Security

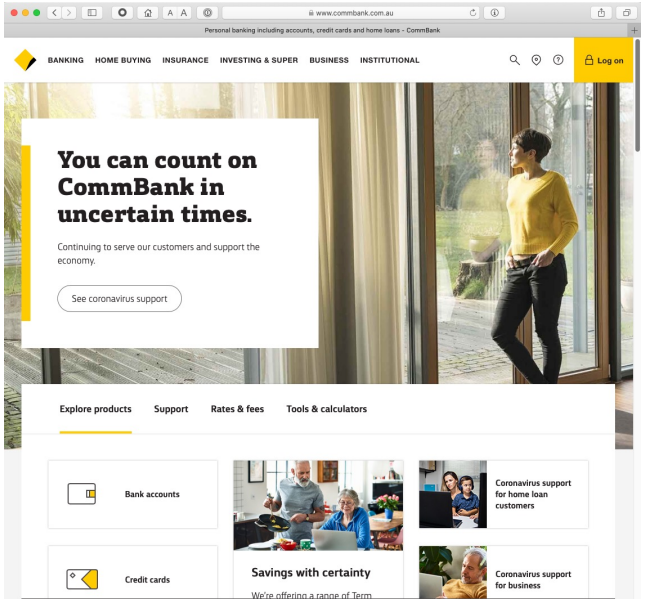
Geoff Huston
Chief Scientist, APNIC

~~Security~~

'insecurity!

Geoff Huston
Chief Scientist, APNIC

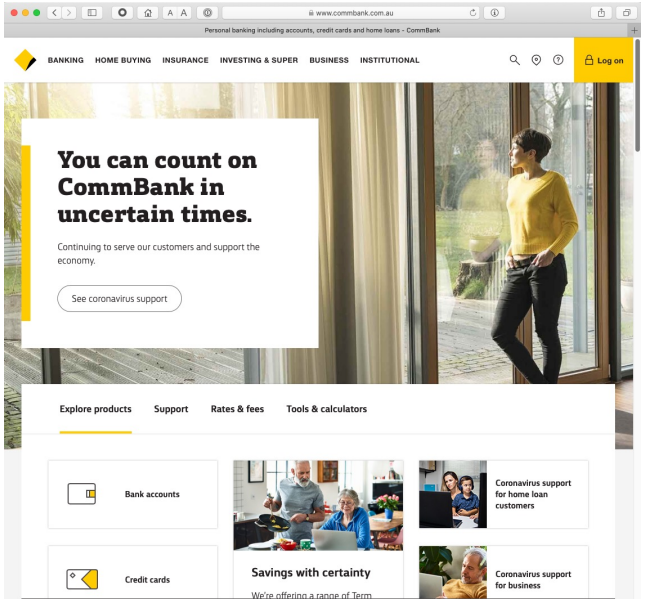
Which Bank?



Let’s start with a simple example:

Why should you pass your account and password to this web site? It might look like your bank, but frankly it could just as easily be a fraudulent site intended to steal your banking credentials. Why should you trust what you see on the screen?

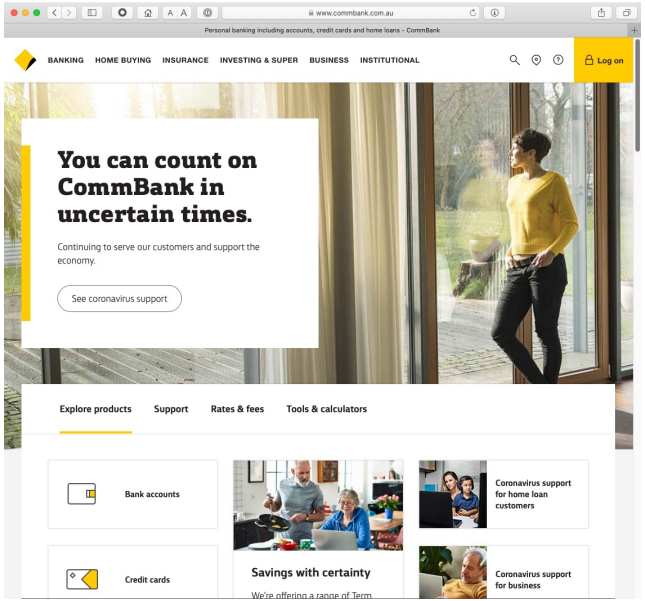
Which Bank? My Bank!



Ok – its not a random example. It's the online bank I use! But the same question is still there. Why should I trust this web page?

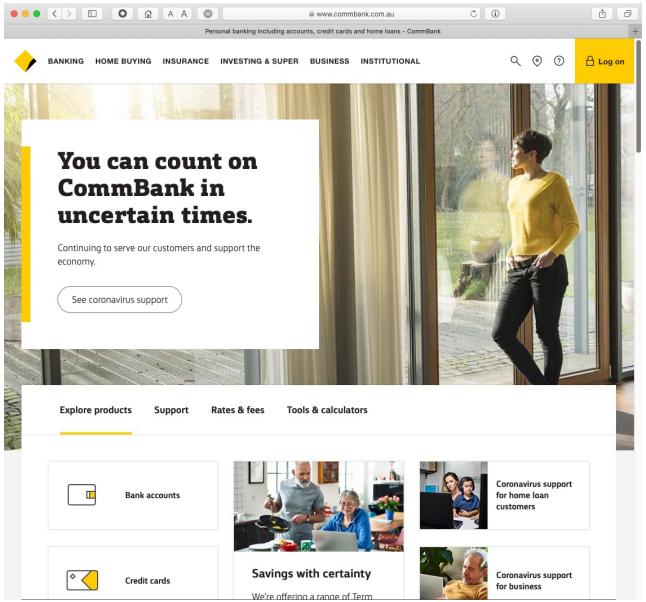
Which Bank? My Bank!

i hope!



Security on the Internet

How do you know that you are really going to where you thought you were going to?



its trivial to mock up a web page to look like another

Security on the Internet

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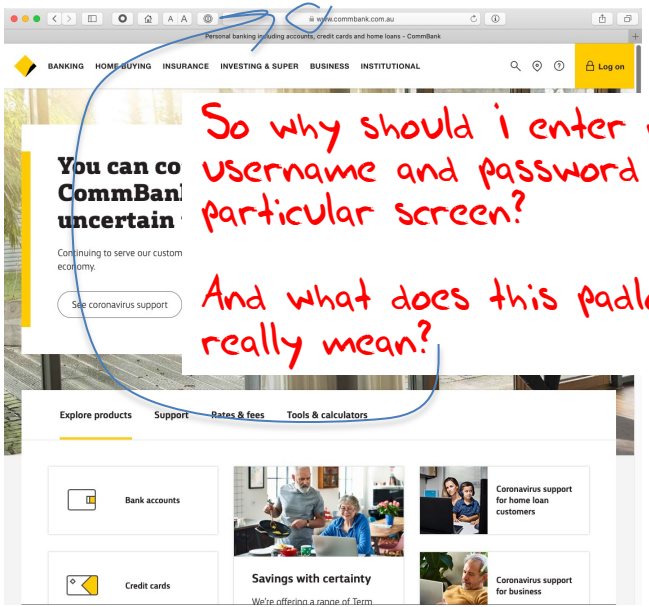


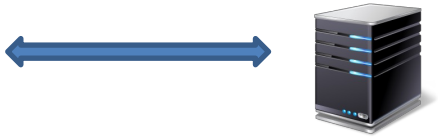
its trivial to mock up a web page to look like another

Opening the Connection: First Steps

Client:

DNS Query:

www.commbank.com.au?



DNS Response:

23.215.58.96

TCP Session:

TCP Connect 23.215.58.96, port 443

Hang on…

```
$ dig -x 23.215.58.96 +short
a23-215-58-96.deploy.static.akamaitechnologies.com.
```

Hang on…

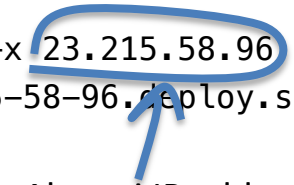
```
$ dig -x 23.215.58.96 +short
a23-215-58-96.deploy.static.akamaitechnologies.com.
```

That's **not** an IP addresses that was allocated to the Commonwealth Bank!

> The Commonwealth Bank of Australia has the address blocks
> 140.168.0.0 - 140.168.255.255 and
> 203.17.185.0 - 203.17.185.255

Hang on…

```
$ dig -x 23.215.58.96 +short
a23-215-58-96.deploy.static.akamaitechnologies.com.
```



That's an Akamai IP address

And I'm NOT a customer of the Internet Bank of Akamai!

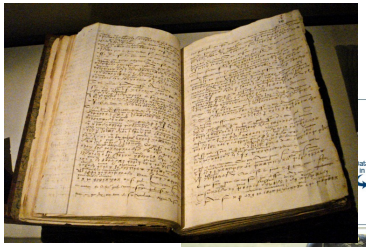
Why should my browser trust that 23.215.58.96 is really the authentic web site for the Commonwealth Bank of Australia, and not some dastardly evil scam designed to steal my passwords and my money?

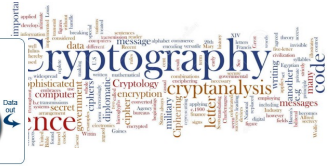
And why should I trust my browser?

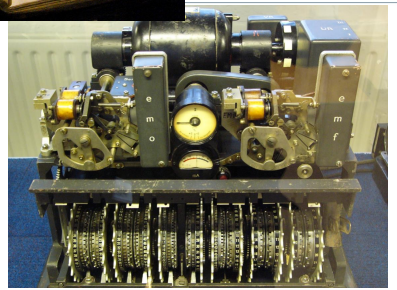
The major question…

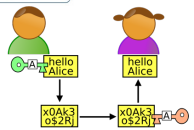
How does my browser tell the difference between an intended truth and a dastardly lie?

It's all about cryptography









Public Key Cryptography

Pick a **pair** of keys such that:

- Messages encoded with one key can only be decoded with the other key
- Knowledge of the value of one key does not infer the value of the other key
- Make one key **public**, and keep the other a closely guarded **private** secret

This is important

So I will repeat it:

- Using public/private key cryptography requires a pair of keys (A,B) such that:
  - Anything encrypted using key A can ONLY be decrypted using key B, and no other key
  - Anything encrypted using key B can ONLY be decrypted using key A, and no other key
  - Knowing the value of one key WILL NOT let you work out the value of the other key anytime soon!

This form of asymmetric cryptography lies at the heart of the Internet's security framework

Public/Private Key Pairs

If I have a copy of your PUBLIC key, and you encrypt a message with your PRIVATE key, and I can decrypt the message using your public key

- I know no one has tampered with your original message
- I am confident that no one else has seen the contents of the message while it was passed through the network
- And I know it was you that sent it.
- And you can’t deny it.

Public Key Certificates

But how do I know this is YOUR public key?

- And not the public key of some dastardly evil agent pretending to be you?

- I don’t know you
- I’ve never met you
- So I have absolutely no clue if this public key value is yours or not!

