Securing a Django (Wait, any!) Website

Nick Thompson

September 26, 2015

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- This will not provide information about securing your server, only information about keeping data secure when it is on the wire.
- More information about securing your server can be found elsewhere.
- Securing the wire is the easy part; harder is keeping authenticated users from grabbing other users data *because that's code you write yourself*.

Getting started:

```
$ git clone https://github.com/NAThompson/django_https.git
$ pyvenv django_https
$ cd django_https
$ pip3 install -r requirements.txt
$ sudo /bin/bash
$$ . bin/activate
```

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```

We'll need root to open up priviledged ports. Sourcing after acquisition of root shell is necessary.

Generating Certificates

```
$ openssl genrsa  openssl genrsa -out example.com.key 4096 # Private ke
$ openssl req -new -sha256 -key example.com.key -out example.com.csr #
$ openssl req -noout -text -in example.com.csr # Validation
$ cat example.com.csr  | pbcopy # Copy/Paste the csr into your certific
```

Installing Certificates

Once you get your certs from your certificate authority, then need to be bundled *in the right order*:

```
$ cat www_example_com.crt COMODORSADomainValidationSecureServerCA.crt \
COMODORSAAddTrustCA.crt AddTrustExternalCARoot.crt > bundle.crt
```

Server Stack

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- In my experience, nginx is less painful, so we'll focus on configuring nginx.
- django-secure settings will tend to override nginx settings, or they will be set twice in the http headers. So use nginx, or use django-secure, not both.

Configuring django-secure

- Add the following to your INSTALLED_APPS in settings.py:

```
INSTALLED_APPS = (
    'sslserver',
    ...,
    'djangosecure',
)
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- Then run the test server via:

```
$ ./manage.py checksecure
$ ./manage.py runsslserver --addrport 127.0.0.1:443
```

This is nice for development because it uses self-signed certificates with relative paths.
But it also might convince your browser that it's experiencing a MITM attack at 127.0.0.1, which is annoying.

Install nginx

```
$ sudo apt-get install nginx # Ubuntu
$ sudo brew install nginx # Mac
```

Turn SSL on and proxy-pass to gunicorn

```
server {
  listen          443;
  ssl             on;
  server_name     example.com;
  ssl_certificate  /somedir/bundle.crt;
  ssl_certificate_key /somedir/mykey.key;

  location / {
     proxy_pass https://127.0.0.1:8000;
     proxy_set_header Host $host;
     proxy_set_header X-Forwarded-For $proxy_add_x_forwarded_for;
  }
}
```

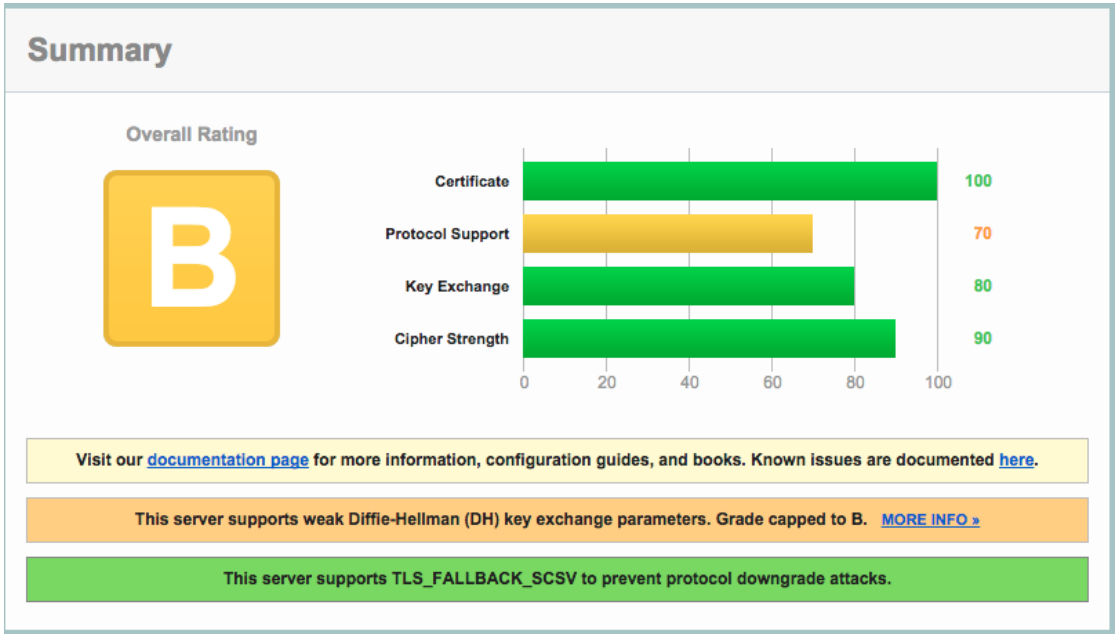
How to serve the website

