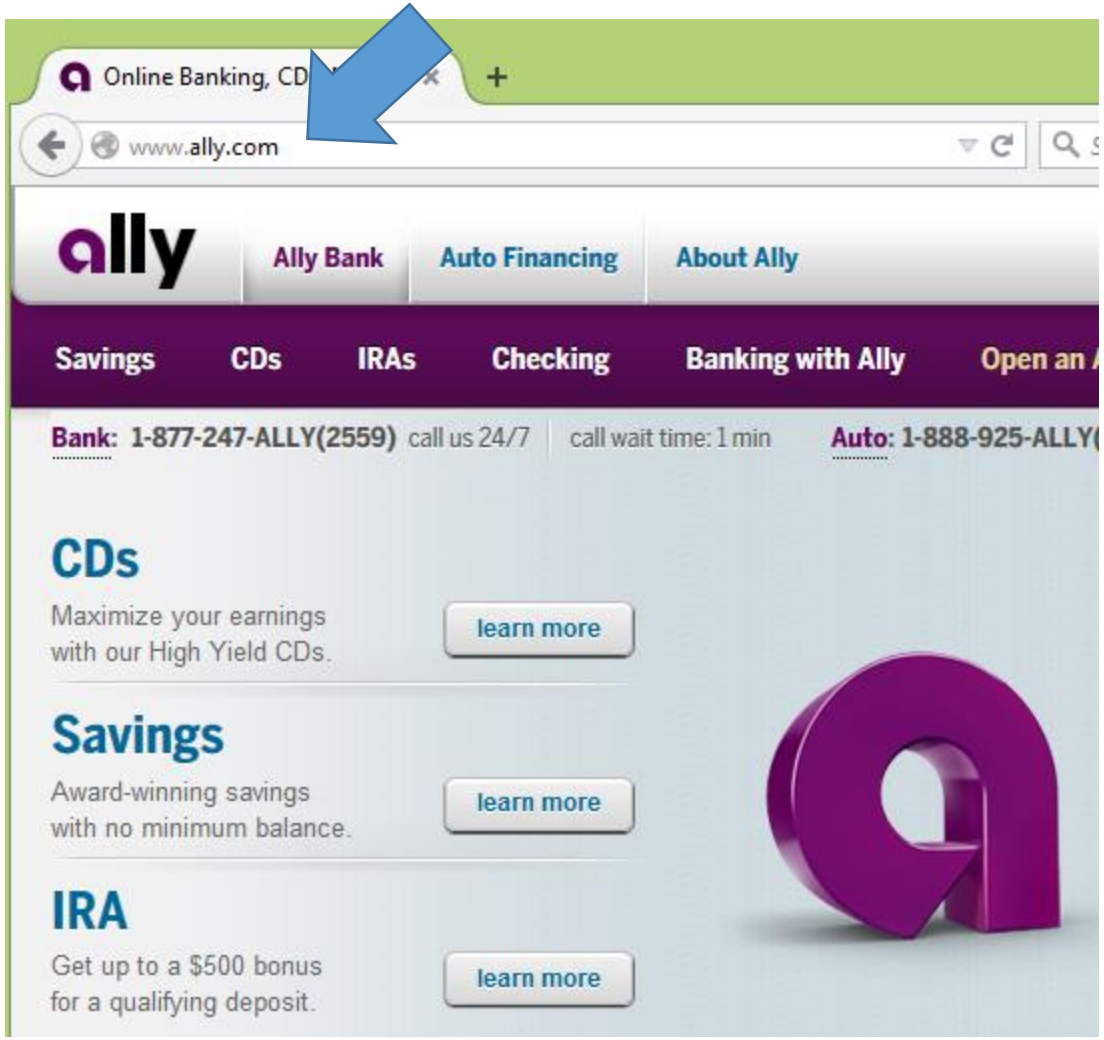
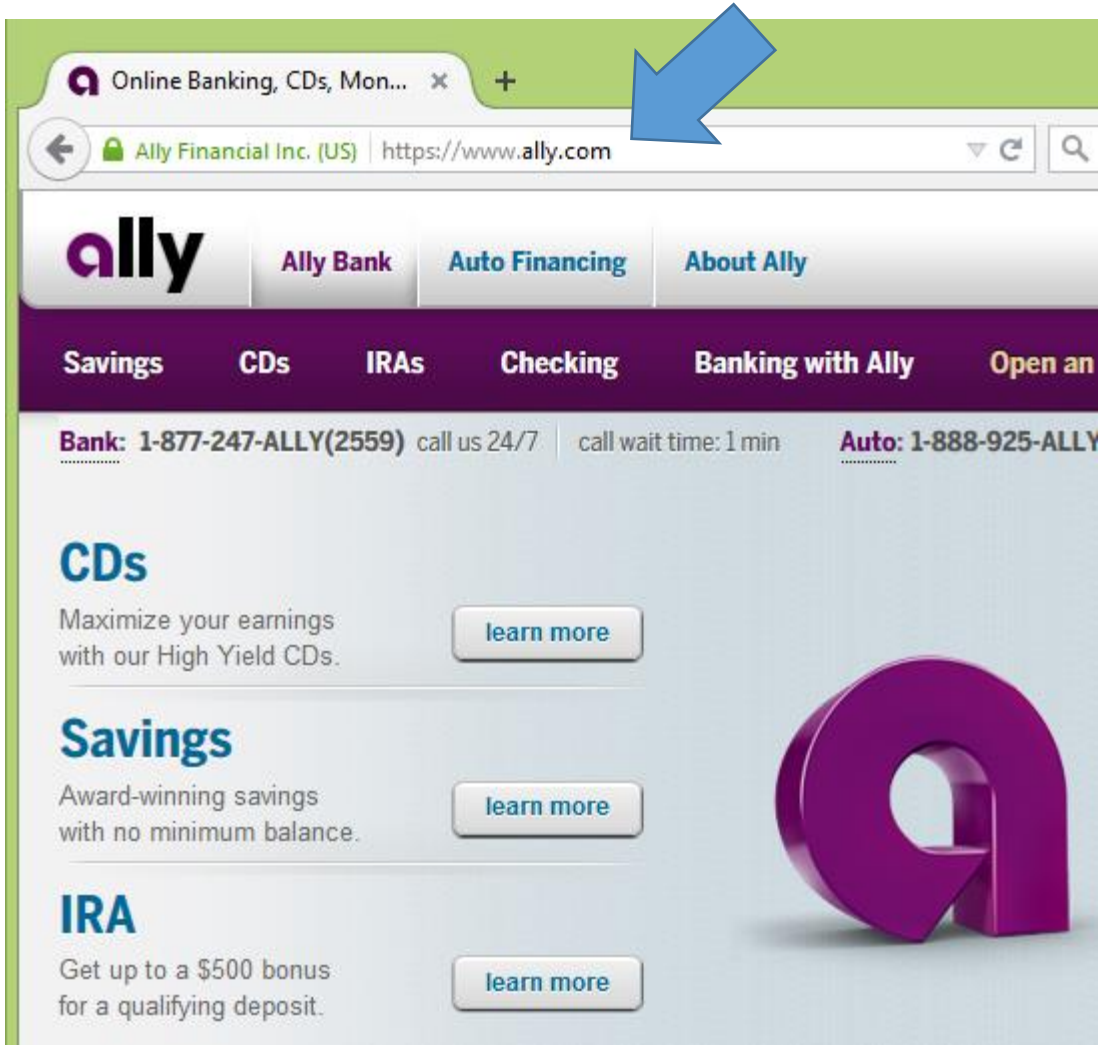
# HTTPS Explained