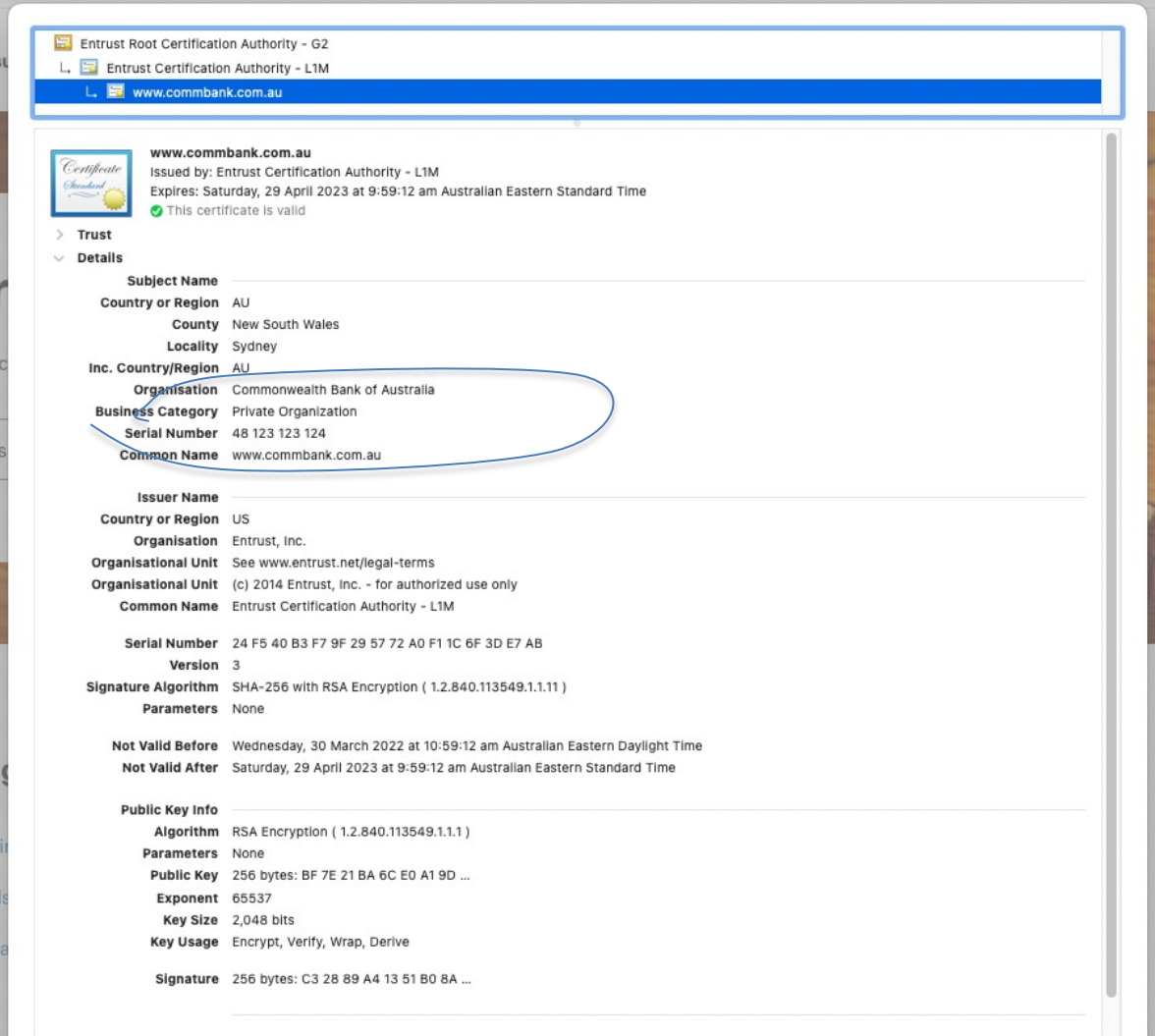
Public Key Certificates

What if I ‘trust’ an intermediary*?

- Who has contacted you and validated your identity and conducted a ‘proof of possession’ test that you have control of a private key that matches your public key

- Then if the intermediary signs an attestation that this is your public key (with their private key) then I would be able to trust this public key
- This ‘attestation’ takes the form of a “public key certificate”

** If you have ever used “public notaries” to validate a document, then this is a digital equivalent*

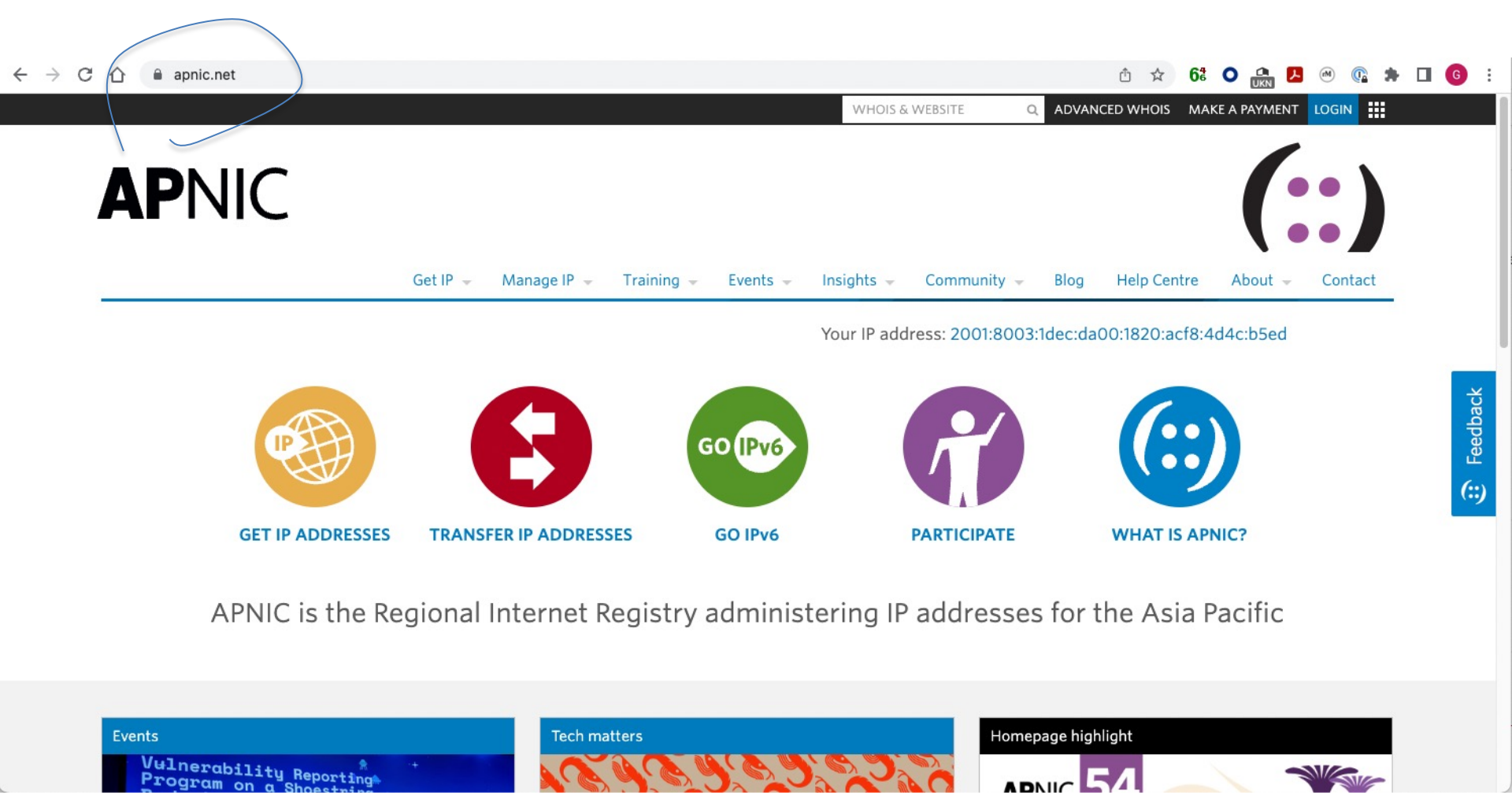


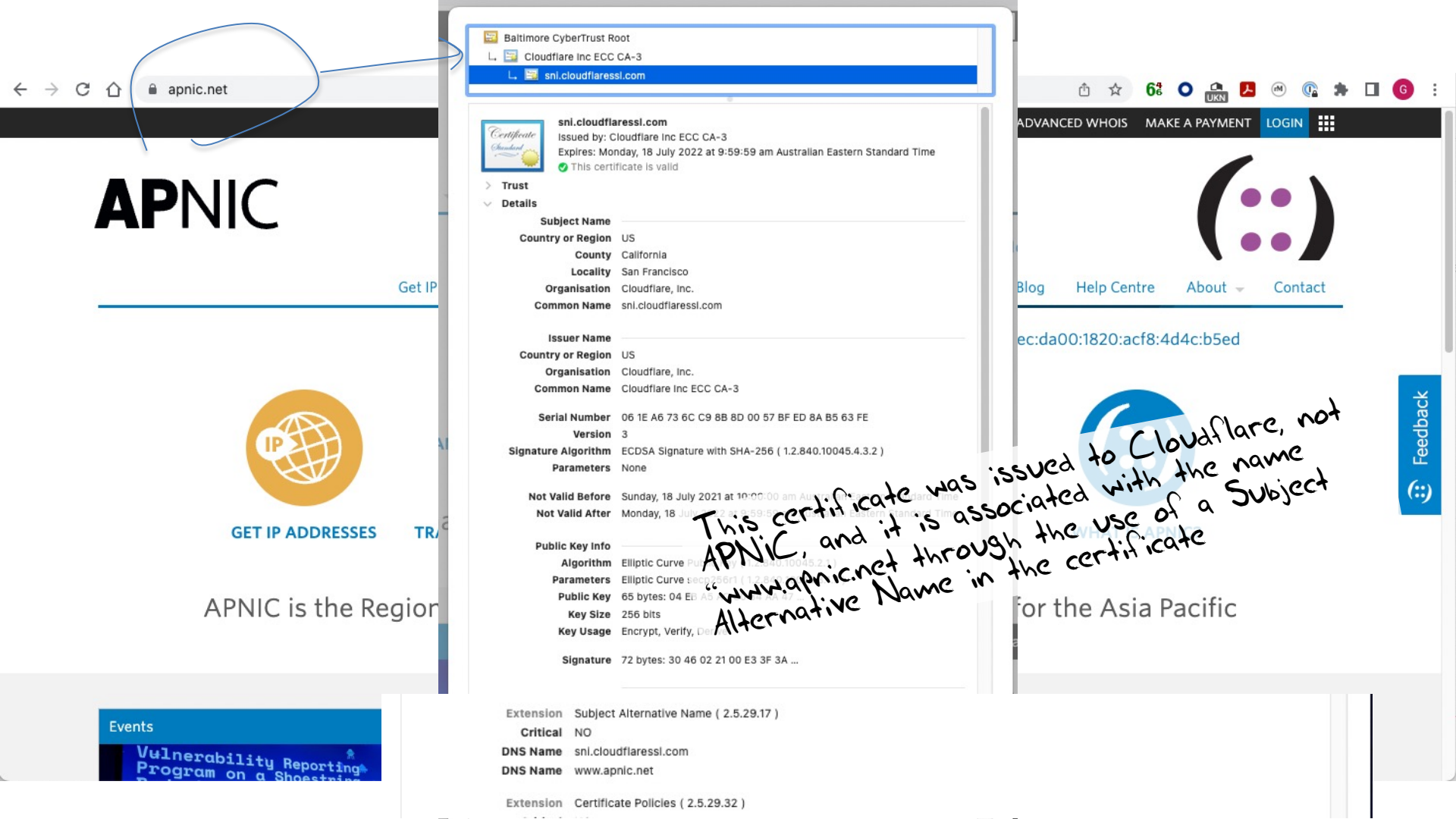
I trust that this is the web site of the Commonwealth Bank because I used the Commonwealth Bank's public key to sete up the encrypted connection to the server.

And I can trust that this is the commonwealth Bank's public key because I trust that Entrust has performed a number of checks before issuing a public key certificate for this public key

And another example

- Lets take www.apnic.net and look at that certificate

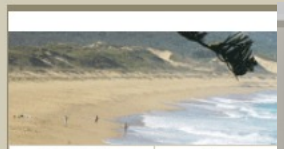

apnic.net
WHOIS & WEBSITE
ADVANCED WHOIS
MAKE A PAYMENT
LOGIN
APNIC
Get IP
Manage IP
Training
Events
Insights
Community
Blog
Help Centre
About
Contact
Your IP address: 2001:8003:1dec:da00:1820:acf8:4d4c:b5ed
GET IP ADDRESSES
TRANSFER IP ADDRESSES
GO IPv6
PARTICIPATE
WHAT IS APNIC?
Feedback
APNIC is the Regional Internet Registry administering IP addresses for the Asia Pacific
Events
Vulnerability Reporting Program on a Shoestring
Tech matters
Homepage highlight


apnic.net
Baltimore CyberTrust Root
Cloudflare Inc ECC CA-3
sni.cloudflaressl.com
sni.cloudflaressl.com
Issued by: Cloudflare Inc ECC CA-3
Expires: Monday, 18 July 2022 at 9:59:59 am Australian Eastern Standard Time
This certificate is valid
Trust
Details
Subject Name
Country or Region US
County California
Locality San Francisco
Organisation Cloudflare, Inc.
Common Name sni.cloudflaressl.com
Issuer Name
Country or Region US
Organisation Cloudflare, Inc.
Common Name Cloudflare Inc ECC CA-3
Serial Number 06 1E A6 73 6C C9 8B 8D 00 57 BF ED 8A B5 63 FE
Version 3
Signature Algorithm ECDSA Signature with SHA-256 (1.2.840.10045.4.3.2)
Parameters None
Not Valid Before Sunday, 18 July 2021 at 10:00:00 am
Not Valid After Monday, 18
Public Key Info
Algorithm Elliptic Curve
Parameters Elliptic Curve
Public Key 65 bytes: 04 EB
Key Size 256 bits
Key Usage Encrypt, Verify,
Signature 72 bytes: 30 46 02 21 00 E3 3F 3A ...
Extension Subject Alternative Name (2.5.29.17)
Critical NO
DNS Name sni.cloudflaressl.com
DNS Name www.apnic.net
Extension Certificate Policies (2.5.29.32)
APNIC
ADVANCED WHOIS
MAKE A PAYMENT
LOGIN
Get IP
Blog
Help Centre
About
Contact
ec:da00:1820:acf8:4d4c:b5ed
GET IP ADDRESSES
APNIC is the Regior
for the Asia Pacific
Feedback
Events
Vulnerability Reporting Program on a Shoestring
This certificate was issued to Cloudflare, not APNIC, and it is associated with the name "www.apnic.net through the use of a Subject Alternative Name in the certificate

And another

- Let’s look at my own web site, with its certificate issued by Let’s Encrypt

potaroo.net



ISP Articles | Papers

Recent Articles

The Path to Reso

MAY 2022

Using the DNS without directl
an approach that is totally ali
might be useful to ask: How d
resolverless form of DNS nam
to whom does it make sense?