```
$$ cd django_https/src
$$ gunicorn -c gunicorn_config.py https.wsgi &
$$ cd ..
$$ nginx -c `pwd`/nginx.conf -t
$$ nginx -c `pwd`/nginx.conf
```

(Again, there are some hard-coded paths in this . . .)

How secure is the default nginx configuration?

- SSL Labs doesn't think it's all that great:



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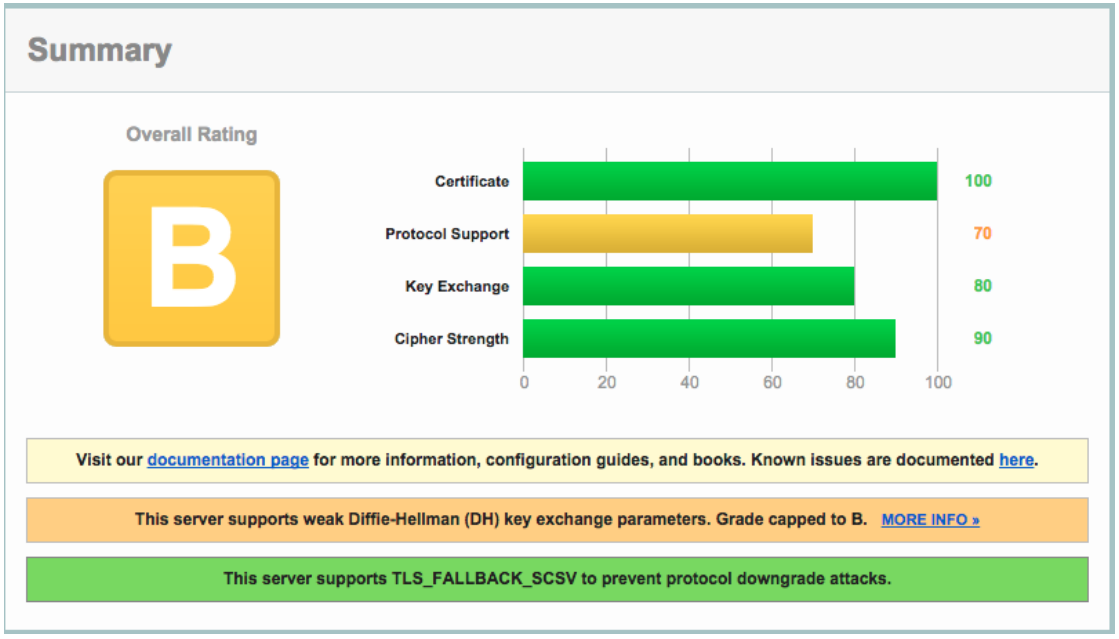

- If your clients have an IT policy, they *will ask about this*.

Improving SSLLabs grade

- In the nginx.conf, change

```
ssl_protocols TLSv1 TLSv1.1 TLSv1.2;
```

  to

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- Note: This will lose you some old IE browsers. SSLLabs will tell you which ones in the handshake simulation section of their report.

Some justification for only supporting TLSv1.2

- The Payment Card Industry (PCI) Security Standards Council says you must remove support for TLSv1.0 to be PCI compliant. “SSL and early TLS are not considered strong cryptography and cannot be used as a security control after 30th June, 2016.“

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- OWASP (Open Web Application Security Project) claims "TLS 1.0 is still widely used as 'best' protocol by a lot of browsers, that are not patched to the very latest version. . . TLSv1.0 should only be used only after risk analysis and acceptance."
- Almost no browsers support TLSv1.1 and *not* TLSv1.2. So make your life easier and just use 1.2.

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- But you can still improve your grade by restricting the supported ciphersuite by adding this to the http section of nginx.conf:

```
ssl_ciphers ECDHE-RSA-AES256-GCM-SHA384:ECDHE-ECDSA-AES256-GCM-SHA3
-AES256-SHA384:ECDHE-ECDSA-AES256-SHA384:ECDHE-RSA-AES256-SHA:ECDHE
-RSA-AES256-GCM-SHA384:DHE-RSA-AES256-GCM-SHA:DHE-RSA-AES256-SHA256
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```

- This is a mess, what does it mean?

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- The browser tells the server what ciphersuites it supports
- The server selects one that is in the ssl_ciphers list,
- The server tells the browser what ciphers they are using, or rejects the connection if they can't agree on a cipher suite.