DR KAMI VANIEA

# http versus https



https://ally.com

**versus**

http://ally.com

# Encryption properties we want:

Cryptography magic sorts this one out for us: Confidentiality, Integrity.

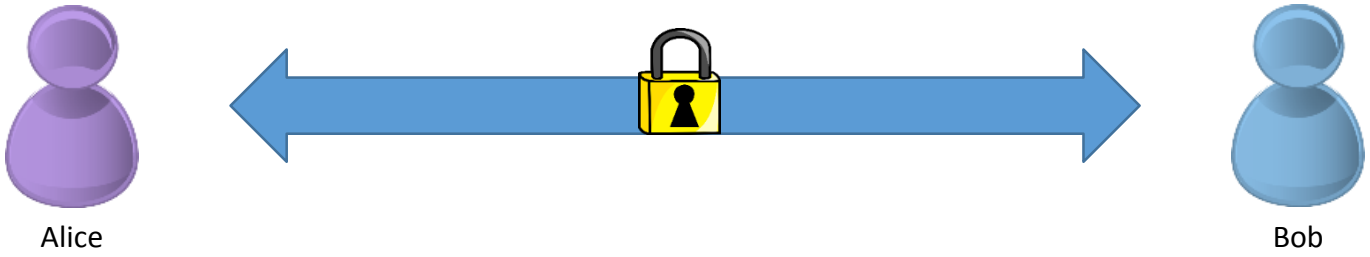
1. The communication between you and the other party is **confidential** and has **not been changed**
   - No one can read what you sent
   - No one can change what you sent

This one is a bit harder. Cryptography can verify you are speaking to the same person, but not identity.