Are we there yet?

MAY 2022

This transition to IPv6 has bee
there was any urgency that w
prospect of IPv4 address exha
exhaustion for a decade now.
question: How much longer is
More...

Using LEOs and GEOs

APRIL 2022

ISRG Root X1
R3
potaroo.net

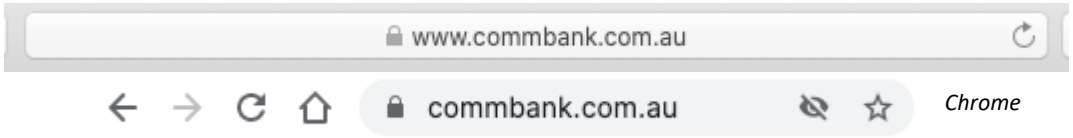
potaroo.net
Issued by: R3
Expires: Tuesday, 23 August 2022 at 9:35:20 am Australian Eastern Standard Time
This certificate is valid

Trust
Details

Subject Name	
Common Name	potaroo.net
Issuer Name	
Country or Region	US
Organisation	Let's Encrypt
Common Name	R3
Serial Number	03 3B A0 FB 2C 1D B5 D0 87 0B CF BE 24 69 5A 20 A8 D4
Version	3
Signature Algorithm	SHA-256 with RSA Encryption (1.2.840.113549.1.1.11)
Parameters	None
Not Valid Before	Wed...
Public Key Algorithm	RSA Encryption (1.2.840.113549.1.1.1)
Public Key	256 bytes: BF 24 1A 56 39 86 01 30 ...
Exponent	65537
Key Size	2,048 bits
Key Usage	Encrypt, Verify, Wrap, Derive
Signature	256 bytes: 26 E3 D0 AE 4F A9 64 7F ...

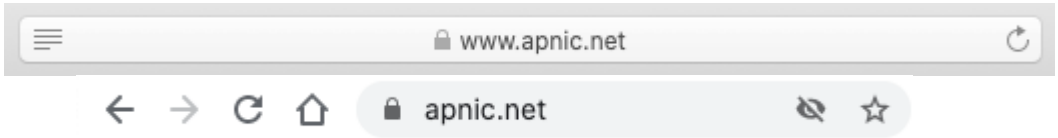
This certificate binds a public key to a domain name without any attestation to the identity of the name "holder"

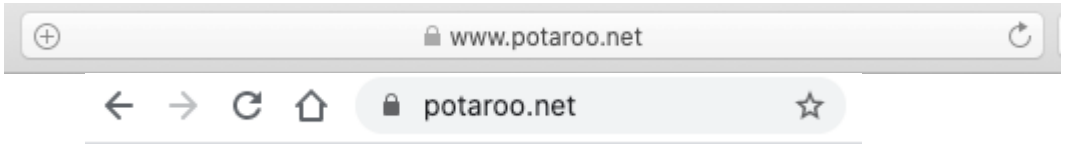
Spot the Difference



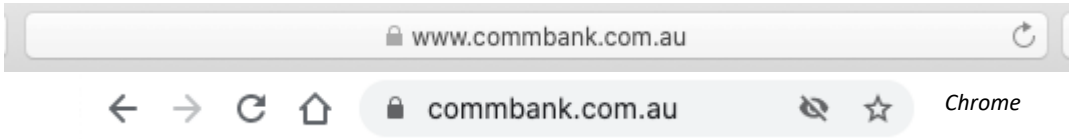
Safari

Chrome





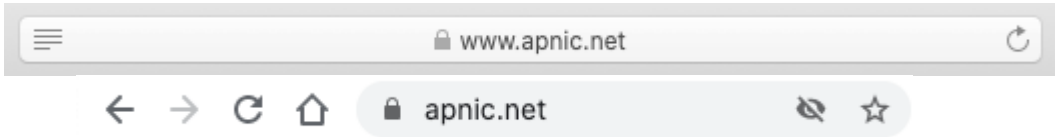
Spot the Difference



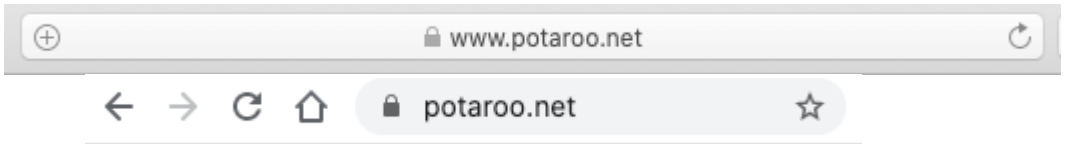
Safari

Chrome

This web site's certificate was issued to an organisation called the "Commonwealth Bank of Australia" located in Sydney, Australia



This web site's certificate was issued to "Cloudflare Inc" located in San Francisco, USA!!



This web site's certificate says *nothing* about the entity that holds the public key associated with this domain

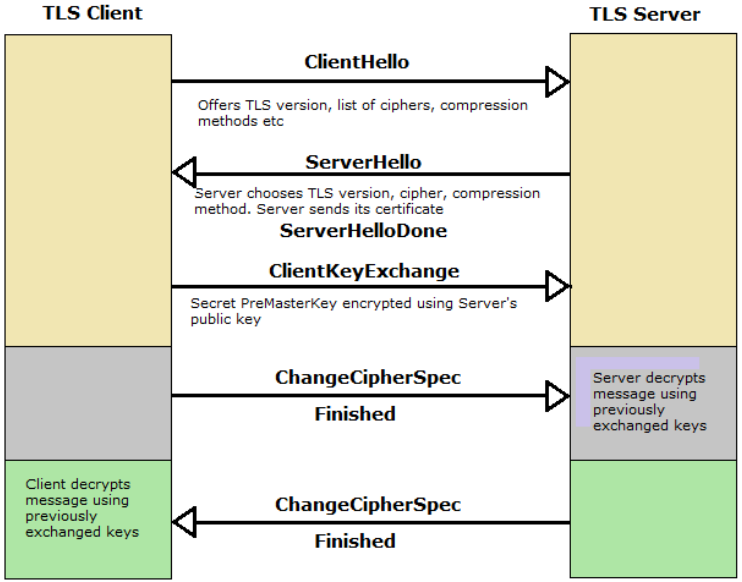
Spot the Difference

- The certification processes taken to issue the certificate were different in each of these cases.
  - One confirmed the identity of the public key holder as well as their association with the domain name
  - The second used a proxy agent and there is no association between the entity domain name that is certified here and the proxy agent
  - The third simply associates a public key with a domain name without any form of identification of the holder of the domain name
- They all have different levels of trustworthiness, yet they all display to the user in exactly the same way
  - Because when we tried to differentiate these different levels of trust (such as painting the padlock icon in green) nobody understood what was going on and nobody cared anyway!

Moving on…

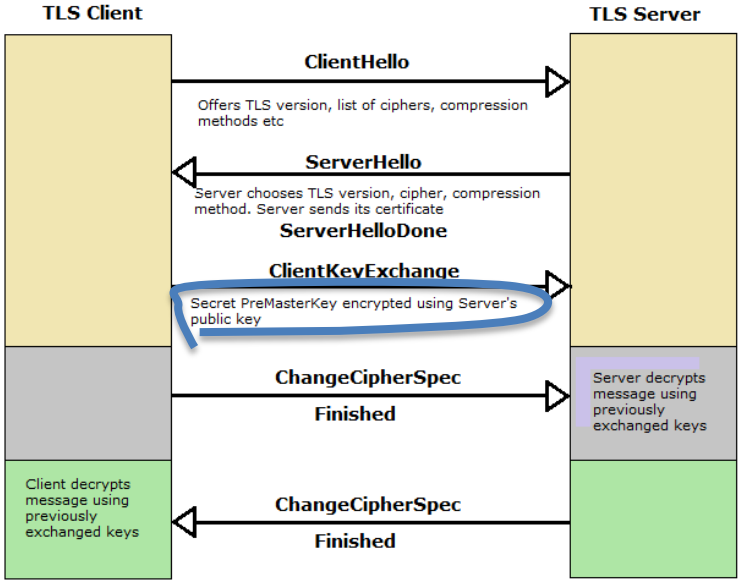
- Ok, so the certificate system is a mess, but TLS still works, right?
- So lets look at the way TLS sets of a secure session

Secure Connections using TLS



https://rhsecurity.wordpress.com/tag/tls/

Secure Connections using TLS



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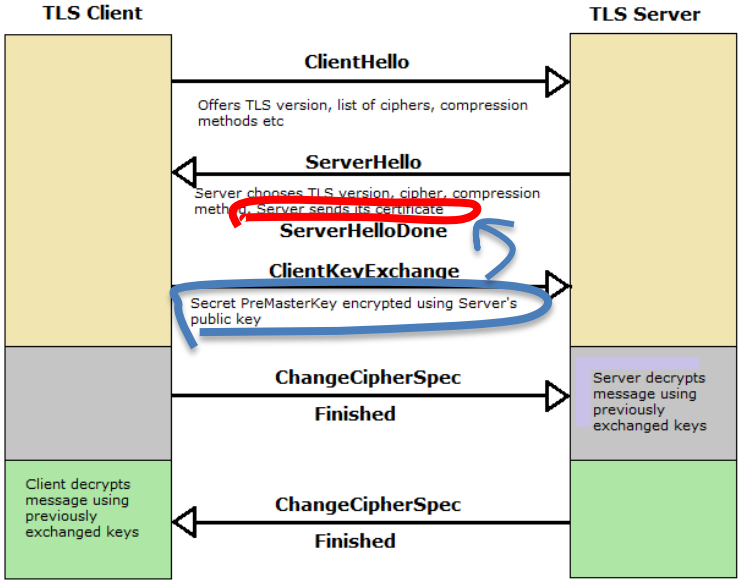
Secure Connections using TLS