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- A message authentication code algorithm (hash function, SHA256)
- An authentication protocol (e.g., RSA)

Understanding available ciphersuites

To see what ciphers your nginx supports, run

```
$ openssl ciphers | tr ':' '\n'
```

(nginx links against openssl's libraries)

Understanding available ciphersuites

- To understand a given cipher, we use

```
$ openssl ciphers -v ECDHE-RSA-AES256-GCM-SHA384
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TLSv1.2 Kx=ECDH     Au=RSA  Enc=AESGCM(256) Mac=AEAD
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- Enc= Encryption; AESGCM(256) is 256 bit Advanced Encryption Standard in Galois Counter mode for encryption (please don't ask about GCM!)
- Mac= Message Authentication; AEAD ="authentication encryption with associated data" for message authentication (inherited from the "Galois counter mode" of AES)

Interpreting ssl_ciphers

Suppose this was our configuration:

```
ssl_ciphers ECDHE-RSA-AES256-GCM-SHA384:ECDHE-ECDSA-AES256-GCM-SHA384;
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- The order matters: Adding “ssl_prefer_server_ciphers on;“ to the nginx.conf tells nginx to ignore the preferences of the browser.

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- So first we would use ECDHE-RSA-AES256-GCM-SHA384, but if the browser doesn't support it, then we use ECDHE-ECDSA-AES256-GCM-SHA384.
- Otherwise, we don't make the connection to the browser.

What ciphersuites does my browser support?

There are some websites who will tell you:

Cipher Suites Supported by Your Browser (ordered by preference):

Spec	Cipher Suite Name	Key Size	Description
(cc,14)	ECDHE-ECDSA-CHACHA20-POLY1305-SHA256	128 Bit	Key exchange: ECDH, encryption: ChaCha20 Poly1305, MAC: SHA256.
(cc,13)	ECDHE-RSA-CHACHA20-POLY1305-SHA256	128 Bit	Key exchange: ECDH, encryption: ChaCha20 Poly1305, MAC: SHA256.
(cc,15)	DHE-RSA-CHACHA20-POLY1305-SHA256	128 Bit	Key exchange: DH, encryption: ChaCha20 Poly1305, MAC: SHA256.
(c0,2b)	ECDHE-ECDSA-AES128-GCM-SHA256	128 Bit	Key exchange: ECDH, encryption: AES, MAC: SHA256.
(c0,2f)	ECDHE-RSA-AES128-GCM-SHA256	128 Bit	Key exchange: ECDH, encryption: AES, MAC: SHA256.
(00,9e)	DHE-RSA-AES128-GCM-SHA256	128 Bit	Key exchange: DH, encryption: AES, MAC: SHA256.
(c0,0a)	ECDHE-ECDSA-AES256-SHA	256 Bit	Key exchange: ECDH, encryption: AES, MAC: SHA1.
(c0,14)	ECDHE-RSA-AES256-SHA	256 Bit	Key exchange: ECDH, encryption: AES, MAC: SHA1.
(00,39)	DHE-RSA-AES256-SHA	256 Bit	Key exchange: DH, encryption: AES, MAC: SHA1.
(c0,09)	ECDHE-ECDSA-AES128-SHA	128 Bit	Key exchange: ECDH, encryption: AES, MAC: SHA1.
(c0,13)	ECDHE-RSA-AES128-SHA	128 Bit	Key exchange: ECDH, encryption: AES, MAC: SHA1.
(00,33)	DHE-RSA-AES128-SHA	128 Bit	Key exchange: DH, encryption: AES, MAC: SHA1.
(00,9c)	RSA-AES128-GCM-SHA256	128 Bit	Key exchange: RSA, encryption: AES, MAC: SHA256.
(00,35)	RSA-AES256-SHA	256 Bit	Key exchange: RSA, encryption: AES, MAC: SHA1.
(00,2f)	RSA-AES128-SHA	128 Bit	Key exchange: RSA, encryption: AES, MAC: SHA1.
(00,0a)	RSA-3DES-EDE-SHA	168 Bit	Key exchange: RSA, encryption: 3DES, MAC: SHA1.
(00,ff)	EMPTY-RENEGOTIATION-INFO-SCSV	0 Bit	Used for secure renegotation.

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- Make sure to sign your certificates with SHA256 over SHA1, or else it will not be trusted by Google Chrome.
- Prefer elliptic curves, unless you think the NSA has a quantum computer.

Defense Against the Logjam attack

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- It's thought that it was only used by state-level adversaries, but it seems that this will change soon.

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This is a secure protocol as solving $A = g^a \mod p$ for a (called "the discrete logarithm") is hard.