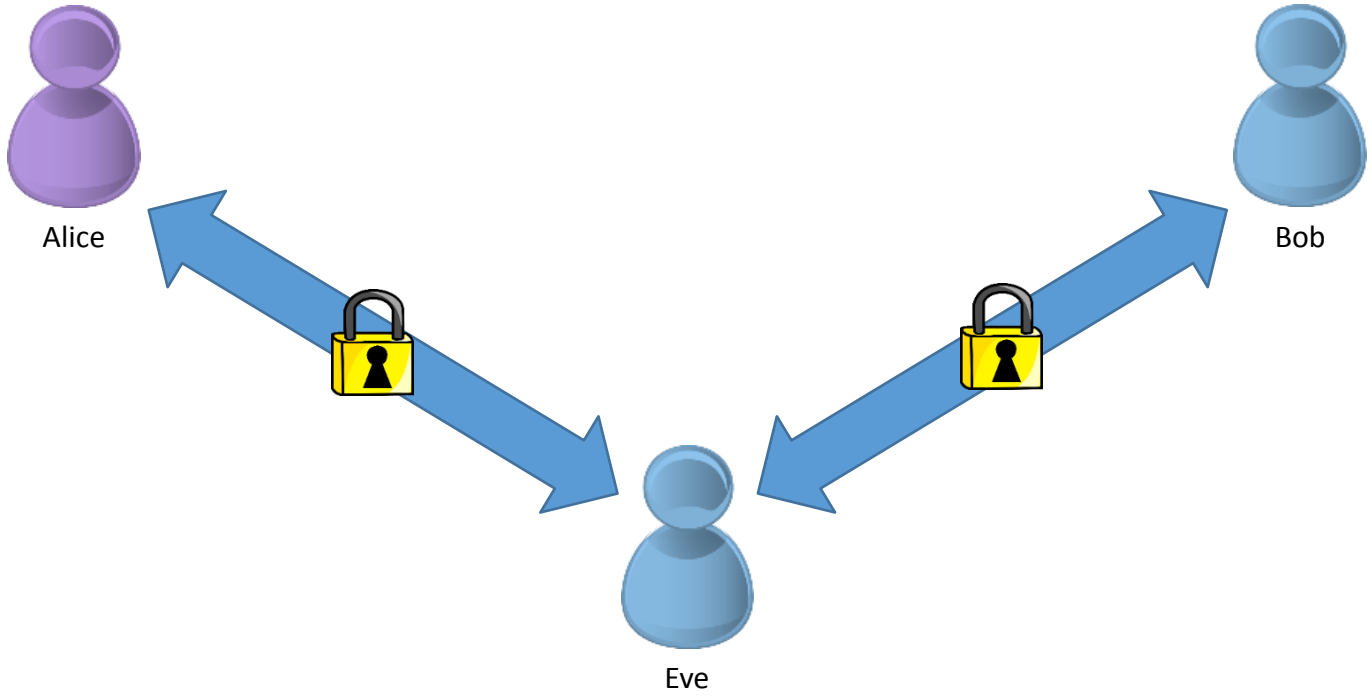
2. **Knowing who** you are communicating with
   - You are talking to who you think you are talking to and not someone else