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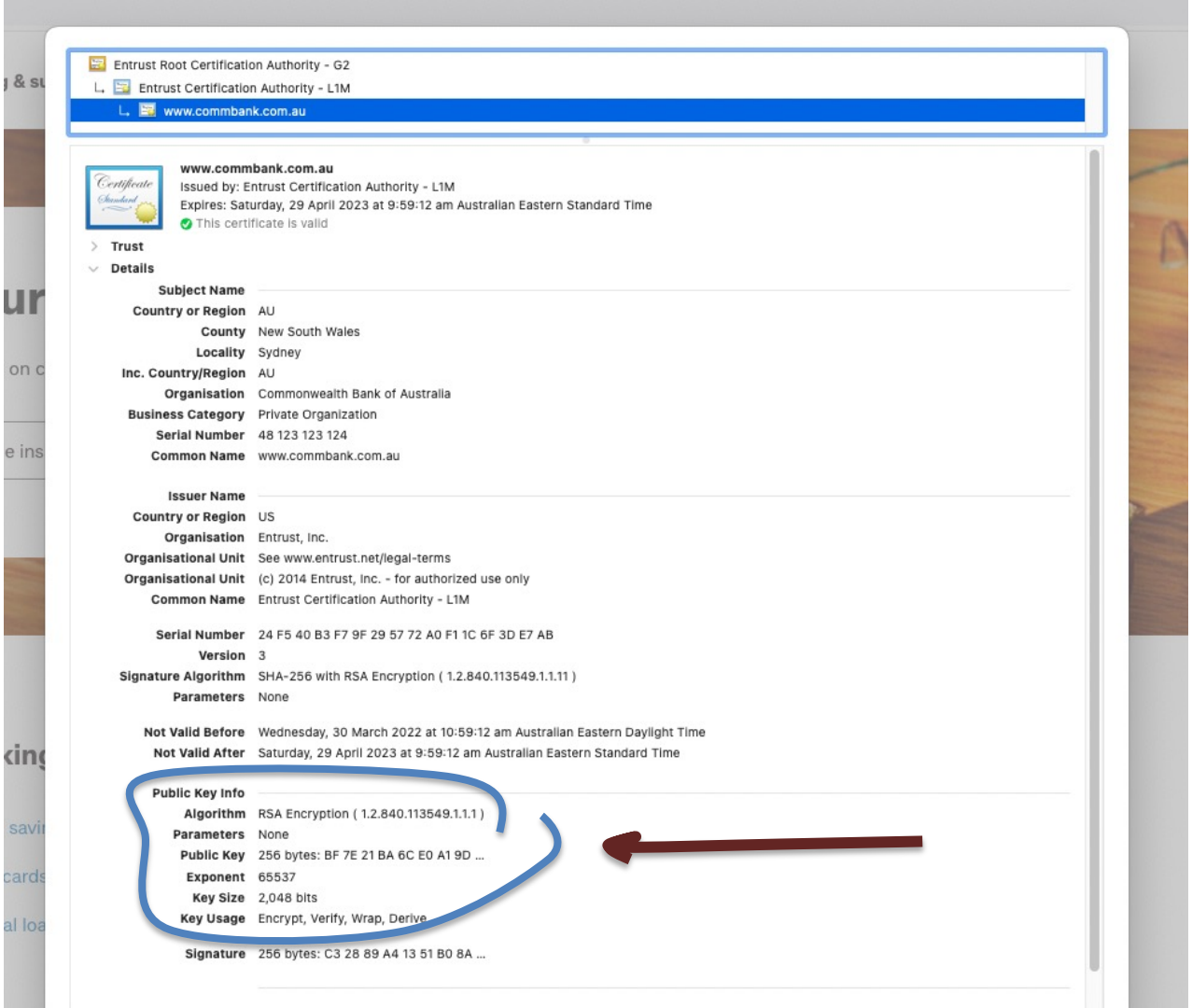
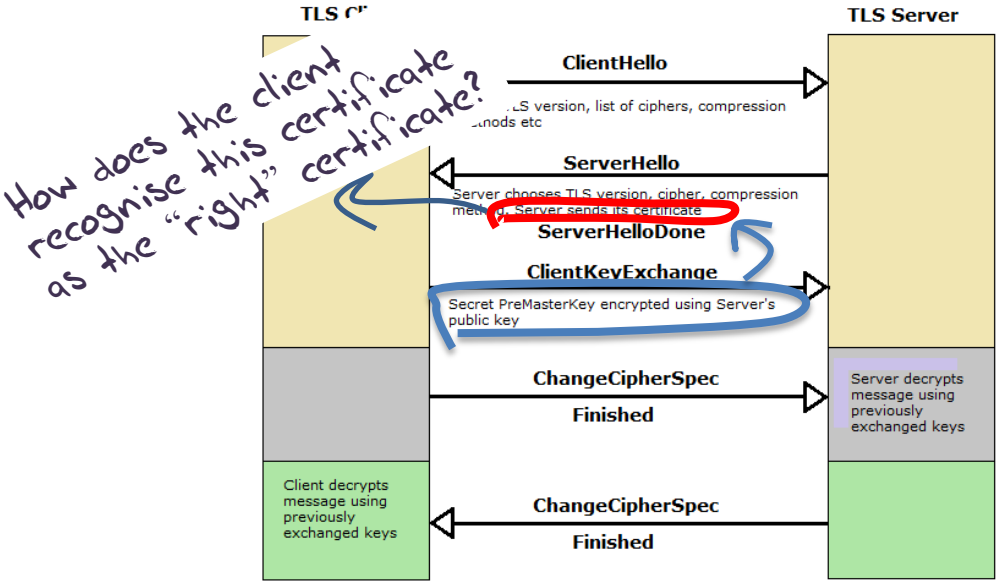

Entrust Root Certification Authority - G2
Entrust Certification Authority - L1M
www.commbank.com.au
www.commbank.com.au
Issued by: Entrust Certification Authority - L1M
Expires: Saturday, 29 April 2023 at 9:59:12 am Australian Eastern Standard Time
This certificate is valid
Trust
Details
Subject Name
Country or Region AU
County New South Wales
Locality Sydney
Inc. Country/Region AU
Organisation Commonwealth Bank of Australia
Business Category Private Organization
Serial Number 48 123 123 124
Common Name www.commbank.com.au
Issuer Name
Country or Region US
Organisation Entrust, Inc.
Organisational Unit See www.entrust.net/legal-terms
Organisational Unit (c) 2014 Entrust, Inc. - for authorized use only
Common Name Entrust Certification Authority - L1M
Serial Number 24 F5 40 B3 F7 9F 29 57 72 A0 F1 1C 6F 3D E7 AB
Version 3
Signature Algorithm SHA-256 with RSA Encryption (1.2.840.113549.1.1.11)
Parameters None
Not Valid Before Wednesday, 30 March 2022 at 10:59:12 am Australian Eastern Daylight Time
Not Valid After Saturday, 29 April 2023 at 9:59:12 am Australian Eastern Standard Time
Public Key Info
Algorithm RSA Encryption (1.2.840.113549.1.1.1)
Parameters None
Public Key 256 bytes: BF 7E 21 BA 6C E0 A1 9D ...
Exponent 65537
Key Size 2,048 bits
Key Usage Encrypt, Verify, Wrap, Derive
Signature 256 bytes: C3 28 89 A4 13 51 B0 8A ...

Secure Connections using TLS



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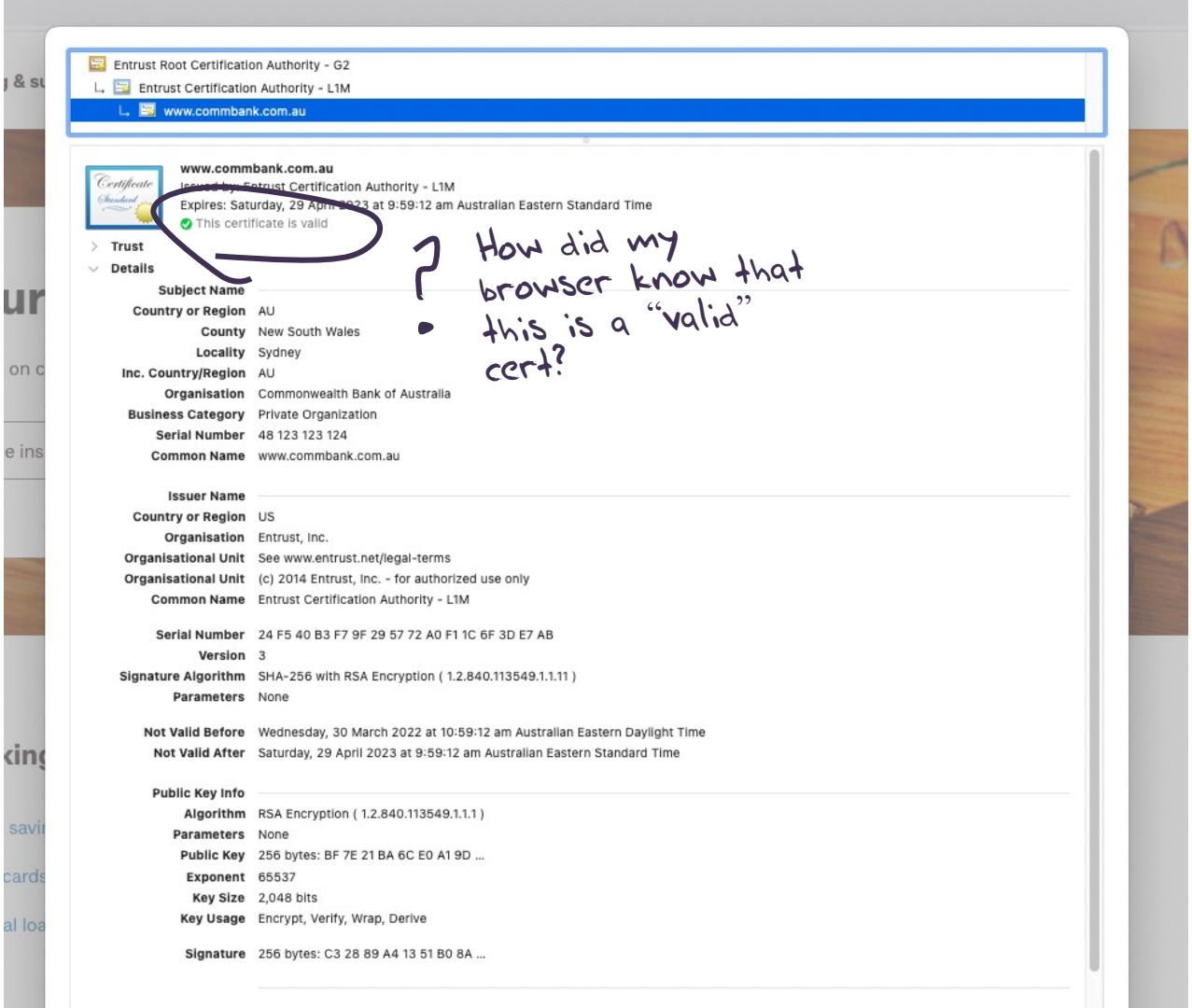
Entrust Root Certification Authority - G2
Entrust Certification Authority - L1M
www.commbank.com.au
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This certificate is valid
Trust
Details
Subject Name
Country or Region AU
County New South Wales
Locality Sydney
Inc. Country/Region AU
Organisation Commonwealth Bank of Australia
Business Category Private Organization
Serial Number 48 123 123 124
Common Name www.commbank.com.au
Issuer Name
Country or Region US
Organisation Entrust, Inc.
Organisational Unit See www.entrust.net/legal-terms
Organisational Unit (c) 2014 Entrust, Inc. - for authorized use only
Common Name Entrust Certification Authority - L1M
Serial Number 24 F5 40 B3 F7 9F 29 57 72 A0 F1 1C 6F 3D E7 AB
Version 3
Signature Algorithm SHA-256 with RSA Encryption (1.2.840.113549.1.1.11)
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Key Usage Encrypt, Verify, Wrap, Derive
Signature 256 bytes: C3 28 89 A4 13 51 B0 8A ...
? How did my browser know that this is a "valid" cert?

Domain Name Certification

- The Commonwealth Bank of Australia has generated a key pair
- And they passed a certificate signing request to a company called “Entrust” in the US
- Who was willing to vouch (in a certificate) that the entity is called the Commonwealth Bank of Australia and they have control of the the domain name www.commbank.com.au and they have a certain public key
- So, if I can associate this public key with a connection then I have a high degree of confidence that I’ve connected to an entity that is able to demonstrate knowledge of the private key for www.commbank.com.au, as long as I am prepared to trust Entrust and the certificates that they issue
- And I’m prepared to trust them because Entrust NEVER lie!

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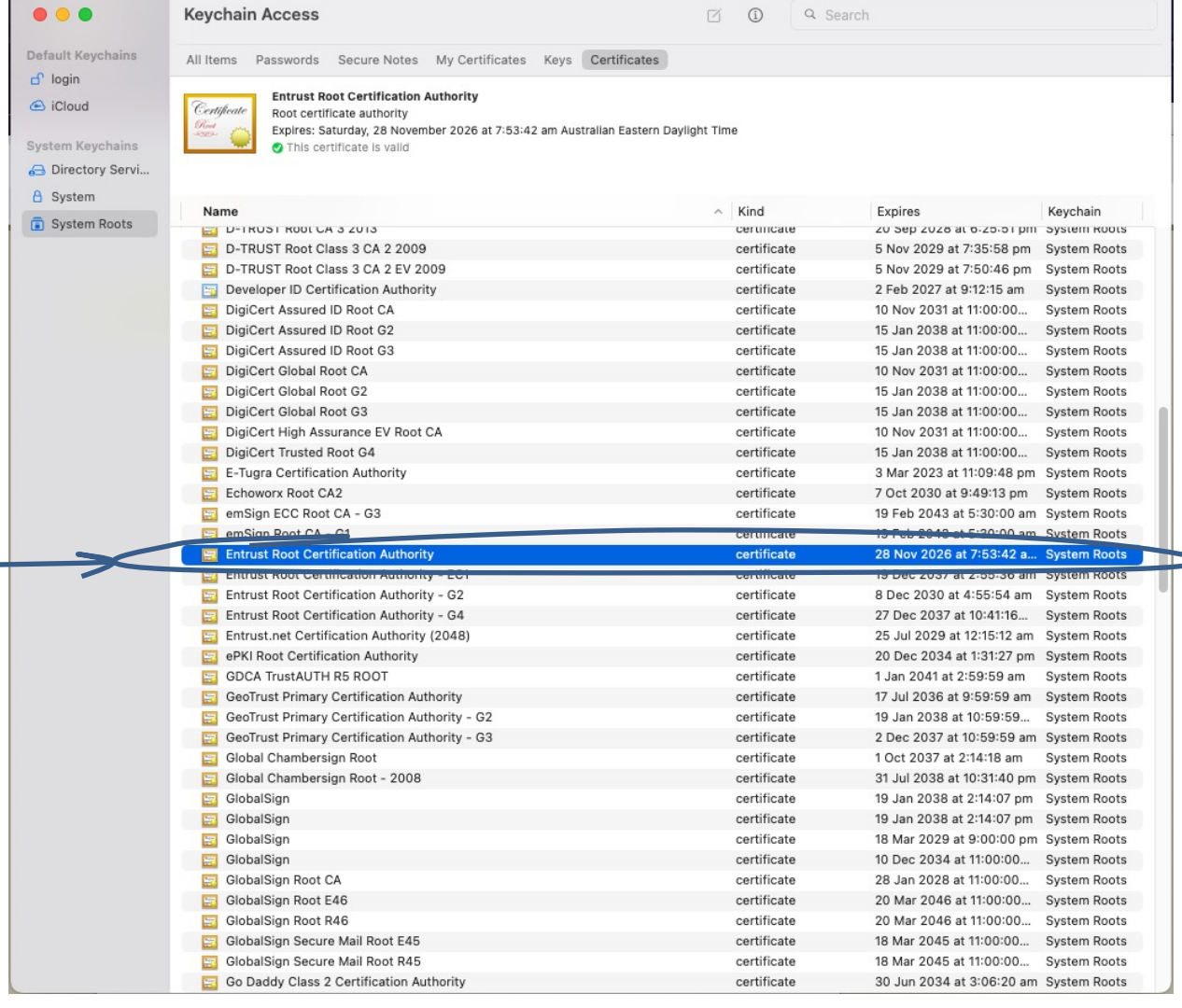
- And I’m , them because Entrust NEVER lie!