Diversion: Enabling Forward Secrecy

". . . which means a compromise of the server's long term signing key does not compromise the confidentiality of past session"

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- Question: What does the server do with a (the random secret) after the SSL session ends?
- Can the NSA subpoena your Diffie-Helman session keys?

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- Then everyone uses the same damn prime.
- "The situation for export Diffie-Hellman is particularly awful, with only two (!) primes used across up 92% of enabled Apache/mod_ssl sites."

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- Then an attacker can do a downgrade attack so that the prime p is only 512 bits.
- This allows a MITM to intercept your server message, and send it saying "we only support 512 bit DH"; the browser supports it, so it agrees to use of export-grade crypto.

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- But for fixed p, using a *very sophisticated* lookup table, computing the *next* discrete log only takes 90 seconds.

The solution is . . .

Generating a large, unique Diffie-Hellman Prime

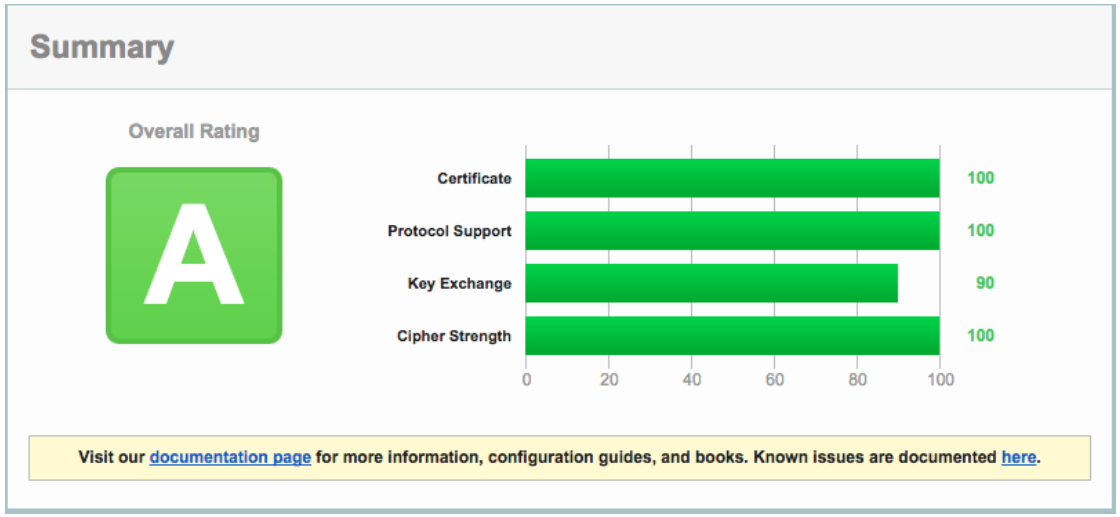
```
$ openssl dhparam -2 -check -out dhparam.pem 4096
```

and add the following line to the nginx.conf:

```
ssl_dhparam /path_to_pem/dhparam.pem
```

The “-2” is the group generator, 4096 is the number of bits.

SSLLabs is now Happy



You can see the SSLLabs rating guide here.

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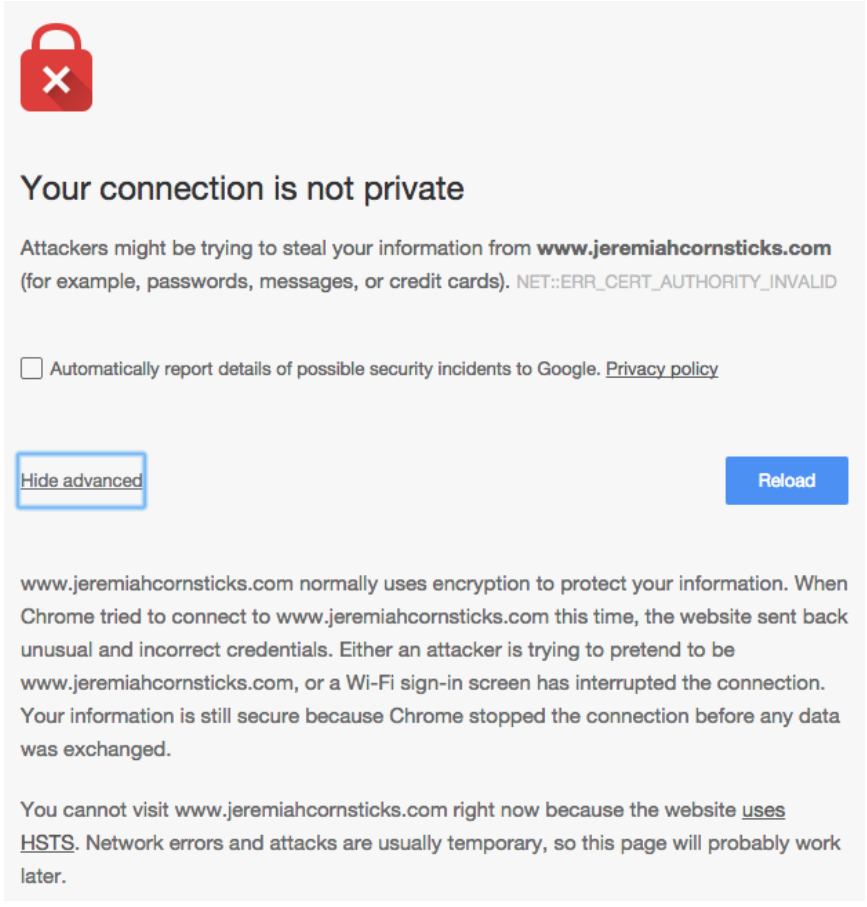
- A protocol by which servers force all traffic to come over https.
- Server informs browser to recognize MITM attack by requests for http traffic
- Stops downgrade attacks and cookie hijacking.
- Stops SSL stripping!

