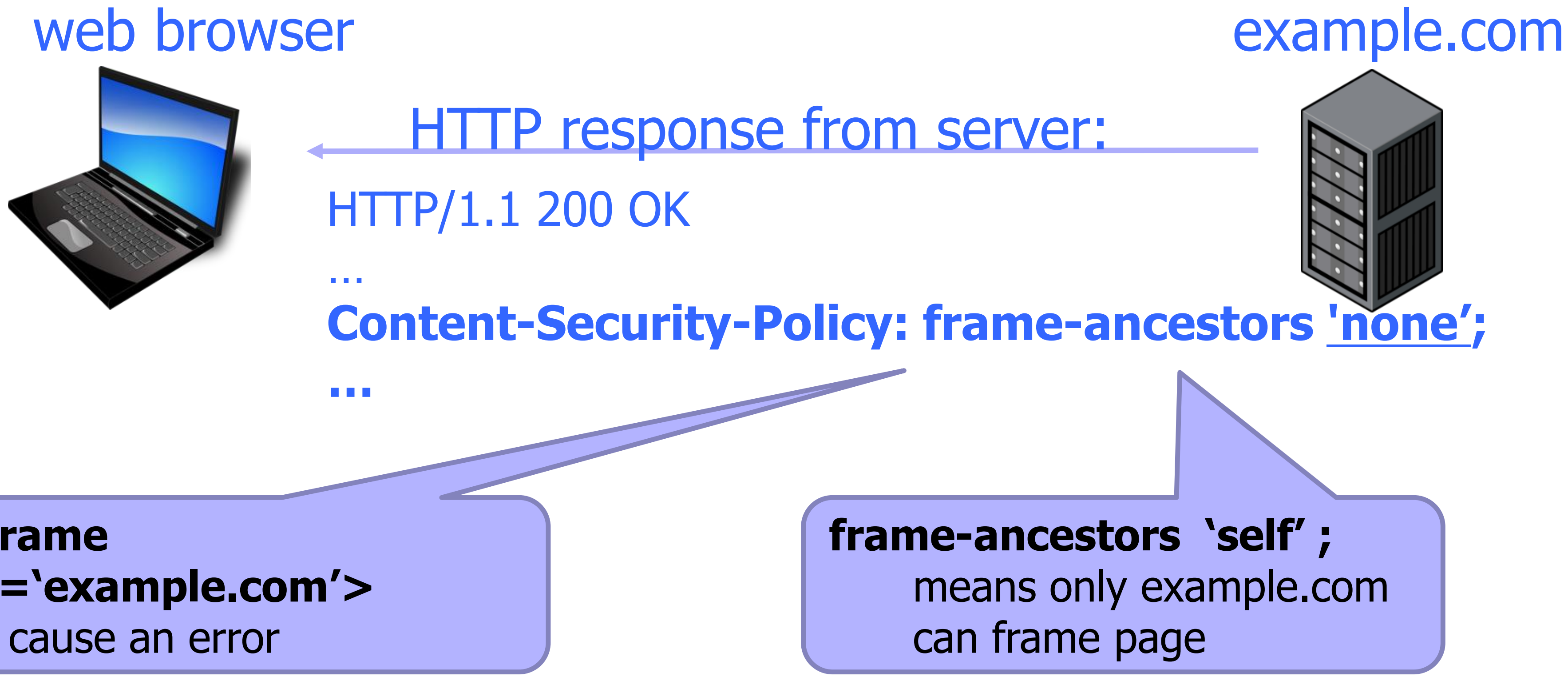
- Per-page policy
- No whitelisting of origins
- Proxy problems

Content Security Policy (Firefox 4)

Another HTTP header: frame-ancestors directive can specify allowed framers

Allows specific restrictions and abilities per site

Correct defense: CSP



web browser

example.com

HTTP response from server:

HTTP/1.1 200 OK

…

Content-Security-Policy: frame-ancestors 'none’;