How do i know that? Why should i trust them?

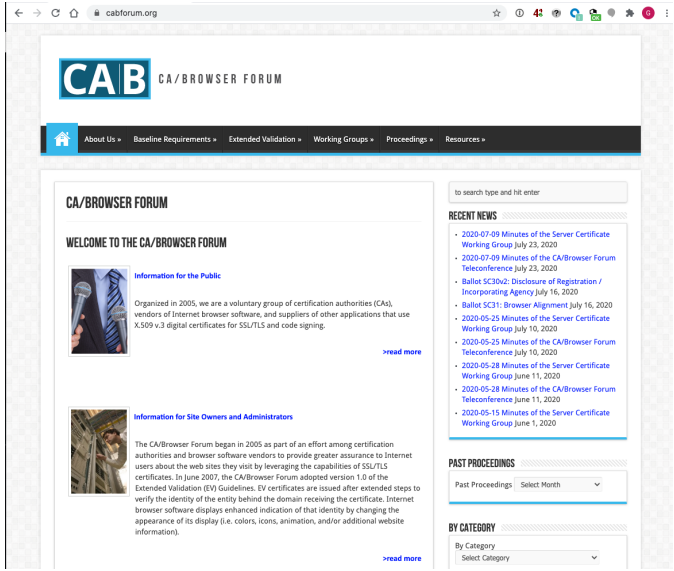
Local Trust



The cert I'm being asked to trust was issued by a certification authority that my browser already trusts – so I trust that cert!

Local Trust

These Certificate Authorities are listed in my computer's trust set because they claim to operate according to the practices defined by the CAB industry forum (of which they are a member) and they **never** lie!



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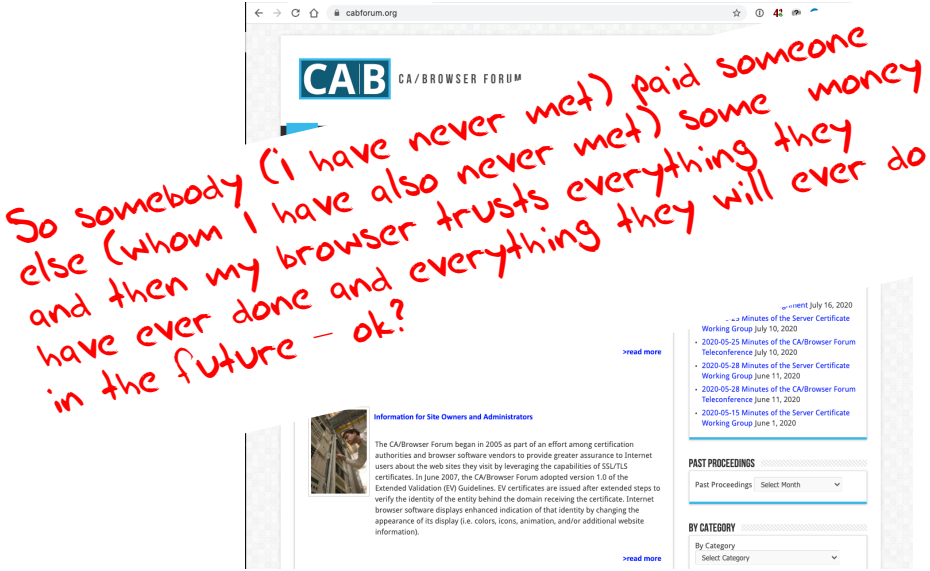
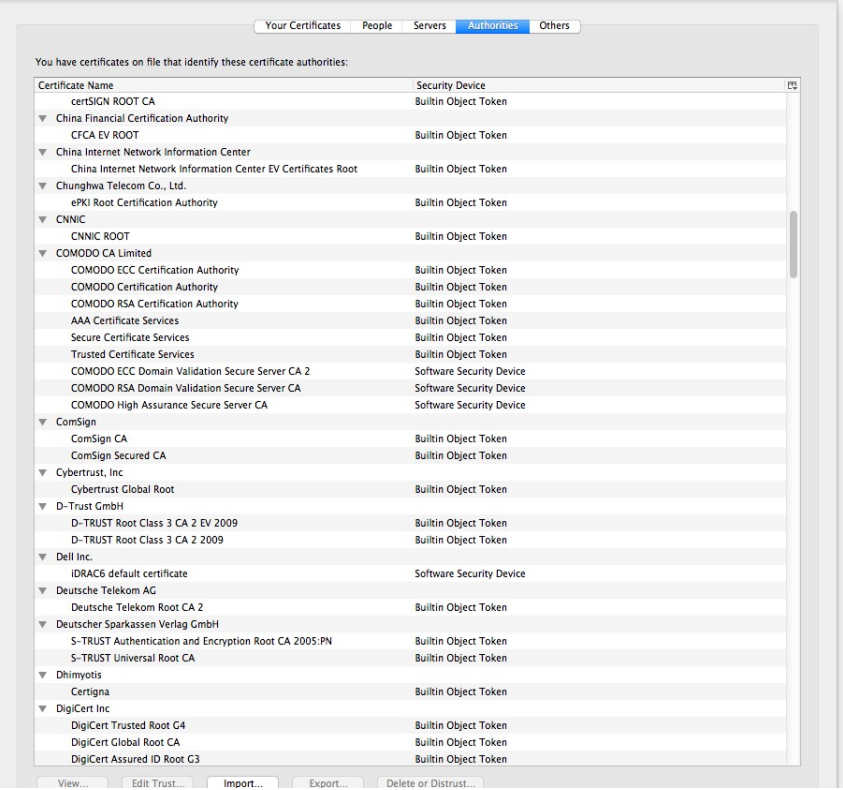


Local Trust or Local Credulity*?

Wow!

Are they **all** trustable?



* cre·du·li·ty
/krəˈd(y)o͞oləd̄ē/

noun

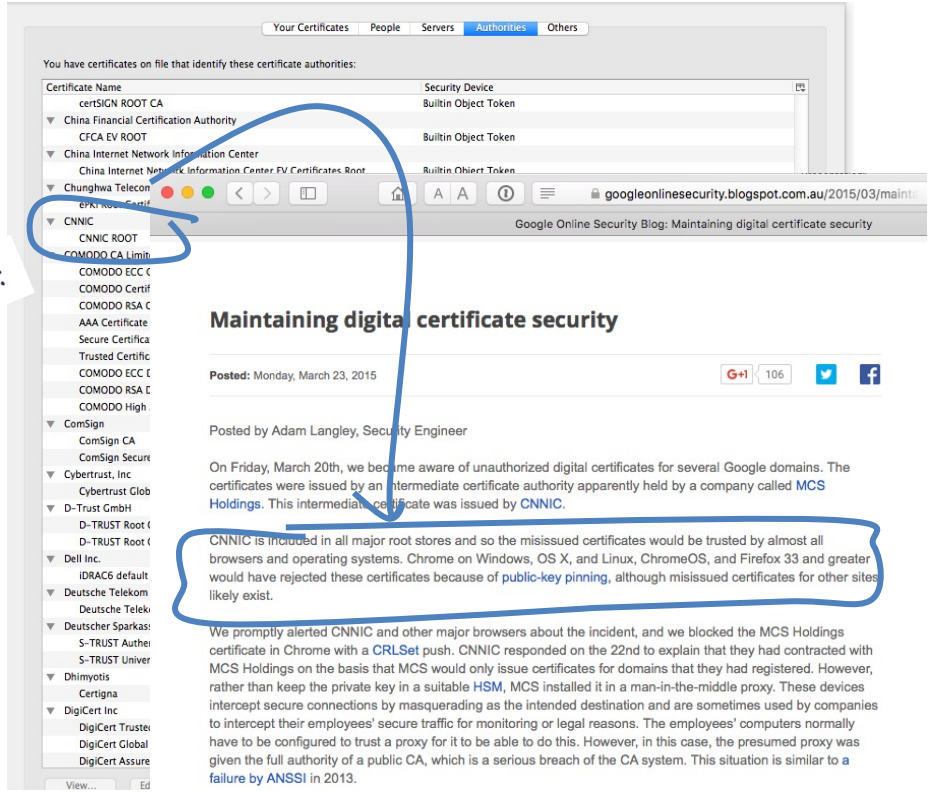
a tendency to be too ready to believe that something is real or true.

Local Credulity

Wow!

Are they **all** trustable?

Evidently Not!



Local Credulity

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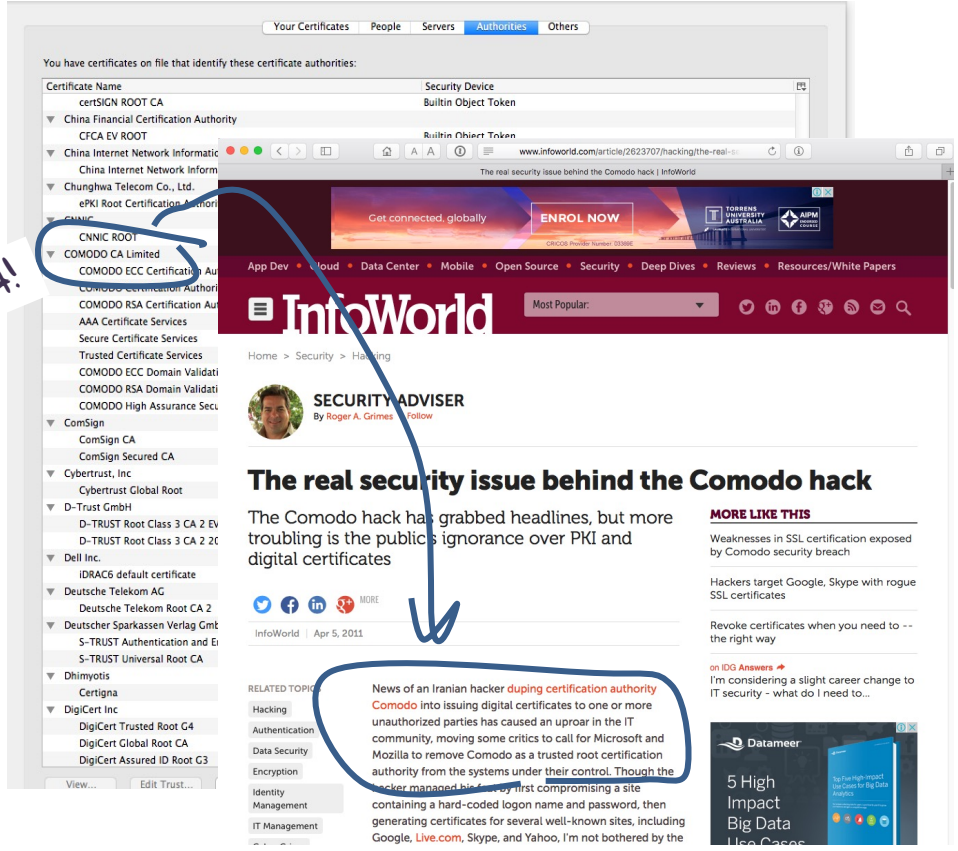
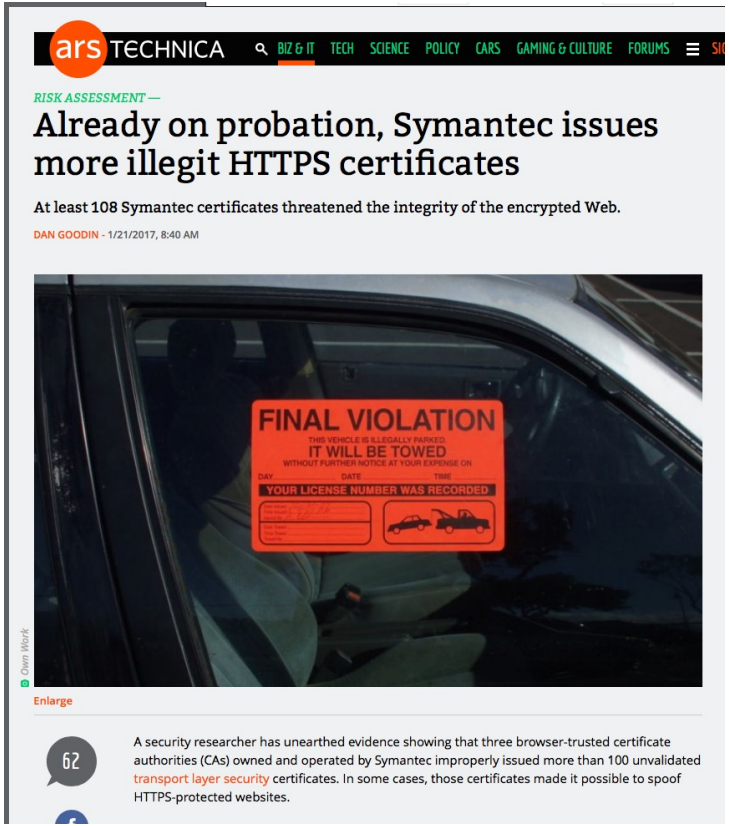


Never?