HSTS

A user who has visited your site previously *cannot* proceed past a bad certificate:



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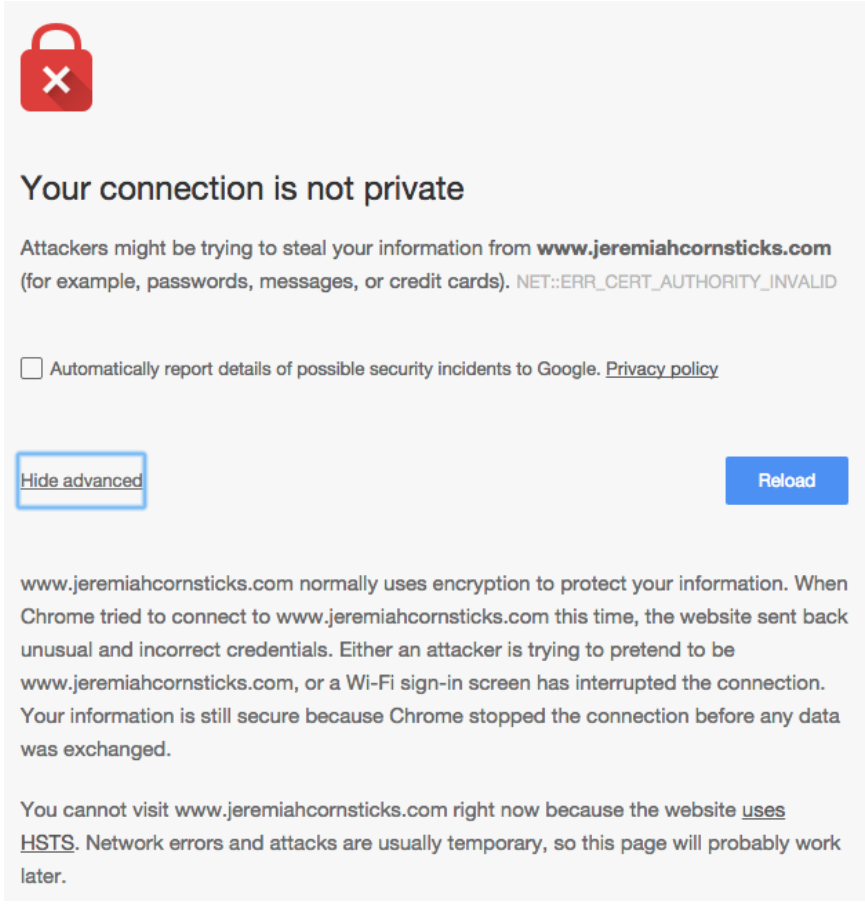

(Unless they clear their browser cache . . . then the user can ignore the warning and proceed.)

HSTS Redirects http to https

But only after a user visits the first time . . .

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- Register your site in the preload list!