…

<iframe src=‘example.com’> will cause an error

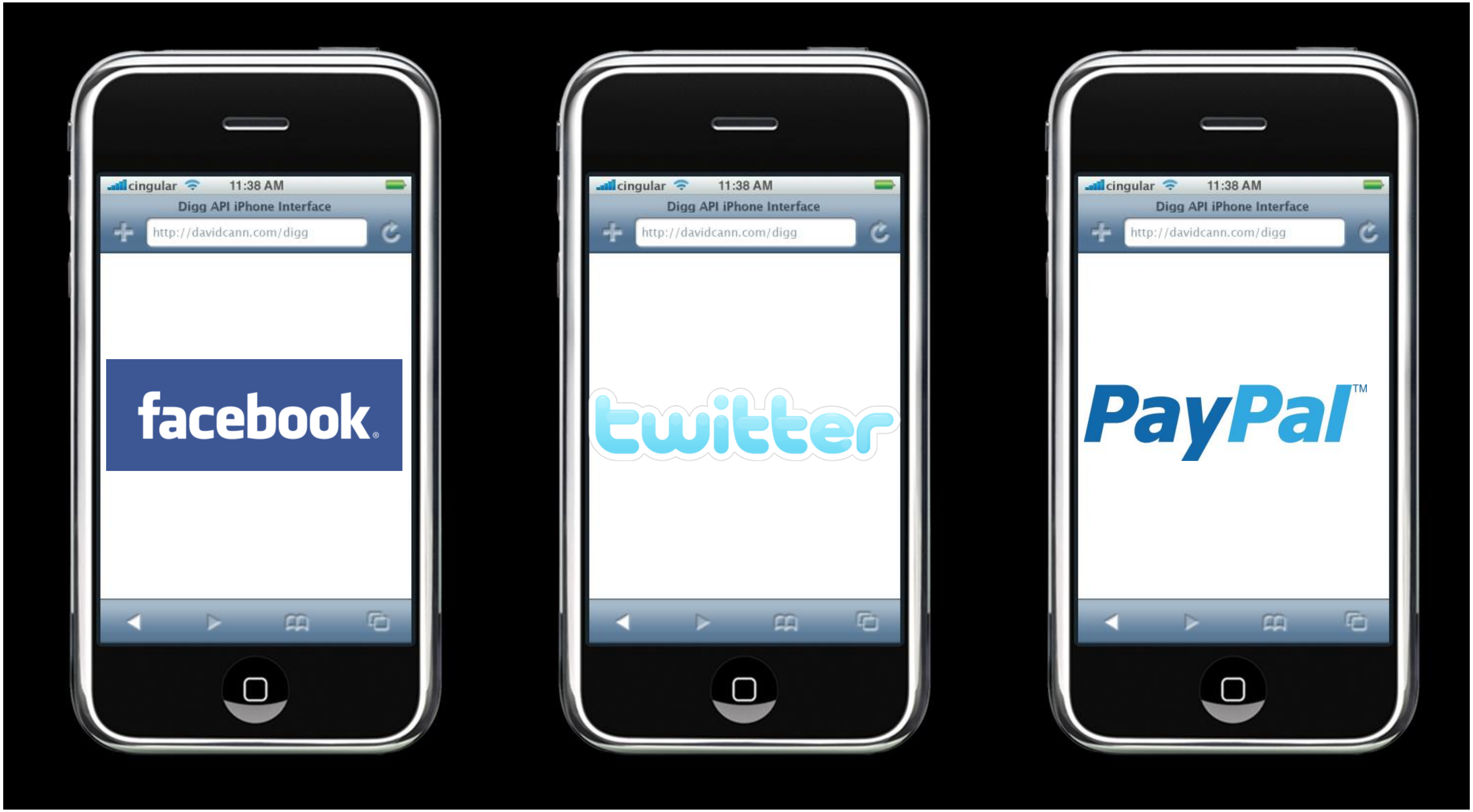
frame-ancestors ‘self’ ; means only example.com can frame page

Best For Now (Still Not Good)

```
<style>html { visibility: hidden }</style>
<script>
if (self == top) {
  document.documentElement.style.visibility = 'visible';
} else {
  top.location = self.location;
}
</script>
```

These Sites Do Frame Busting

Do These?


cingular
11:38 AM
Digg API iPhone Interface
http://davidcann.com/digg
facebook
cingular
11:38 AM
Digg API iPhone Interface
http://davidcann.com/digg
twitter
cingular
11:38 AM
Digg API iPhone Interface
http://davidcann.com/digg
PayPal™

Tap-jacking

User visits a gaming website:

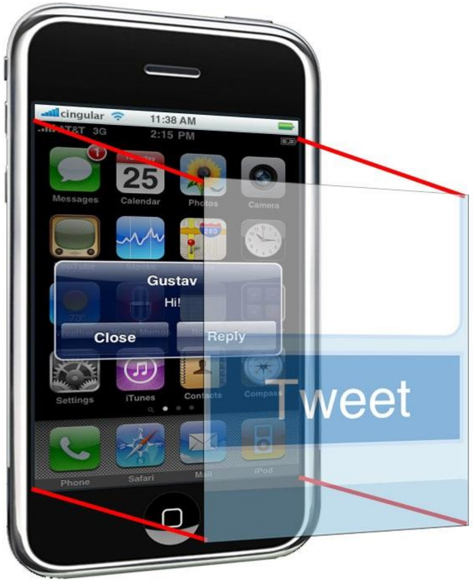
Can zoom, auto scroll

Website zooms buttons in a transparent frame so they cover entire screen

… hides or fakes URL bar

… imitates a known app to trick user into clicking

- Ex: display incoming text message screen, but frame Twitter


cingular
11:38 AM
AT&T 3G
2:15 PM
25
Messages
Calendar
Photos
Camera
Gustav
Hi!
Close
Reply
Settings
iTunes
Contacts
Compass
Tweet
Phone
Safari
Mail
iPod