# Alice wants to talk securely with Bob

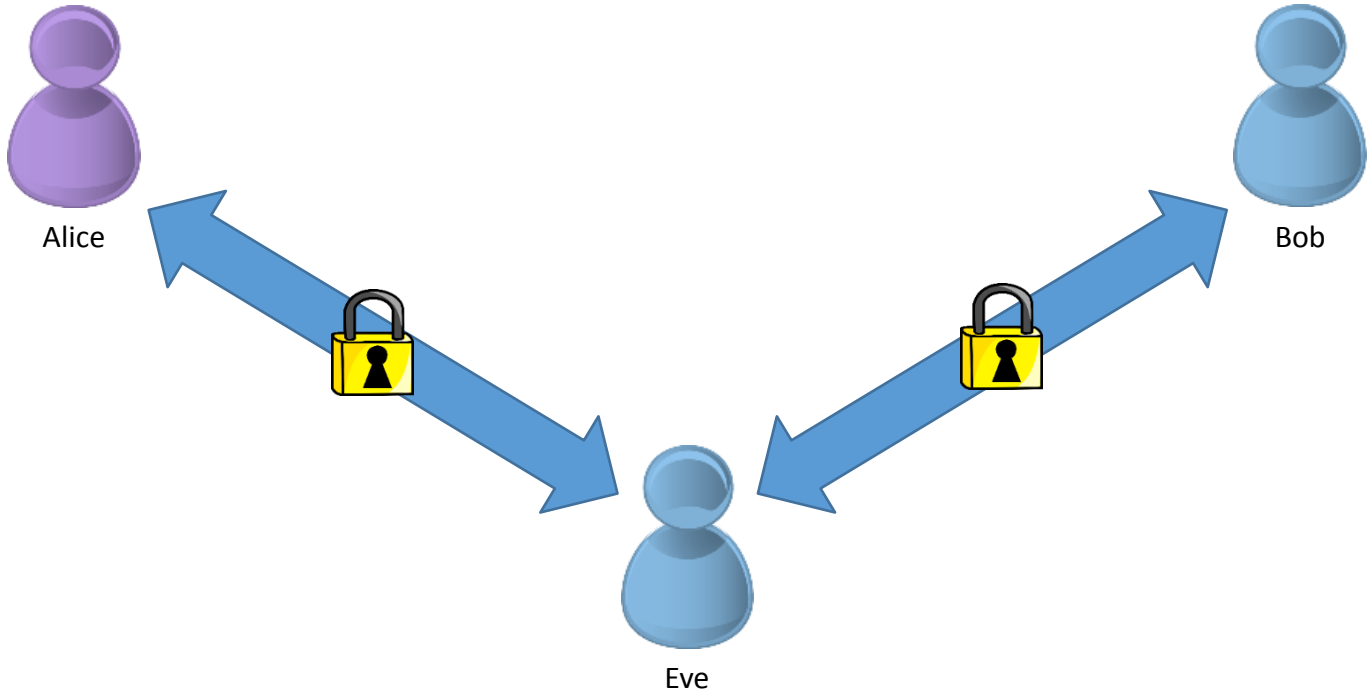
# She can encrypt the connection (1)



# But how can Alice know she is talking to Bob and not talking to Eve? (2)



# Man in the middle attack



# Encryption properties we want:

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**First, a short primer on encryption.**

**You will need to understand this eventually, but for now you mostly need to get the general idea of it.**

# Link identity to keys

- Encryption often depends on keys like the one on the right
- These keys are used with a whole pile of math to encrypt and decrypt a file.

Overly simple example:

| **Message** | **C** | **R** | **Y** | **P** | **T** | **O** |
|---|---|---|---|---|---|---|
| Key | A | Y | S | Y | I | F |
| Encrypted | C | P | Q | N | B | T |

# My public key


-----BEGIN PGP PUBLIC KEY BLOCK-----
Version: GnuPG v2

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=x5FK
-----END PGP PUBLIC KEY BLOCK-----

# Public/private key cryptography

- Generate two “keys” that are paired
- **Whatever one key locks only the other key can unlock**
- Public keys are given out to everybody
- Private keys are kept private

# My public key


-----BEGIN PGP PUBLIC KEY BLOCK-----
Version: GnuPG v2

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YKG3gbV9iyczAS31gbogVLAZqNSWhp8vVIEE28Fyf/Ed
=x5FK
-----END PGP PUBLIC KEY BLOCK-----

# I want to prove a message is from me

- I encrypt (lock) the message with my private key
- Anyone with the public key can use it to decrypt (unlock) the file. If it decrypts (unlocks), then it must have been encrypted (locked) by my private key and no other.

# My public key


-----BEGIN PGP PUBLIC KEY BLOCK-----
Version: GnuPG v2

mQENBFHMcgABCAC9WrYDO6K2L3VHyi4eHN6suHLqMpJ+SO+IUTuLEVnUzIoXAUXH
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YKG3gbV9iyczAS31gbogVLAZqNSWhp8vVIEE28Fyf/Ed
=x5FK
-----END PGP PUBLIC KEY BLOCK-----

# I want to send Bob a message that no one else can read

- I encrypt (lock) the message with Bob's public key.
- Only Bob has his private key, so only Bob can decrypt (unlock) the message.

# My public key


-----BEGIN PGP PUBLIC KEY BLOCK-----
Version: GnuPG v2

mQENBFHMcgABCAC9WrYDO6K2L3VHyi4eHN6suHLqMpJ+SO+IUTuLEVnUzIoXAUXH
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YKG3gbV9iyczAS31gbogVLAZqNSWhp8vVIEE28Fyf/Ed
=x5FK
-----END PGP PUBLIC KEY BLOCK-----

**If I do both of those at the same time I can prove that only I could have sent the message and that only Bob can read it.**

# My public key


-----BEGIN PGP PUBLIC KEY BLOCK-----
Version: GnuPG v2

mQENBFHMcgABCAC9WrYDO6K2L3VHyi4eHN6suHLqMpJ+SO+IUTuLEVnUzIoXAUXH
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YKG3gbV9iyczAS31gbogVLAZqNSWhp8vVIEE28Fyf/Ed
=x5FK
-----END PGP PUBLIC KEY BLOCK-----

**But we still have a problem:**

**All that assumes that we know which key goes with which person (2).**

**How do we solve the identity problem?**

**Idea: Have the humans do the linking of identity to cryptographic keys.**

We could post the public key somewhere highly public and verifiable it came from us.