Well, hardly ever



ars TECHNICA BIZ & IT TECH SCIENCE POLICY CARS GAMING & CULTURE FORUMS

RISK ASSESSMENT —

Already on probation, Symantec issues more illegit HTTPS certificates

At least 108 Symantec certificates threatened the integrity of the encrypted Web.

DAN GOODIN - 1/21/2017, 8:40 AM

Own Work

Enlarge

62

A security researcher has unearthed evidence showing that three browser-trusted certificate authorities (CAs) owned and operated by Symantec improperly issued more than 100 unvalidated transport layer security certificates. In some cases, those certificates made it possible to spoof HTTPS-protected websites.

http://arstechnica.com/security/2017/01/already-on-probation-symantec-issues-more-illegit-https-certificates/

Misissued/Suspicious Symantec Certificates

Andrew Ayer | Thu, 19 Jan 2017 13:47:06 -0800

I. Misissued certificates for example.com

On 2016-07-14, Symantec misissued the following certificates for example.com:

https://crt.sh/?sha256=A8F14F52CC12B2D7153A13316E7DA39E6AE37B1A10C16288B9024A9B9DC3C4C6

https://crt.sh/?sha256=8B5956C57FDCF720B6907A4B1BC8CA2E46CD90EAD5C061A426CF48A6117BFBFA

https://crt.sh/?sha256=94482136A1400BC3A1136FECA3E79D4D200E03DD20B245D19F0E78B5679EAF48

https://crt.sh/?sha256=C69AB04C1B20E6FC7861C67476CADDA1DAE7A8DCF6E23E15311C2D2794BFCD11

I confirmed with ICANN, the owner of example.com, that they did not authorize these certificates. These certificates were already revoked at the time I found them.

II. Suspicious certificates for domains containing the word "test"

On 2016-11-15 and 2016-10-26, Symantec issued certificates for various domains containing the word "test" which I strongly suspect were misissued:

Well, hardly ever

Google Security Blog

The latest news and insights from Google on security and safety on the Internet

Distrust of the Symantec PKI: Immediate action needed by site operators

March 7, 2018

Posted by Devon O'Brien, Ryan Sleevi, Emily Stark, Chrome security team

We previously announced plans to deprecate Chrome's trust in the Symantec certificate authority (including Symantec-owned brands like Thawte, VeriSign, Equifax, GeoTrust, and RapidSSL). This post outlines how site operators can determine if they're affected by this deprecation, and if so, what needs to be done and by when. Failure to replace these certificates will result in site breakage in upcoming versions of major browsers, including Chrome.

Chrome 66

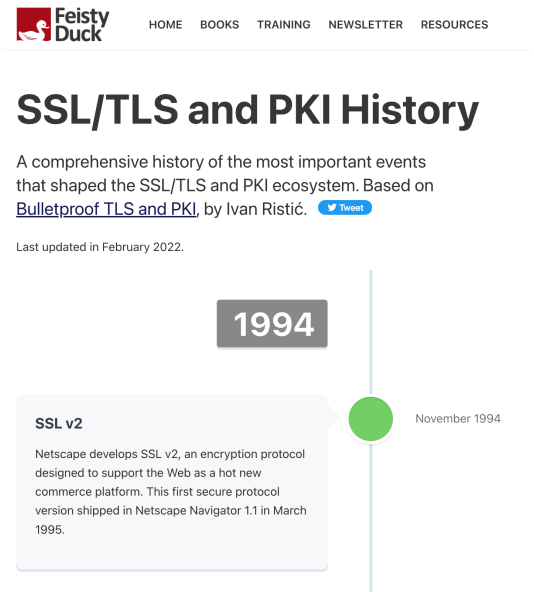
If your site is using a SSL/TLS certificate from Symantec that was issued before June 1, 2016, it will stop functioning in Chrome 66, which could already be impacting your users.

If you are uncertain about whether your site is using such a certificate, you can preview these changes in Chrome Canary to see if your site is affected. If connecting to your site displays a certificate error or a warning in DevTools as shown below, you'll need to replace your certificate. You can get a new certificate from any trusted CA, including Digicert, which recently acquired Symantec's CA business.

These are isolated events

No they're not:

https://www.feistyduck.com/ssl-tls-and-pki-history/



With unpleasant consequences when it all goes wrong

With unpleasant consequences when it all goes wrong

VOLATILITY IS THE NEW MARKET NORM
Large swings in share prices are more common now than at any other time in recent stock market history. PAGE 16

Société Générale, BNP Paribas and Crédit Agricole, are considered integral actors in the French economy, lending

sters helped ignited
untry's 45-member

talk
ow

Cuba aimed at U.S.
er husband not to
anything happens,
tay right here with
told him in October
be with you, and I
u, and the children
ithout you."
nterview conducted
e of only three that
after Mr. Kennedy's
ublished as a

Iranian activists feel the chill as hacker taps into e-mails

BY SOMINI SENGUPTA

He claims to be 21 years old, a student of software engineering in Tehran who reveres Ayatollah Ali Khamenei and despises dissidents in his country.

He sneaked into the computer systems of a security firm on the outskirts of Amsterdam. He created fake credentials that could allow someone to spy on Internet connections that appeared to be secure. He then shared that bounty with people he declines to identify.

The fruits of his labor are believed to ed to tap into the online many as 300,000 ummer.

online security mechanism that is trusted by Internet users all over the world.

Comodohacker, as he calls himself, insists that he acted on his own and is unperturbed by the notion that his work might have been used to spy on anti-government compatriots.

"I'm totally independent," he said in an e-mail exchange with The New York Times. "I just share my findings with some people in Iran. They are free to do anything they want with my findings and things I share with them, but I'm

ernet attacks, this oment of

HACKER, PA

International Herald Tribune
Sep 13, 2011 Front Page

BORDER GATEWAY PROTOCOL ATTACK —

Suspicious event hijacks Amazon traffic for 2 hours, steals cryptocurrency

Almost 1,300 addresses for Amazon Route 53 rerouted for two hours.

DAN GOODIN - 4/25/2018, 5:00 AM

Amazon

123

Amazon lost control of a small number of its cloud services IP addresses for two hours on Tuesday morning when hackers exploited a known Internet-protocol weakness that let them to redirect traffic to rogue destinations. By subverting Amazon's domain-resolution service, the attackers masqueraded as cryptocurrency website MyEtherWallet.com and stole about $150,000 in digital coins from unwitting end users. They may have targeted other Amazon customers as well.

The incident, which started around 6 AM California time, hijacked roughly 1,300 IP addresses, Oracle-owned Internet Intelligence said on Twitter. The malicious redirection was caused by fraudulent routes that were announced by Columbus, Ohio-based eNet, a large Internet service provider that is referred to as autonomous system 10297. Once in place, the eNet announcement caused Hurricane Electric and possibly Hurricane Electric customers and other eNet peers to send traffic over the same unauthorized routes. The 1,300 addresses belonged to Route 53, Amazon's domain name system service

The attackers managed to steal about $150,000 of currency from MyEtherWallet users,

What's going wrong here?

What's going wrong here?

- The TLS handshake cannot specify WHICH CA should be used by the client to validate the digital certificate that describes the server's public key
- The result is that your browser will allow ANY CA to be used to validate a certificate!

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WOW! That's awesomely bad!

What's going wrong here?

- The TLS handshake cannot specify WHICH CA sh
di
pu
- Th
CA

Here's a lock – it might be the lock on your front door for all i know.

The lock might LOOK secure, but don't worry – literally ANY key can open it!

validate a certificate!

WOW! That's awesomely bad!

What's going wrong here?

- There is no incentive for quality in the CA marketplace
- Why pay more for any certificate when the entire CA structure is only as strong as the weakest CA
- And your browser trusts a LOT of CAs!
  - About 60 – 100 CA's
  - About 1,500 Subordinate RA's
  - Operated by 650 different organisations

See the EFF SSL observatory
http://www.eff.org/files/DefconSSLiverse.pdf

In a Commercial Environment

Where CA's compete with each other for market share

And quality offers no protection

Then what 'wins' in the market?

?

In a Commercial Environment

Where CA's compete with each other for market share

And quality offers no protection

Then what 'wins' in the market?

But its all OK

Really.

- Because ‘bad’ certificates can be revoked
- And browsers **always** check revocation status of certificates before they trust them

Always?

Ok - Not Always.
Some do.
Sometimes.

Platform	Chrome	Firefox	Opera	Safari	Edge
Mac OS X 10.15.3	**YES** 80.0.3987.132	**YES** 73.0.1	**YES** 67.0.3575.53	**YES** 13.0.5	
iOS 13.3.1	**YES** 80.0.3987.95	**YES** 23.0	**NO** 16.0.15	**YES** 13.3.1	
Android 10	**NO** 80.0.3987.132	**NO** 68.6.0	**NO** 56.1		
Windows 10	**NO** 80.0.3987.132	**YES** 74.0	**NO** 67		**YES** 44.18362

Table 1 – Browser Revocation Status

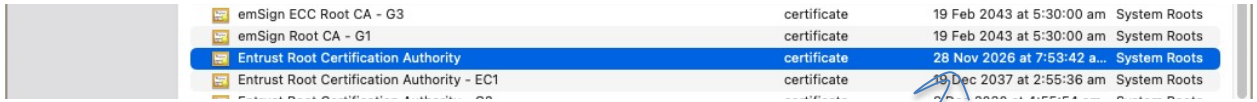
https://www.potaroo.net/ispcol/2020-03/revocation.html

So we can't count on revocation

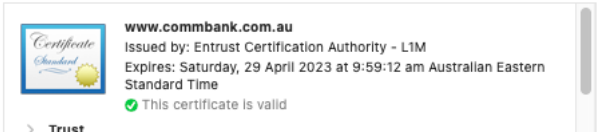
- If we can’t revoke certificates then we need to reduce certificate lifetimes

So we can't count on revocation

- If we can’t revoke certificates then we need to reduce certificate lifetimes
- But we are not doing that!



Yes, 2026!!!



Yes, 2023!!!

So we can't count on revocation

- If we can’t revoke certificates then we need to reduce certificate lifetimes
- What’s a “safe” certificate lifetime?

ars TECHNICA

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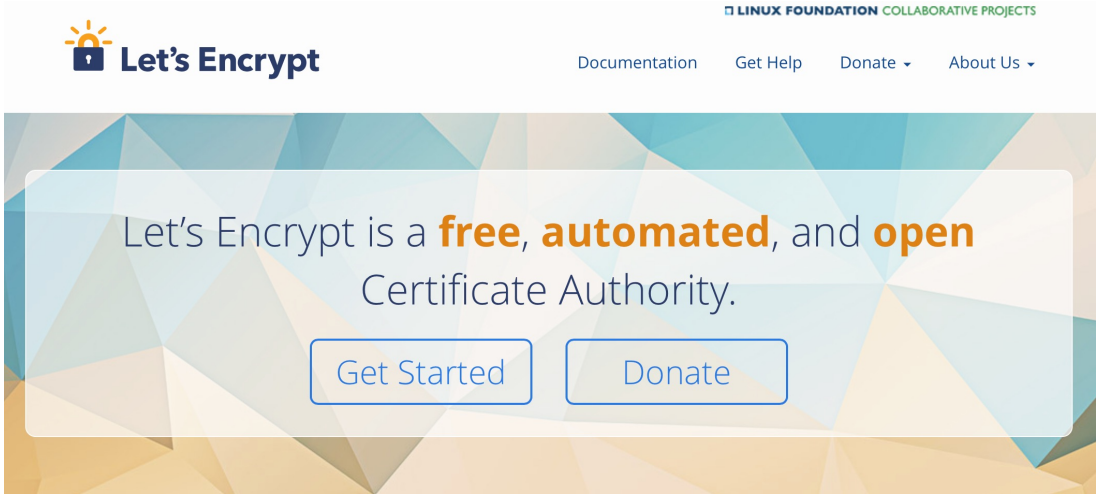
So we can't count on revocation

- If we can’t revoke certificates then we need to reduce certificate lifetimes
- What’s a “safe” certificate lifetime?
- If we want 2 hours or less then we need to think hard about how to achieve this

How can we make certificates better?