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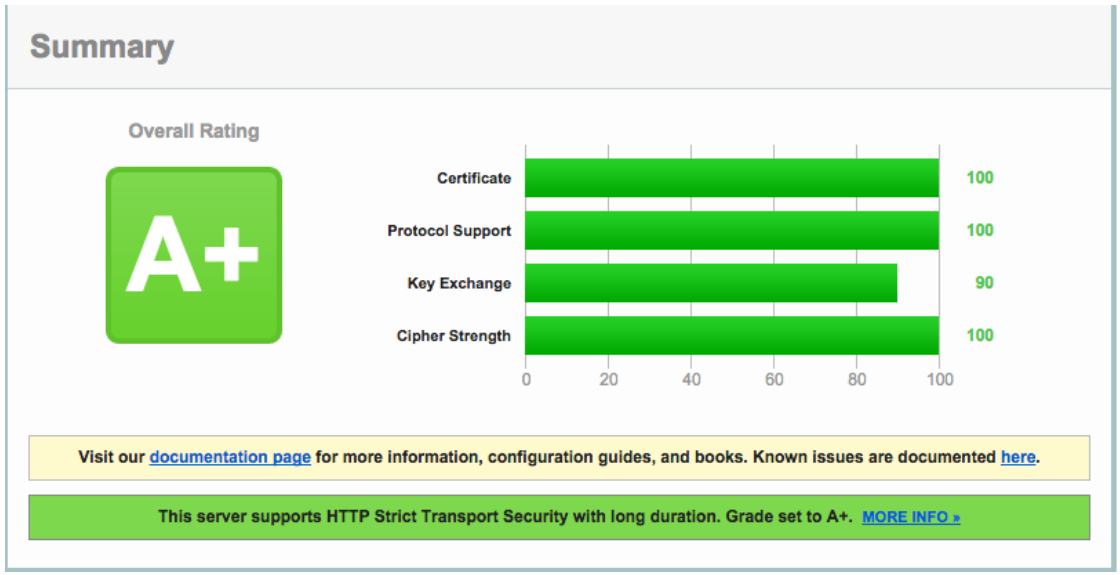
- Register your site in the preload list!
- "This form is used to submit domains for inclusion in Chrome's HTTP Strict Transport Security (HSTS) preload list. This is a list of sites that are hardcoded into Chrome as being HTTPS only."

Configuring HSTS

- Add this to the server section in “default”:

```
add_header Strict-Transport-Security \
 "max-age=63072000; includeSubdomains";
```



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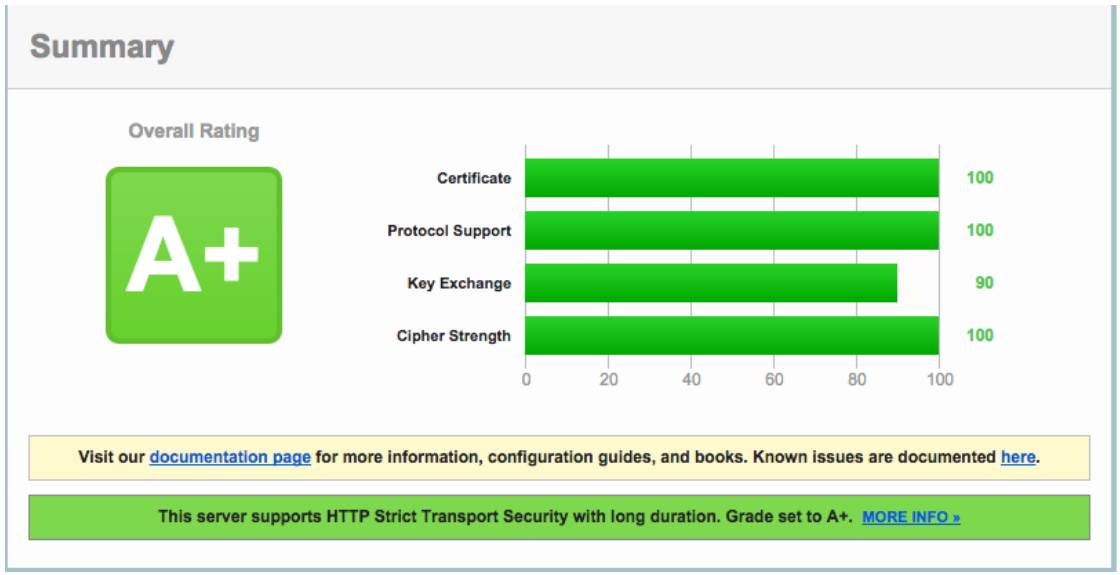

- The server now says: "For the next 63072000 seconds, this server and its subdomains will only be using https. Any http traffic is a MITM attack."

HSTS Configured in django-secure

- Add the following to your settings.py:

```
SECURE_HSTS_SECONDS = 63072000
SECURE_HSTS_SUBDOMAINS = True
SECURE_HSTS_INCLUDE_SUBDOMAINS = True
```

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SECURE_HSTS_SECONDS = 63072000
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- Not that this will override the nginx settings, if you set them both.

Debugging Aid:

- The server's use of HSTS is communicated via http headers, and nginx doesn't do a strong validation of the nginx.conf. In addition, nginx version changes can silently break your nginx.conf.

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- To validate that you've actually set a http header:

```
$ curl -v -I https://example.com
< Strict-Transport-Security: max-age=63072000; includeSubdomains; a
Strict-Transport-Security: max-age=63072000; includeSubdomains; alw
< X-Frame-Options: DENY
X-Frame-Options: DENY
< X-Content-Type-Options: nosniff
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```

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$ openssl req -new -sha256 -key foo.key -out foo.csr
```

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$ openssl req -new -sha256 -key foo.key -out foo.csr
```
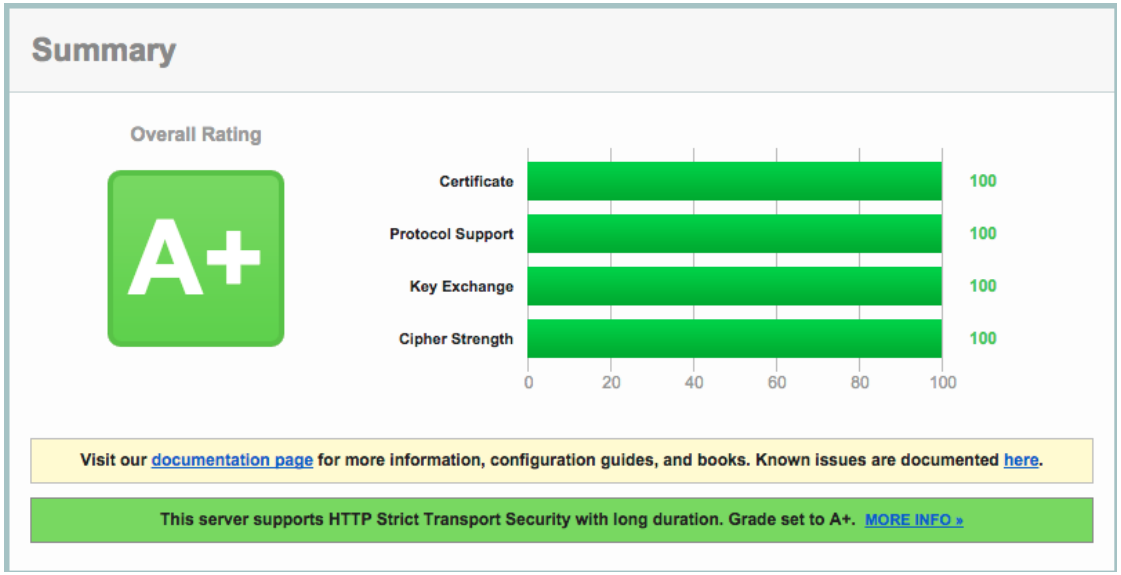

Use this certificate signing request to get certs from your provider, and you're done!



OCSP Stapling

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- Browsers must query certificate authority (CA), revealing websites they visit
- OCSP Stapling: Server caches CA's OCSP digitally signed response, increasing privacy as well as speed

Enabling OCSP Stapling in nginx

- Bundle intermediate and root certifications:

  `cat  foo1.crt foo2.crt > ocsp.crt;`

  Since I bought $5 certificates for this talk, I did:

```
cat COMODORSADomainValidationSecureServerCA.crt \
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   COMODORSAAddTrustCA.crt > ocsp.crt
  ```

- Then add the following lines to the nginx.conf:

  ```
  resolver 8.8.8.8;
  ssl_stapling on;
  ssl_stapling_verify on;
  ssl_trusted_certificate /pathtocerts/ocsp.crt;
  ```

Diversion: Certificate Authorities

- Free, trusted certificates coming next month from Let's Encrypt

Clickjacking

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- Then they make your page invisible, but put "Win free iPad!", and a place to click over the "Buy it now" link of the ebay listing
- If you are logged in on ebay, you are the proud owner of a new car!

Clickjacking

"One of the most notorious examples of Clickjacking was an attack against the Adobe Flash plugin settings page. By loading this page into an invisible iframe, an attacker could trick a user into altering the security settings of Flash, giving permission for any Flash animation to utilize the computer's microphone and camera."

Defense against clickjacking

As a web user: You're screwed. But you shouldn't click on "Free iPad" links.

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  SECURE_FRAME_DENY = True
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- Note that this is a non-standard extension to html. There is a standardized way (see content security policies), but it's not yet supported by all modern browsers

Defense against clickjacking

- This is such a huge problem that the default django configuration actually sets the http response header "X-Frame-Options: SAMEORIGIN":