Option A: Take all the money out of the system!



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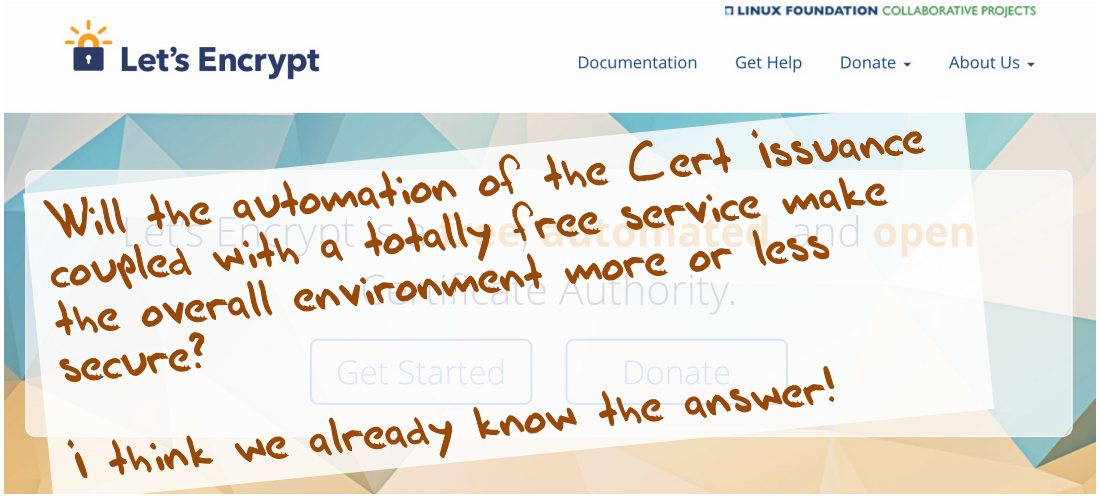
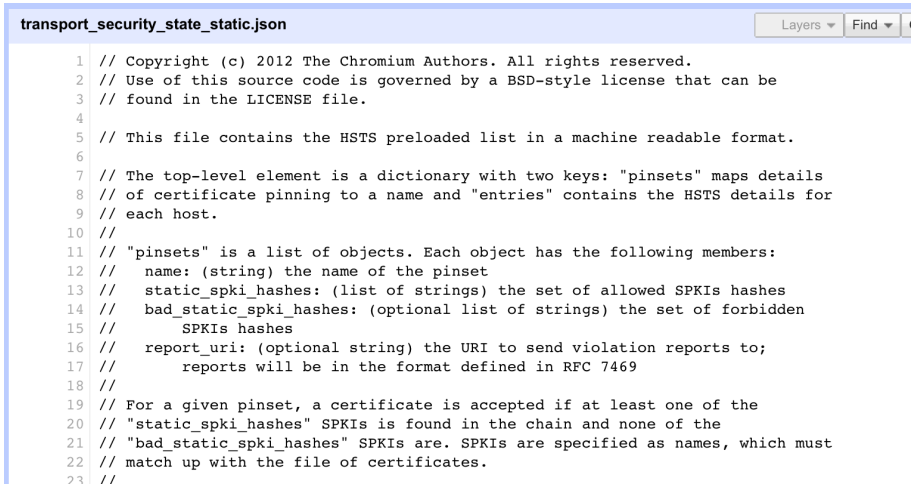


How can we make certificates better?

Option B: White Listing and Pinning with HSTS

https://code.google.com/p/chromium/codesearch#chromium/src/net/http/transport_security_state_static.json



How can we make certificates better?

Option B: White Listing and Pinning with HSTS

https://code.google.com/p/chromium/codesearch#chromium/src/net/http/transport_security_state_static.json

its not a totally insane idea -- until you realise that it appears to be completely unscaleable!

its just Google protecting itself and no one else

transport_security_state_static.json

```
// found in the LICENSE file.

// This file contains the HSTS preloaded list in a machine readable format.

// The top-level element is a dictionary with two keys: "pinsets" maps details
// of certificate pinning to a name and "entries" contains the HSTS details for
// each host.
//
// "pinsets" is a list of objects. Each object has the following members:
//   name: (string) the name of the pinset
//   static_spki_hashes: (list of strings) the set of allowed SPKIs hashes
//   bad_static_spki_hashes: (optional list of strings) the set of forbidden
//       SPKIs hashes
//   report_uri: (optional string) the URI to send violation reports to;
//       reports will be in the format defined in RFC 7469
//
// For a given pinset, a certificate is accepted if at least one of the
// "static_spki_hashes" SPKIs is found in the chain and none of the
// "bad_static_spki_hashes" SPKIs are. SPKIs are specified as names, which must
// match up with the file of certificates.
//
```

How can we make certificates better?

O ption B: White Listing and Pinning with HSTS

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http https://code.google.com/p/chromium/codesearch#cnromium/src/net/http/ transport_security_state_static.json

INFOWORLD TECH WATCH

By Fahmida Y. Rashid, Senior Writer, InfoWorld | JAN 30, 2017

About | Informed news analysis every weekday

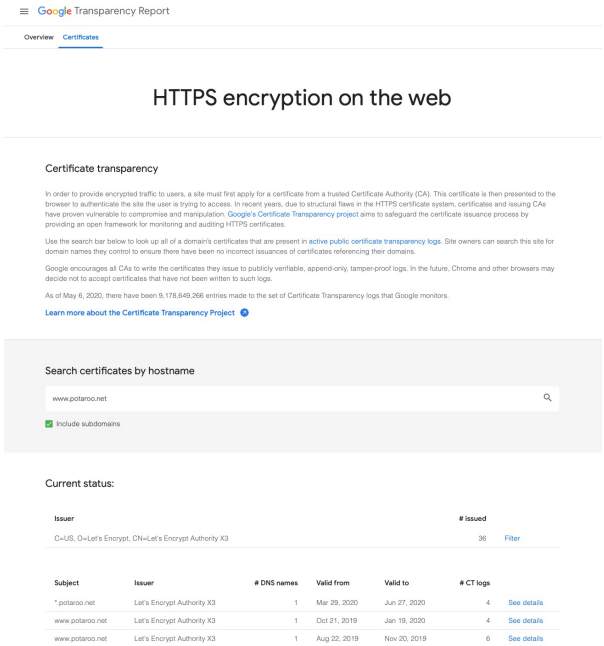
Google moves into the Certificate Authority business

Google doesn't seem to trust the current system, as it has launched its own security certificates

```
17 //       reports will be in the format defined in RFC 7469
18 //
19 // For a given pinset, a certificate is accepted if at least one of the
20 // "static_spki_hashes" SPKIs is found in the chain and none of the
21 // "bad_static_spki_hashes" SPKIs are. SPKIs are specified as names, which must
22 // match up with the file of certificates.
23 //
```

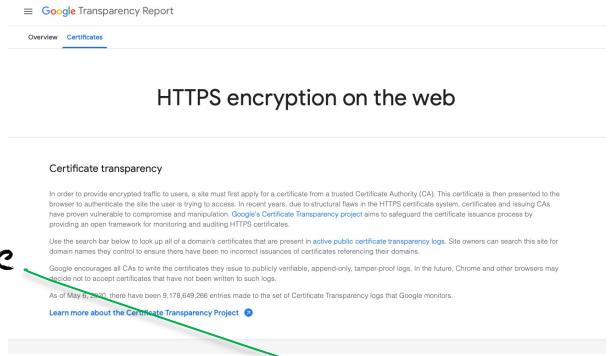
How can we make certificates better?

Option C: Certificate Transparency



How can we make certificates better?

Option C: Certificate Transparency



This is true

In order to provide encrypted traffic to users, a site must first apply for a certificate from a trusted Certificate Authority (CA). This certificate is then presented to the browser to authenticate the site the user is trying to access. In recent years, due to structural flaws in the HTTPS certificate system, certificates and issuing CAs have proven vulnerable to compromise and manipulation. Google's Certificate Transparency project aims to safeguard the certificate issuance process by providing an open framework for monitoring and auditing HTTPS certificates.

Current status:

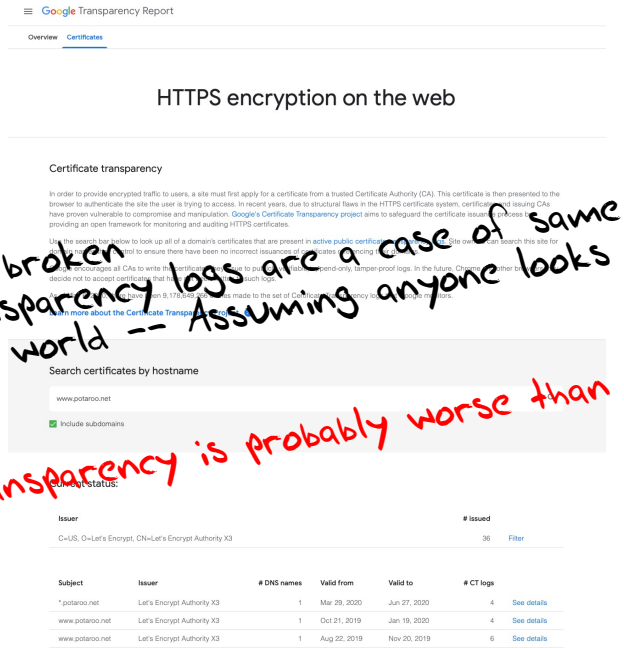
Issuer	# Issued	
C=US, O=Let's Encrypt, CN=Let's Encrypt Authority X3	36	Filter

Subject	Issuer	# DNS names	Valid from	Valid to	# CT logs	
*.potaroo.net	Let's Encrypt Authority X3	1	Mar 29, 2020	Jun 27, 2020	4	See details
www.potaroo.net	Let's Encrypt Authority X3	1	Oct 21, 2019	Jan 19, 2020	4	See details
www.potaroo.net	Let's Encrypt Authority X3	1	Aug 22, 2019	Nov 20, 2019	6	See details

This is a fail

How can we maske certificates better?

Option C: Certificate Transparency

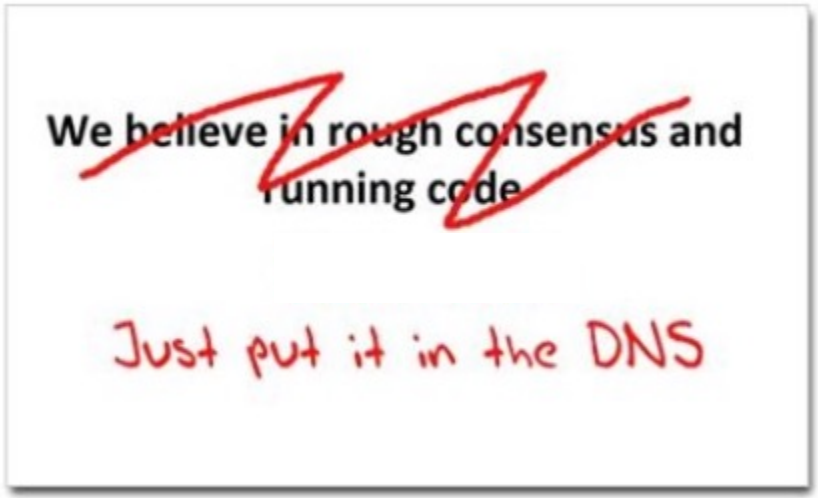


its just so broken
These transparency logs are a case of same week service in a millisecond world -- Assuming anyone looks in the first place!

Cert Transparency is probably worse than a placebo!

How can we make certificates better?

Option D: Use the DNS!



Seriously? The DNS?

Where better to find out the public key associated with a DNS-named service than to look it up in the DNS?

- Why not query the DNS for the HSTS record?
- Why not query the DNS for the issuer CA?
- Why not query the DNS for the hash of the domain name cert?
- Why not query the DNS for the hash of the domain name public key?

Seriously? The DNS?