```
MIDDLEWARE_CLASSES = (
...
'django.middleware.clickjacking.XFrameOptionsMiddleware',
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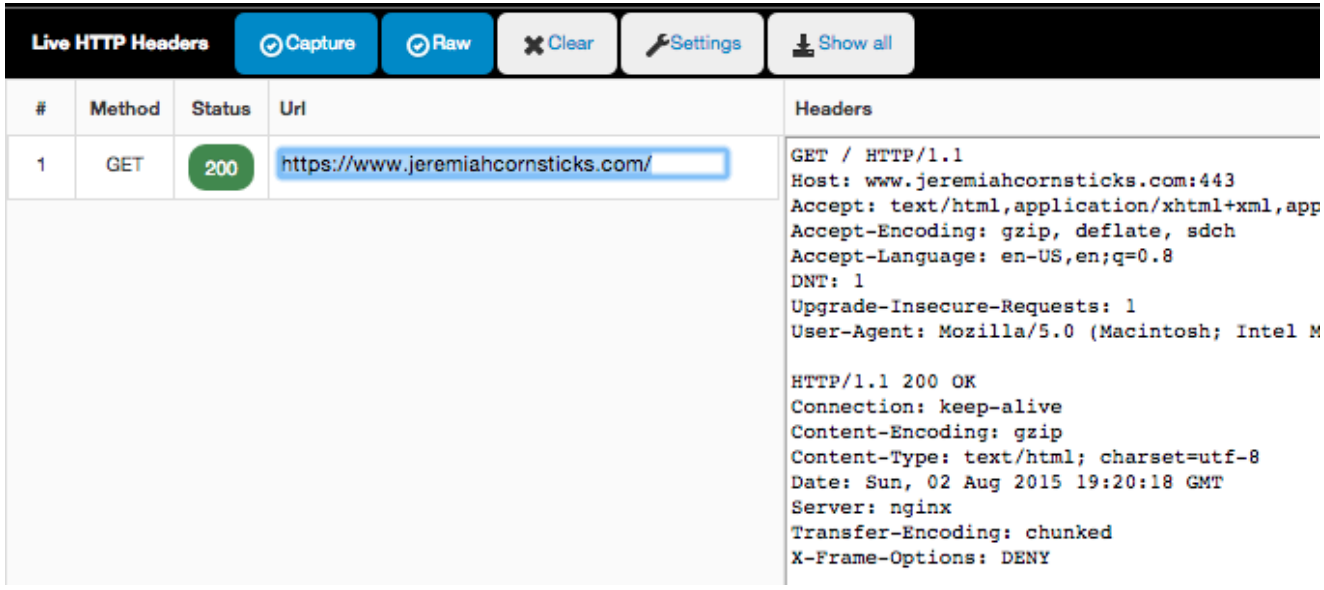
- SAMEORIGIN means you can embed your own webpages in html frames, but disallows its embedding in other people's websites.

Verify the http header

Again, verify that the `X-Frame-Options: DENY` header has been sent:



Content Sniffing

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- So Microsoft decided to give IE the capacity to guess the interpretation of a byte-stream, called content-sniffing

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- This is mainly a problem on sites where users can both upload and download data.

Preventing Content Sniffing Attacks

- Add the following to the nginx.conf:

```
add_header X-Content-Type-Options nosniff;
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- Or to your settings.py:

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  ```

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- Example: The Iranian gov't hacked the Dutch certificate authority, and issued a certificate for google.com.
- An Iranian hacked Comodo and issued numerous certificates for various websites, allowing him to eavesdrop on anyone who resolved to his certs.

Mitigation for Certificate Authority Fraud:

- A way of dealing with CA fraud is called *public key pinning*.

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- A way of dealing with CA fraud is called *public key pinning*.
- This tells your browser to remember what the public keys were for your website; *trusting what it receives the first time*

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- If that key gets compromised, users browsers will detect fraud if you have to generate new keys. So you need to generate a hash of a backup key:

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$ openssl rsa -in backup.key -outform der -pubout |
    openssl dgst -sha256 -binary |
      openssl enc -base64
```

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```
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      openssl dgst -sha256 -binary |
        openssl enc -base64
```

- Copy and paste these hashes into the server section of `default`:

```
add_header Public-Key-Pins
      'pin-sha256="N75JcN+pnfzlS9WlZ5MQ5bMrYf8FixevQdnXECdeI8k=";
      pin-sha256="LK8yU6d5hJnXaONIycD2bYNCwu9MVBL3MjM/Fs1a9pg=";
      includeSubDomains; max-age=5184000';
```

Pony Checkup

For django-powered websites, use Pony Checkup to do additional security validation.

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  server_tokens off;
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- SSLlabs can still determine that nginx is serving the website, but doesn't know the version.