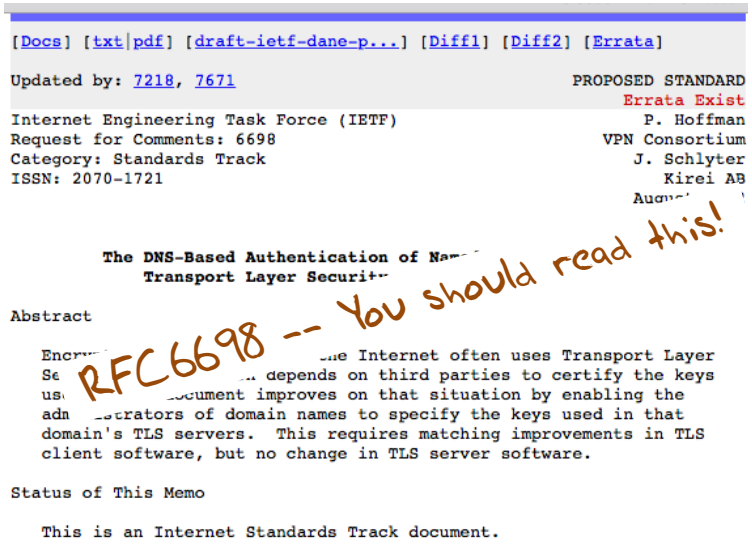
Where better to find out the public key associated with a DNS-named service than to look it up in the DNS?

- Why not query the DNS for the HSTS…
- Why not query the DNS for…er CA?
- Why not query the…ne hash of the domain name cert?
- Why not…DNS for the hash of the domain name public key?

Who needs CA's anyway?

DANE

- Using the DNS to associated domain name public key certificates with domain name



[Docs] [txt|pdf] [draft-ietf-dane-p...] [Diff1] [Diff2] [Errata]

Updated by: 7218, 7671 — PROPOSED STANDARD, Errata Exist

Internet Engineering Task Force (IETF)
Request for Comments: 6698
Category: Standards Track
ISSN: 2070-1721

P. Hoffman, VPN Consortium
J. Schlyter, Kirei AB
Aug...

The DNS-Based Authentication of Na...
Transport Layer Securit...

RFC6698 -- You should read this!

Abstract

Encr... ...e Internet often uses Transport Layer Se... ... depends on third parties to certify the keys us... ...ocument improves on that situation by enabling the adm... ...erators of domain names to specify the keys used in that domain's TLS servers. This requires matching improvements in TLS client software, but no change in TLS server software.

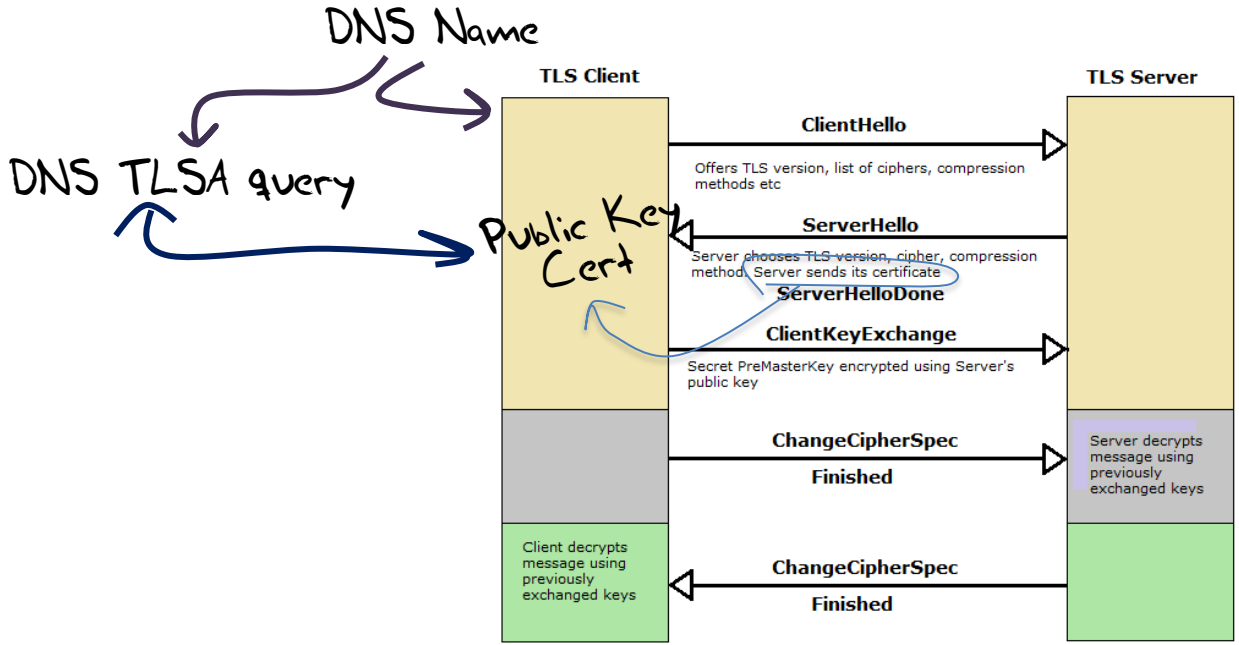
Status of This Memo

This is an Internet Standards Track document.

TLS with DANE

- Client receives server cert in Server Hello
  - *Client lookups the DNS for the TLSA Resource Record of the domain name*
  - *Client validates the presented certificate against the TLSA RR*
- Client performs Client Key exchange

TLS Connections



https://rhsecurity.wordpress.com/tag/tls/

Just one problem…

- The DNS is full of liars and lies!
- And this can compromise the integrity of public key information embedded in the DNS
- Unless we fix the DNS we are no better off than before with these TLSA records!

Just one response…

- We need to allow users to **validate** DNS responses for themselves
- And for this we need a Secure DNS framework
- Which we have – and it's called **DNSSEC**!

DANE + DNSSEC

- Query the DNS for the TLSA record of the domain name and ask for the DNSSEC signature to be included in the response
- Validate the signature to ensure that you have an unbroken signature chain to the root trust point
- At this point you can accept the TLSA record as the authentic record, and set up a TLS session based on this data

DANE + DNSSEC

- Query the DNS for the TLSA record of the domain name and ask for the DNSSEC signature to be included in the response
- Validate the signature to ensure that you have an unbroken signature chain to the root
- At this point you can use the TLSA record as the authentic record, and set up a TLS session based on this data

Yes, but No!

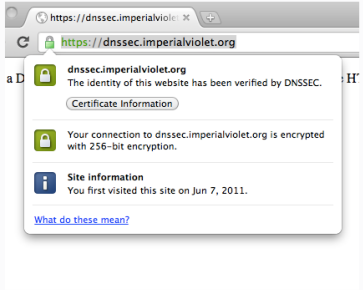
DANE + DNSSEC

ImperialViolet

DNSSEC authenticated HTTPS in Chrome (16 Jun 2011)

Update: this has been removed from Chrome due to lack of use.

DNSSEC validation of HTTPS sites has been hanging around in Chrome for nearly a year now. But it's now enabled by default in the current canary and dev channels of Chrome and is on schedule to go stable with Chrome 14. If you're running a canary or dev channel (and you need today's dev channel release: 14.0.794.0) then you can go to https://dnssec.imperialviolet.org and see a DNSSEC signed site in action.

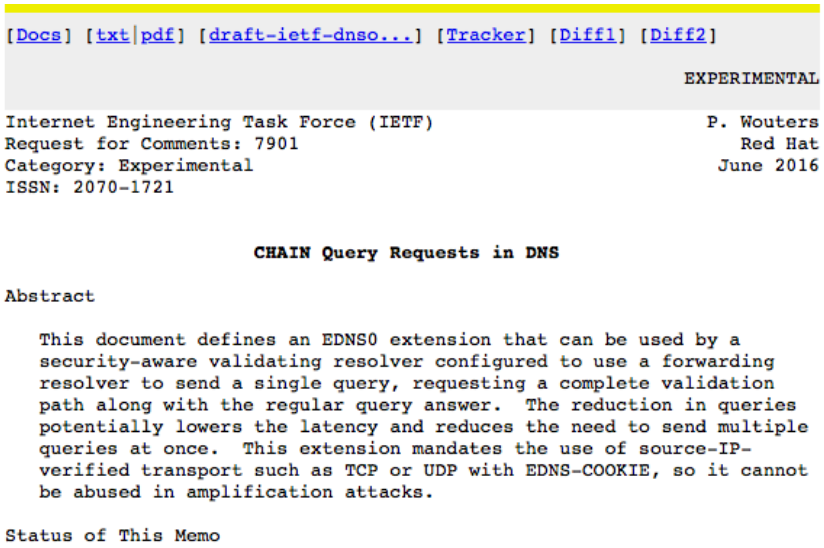


DNSSEC stapled certificates (and the reason that I use that phrase will become clear in a minute) are aimed at sites that currently have, or would use, self-signed certificates and, possibly, larger organisations that are Chrome based and want certificates for internal sites without having to bother with installing a custom root CA on all the client devices. Suggesting that this heralds the end of the CA system would be utterly inaccurate. Given the deployed base of software, all non-trival sites will continue to use CA signed certificates for decades, at least. DNSSEC signing is just a gateway drug to better transport security.

DANE validation can be SO SLOW!

Or…

Faster validation?



[Docs] [txt|pdf] [draft-ietf-dnso...] [Tracker] [Diff1] [Diff2]

EXPERIMENTAL

Internet Engineering Task Force (IETF) — P. Wouters
Request for Comments: 7901 — Red Hat
Category: Experimental — June 2016
ISSN: 2070-1721

CHAIN Query Requests in DNS

Abstract

This document defines an EDNS0 extension that can be used by a security-aware validating resolver configured to use a forwarding resolver to send a single query, requesting a complete validation path along with the regular query answer. The reduction in queries potentially lowers the latency and reduces the need to send multiple queries at once. This extension mandates the use of source-IP-verified transport such as TCP or UDP with EDNS-COOKIE, so it cannot be abused in amplification attacks.

Status of This Memo

Or … Look! No DNS!

- Server packages server cert, TLSA record and the DNSSEC credential chain in a single bundle
- Client receives bundle in Server Hello
  - *Client performs validation of TLSA Resource Record using the supplied DNSEC signatures plus the local DNS Root Trust Anchor without performing any DNS queries*
  - *Client validates the presented certificate against the TLSA RR*
- Client performs Client Key exchange

Doing a better job

We could do a **far** better job at Internet Security by moving on from X.509 public key certificates:

- Publishing DNSSEC-signed zones
- Publishing DANE TLSA records
- Using DNSSEC-validating resolution
- Using TLSA records to guide TLS Key Exchange
- Stapling the TLSA + sig bundle into TLS

Doing a better job

We could do a **far** better job [illegible] oving on from X.509 public ke[illegible]

But nothing has happened for more than a decade!

Why not?

- [illegible] TLS Key Exchange
- St[illegible] TLSA + sig bundle into TLS

Why is this so hard?

Why is this so hard?

We have different goals

- Some people want to provide strong hierarchical controls on the certificates and keys because it entrenches their role in providing services
- Some want to do it because it gives them a point of control to intrude into the conversations of their citizens
- Others want to exploit weaknesses in the system to leverage a competitive advantage
- Some people think users prefer faster applications, even if they have security weaknesses
- Others think users are willing to pay a time penalty for better authentication controls

Why is this so hard?

Because there are so many moving parts?

- In a system that is constructed upon the efforts of multiple systems and multiple providers we are relying on someone in charge to orchestrate the components to as working whole

Saturn V Launch Vehicle
Three stage rocket, each built by a different contractor
Each of whom used multiple subcontractors
3 million components
Each supplied by the lowest bidder!

Why is this so hard?

Because we are relying on the market to provide coherence and consistency of orchestration across providers?

- And perhaps that's the key point here
- Loosely coupled systems will always present windows of vulnerability
  - Routing integrity
  - Name registration
  - Name certification
  - Service control
- Effective defence involves not only component defence but also in defending the points of interaction between components
- And we find this very hard to achieve when the market itself is the orchestration agent

Users and Trust

- Users just want to be able to trust that the websites and services that they connect to and share their credentials, passwords and content with are truly the ones they expected to be using without first studying for a PhD in Network Operational Security
- Somehow we're missing that simple objective and we've interposed complexity and adornment that have taken on a life of their own and are in fact eroding trust
- And that's bad!
- **If we can't trust our communications infrastructure, then we don't have a useful communications infrastructure.**

What a dysfunctional mess we've created!

Can we make it better?

We could do a better job if we knew what we wanted

Can we make it better?

We could do a better job if we knew what we wanted

– Single point of trust for EVERTHING (DNSSEC)

or

– Many points of trust in a highly distributed framework (Web PKI)

Can we make it better?

We could do a better job if we knew what we wanted

– Highly robust validation performed by the client

or

– Fast!

Can we make it better?

We could do a better job if we knew what we wanted

– Single common secure credential infrastructure

or

– Application-specific credentials

Can we make it better?

- Yes, if we could only agree on what we want in the first place!
- And we just can’t agree on that!

That's it!

Questions?