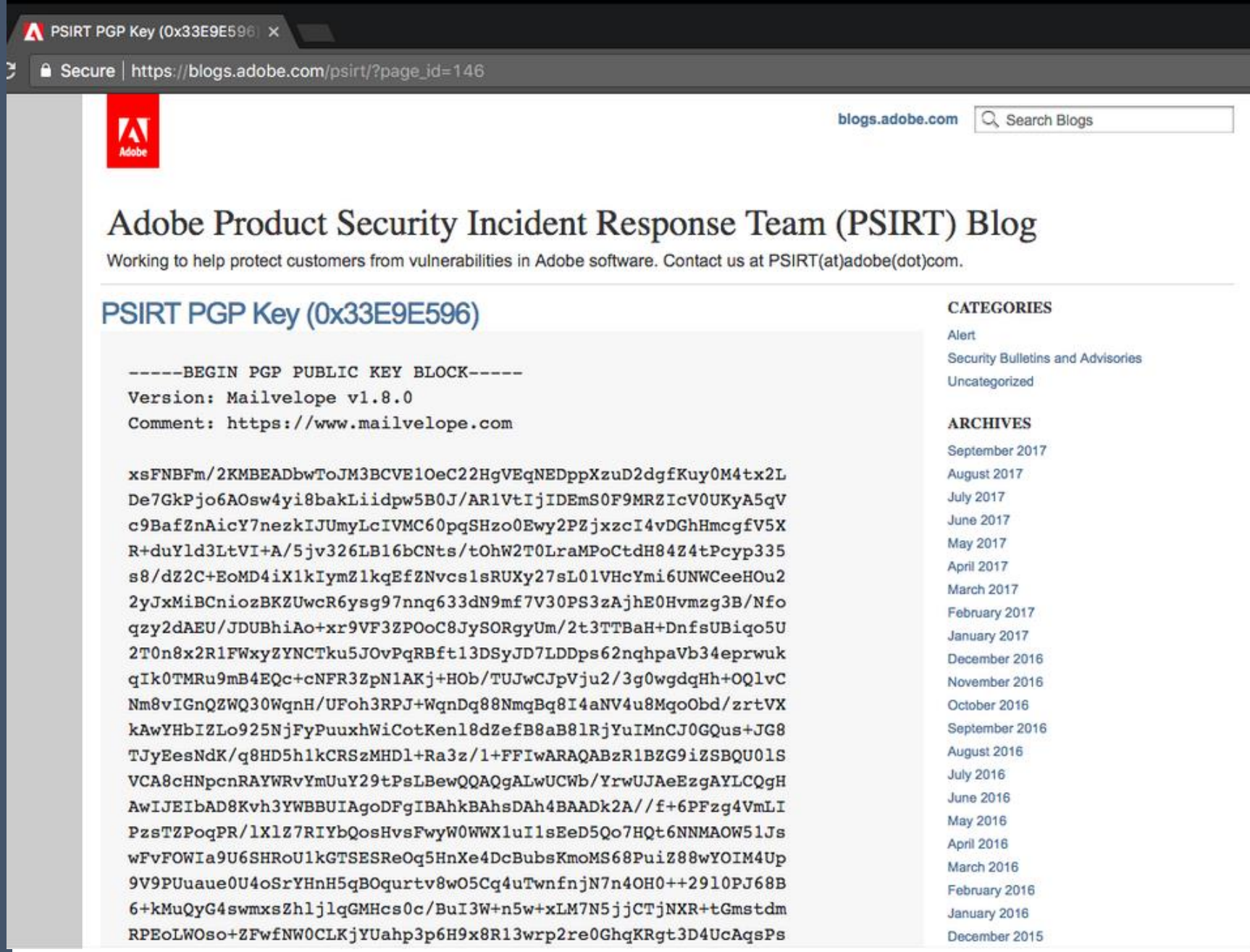


Photo credit: Juho Nurminen @jupenur

# Other people can then compare the keys on their computers to the highly visible copy.

```
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```
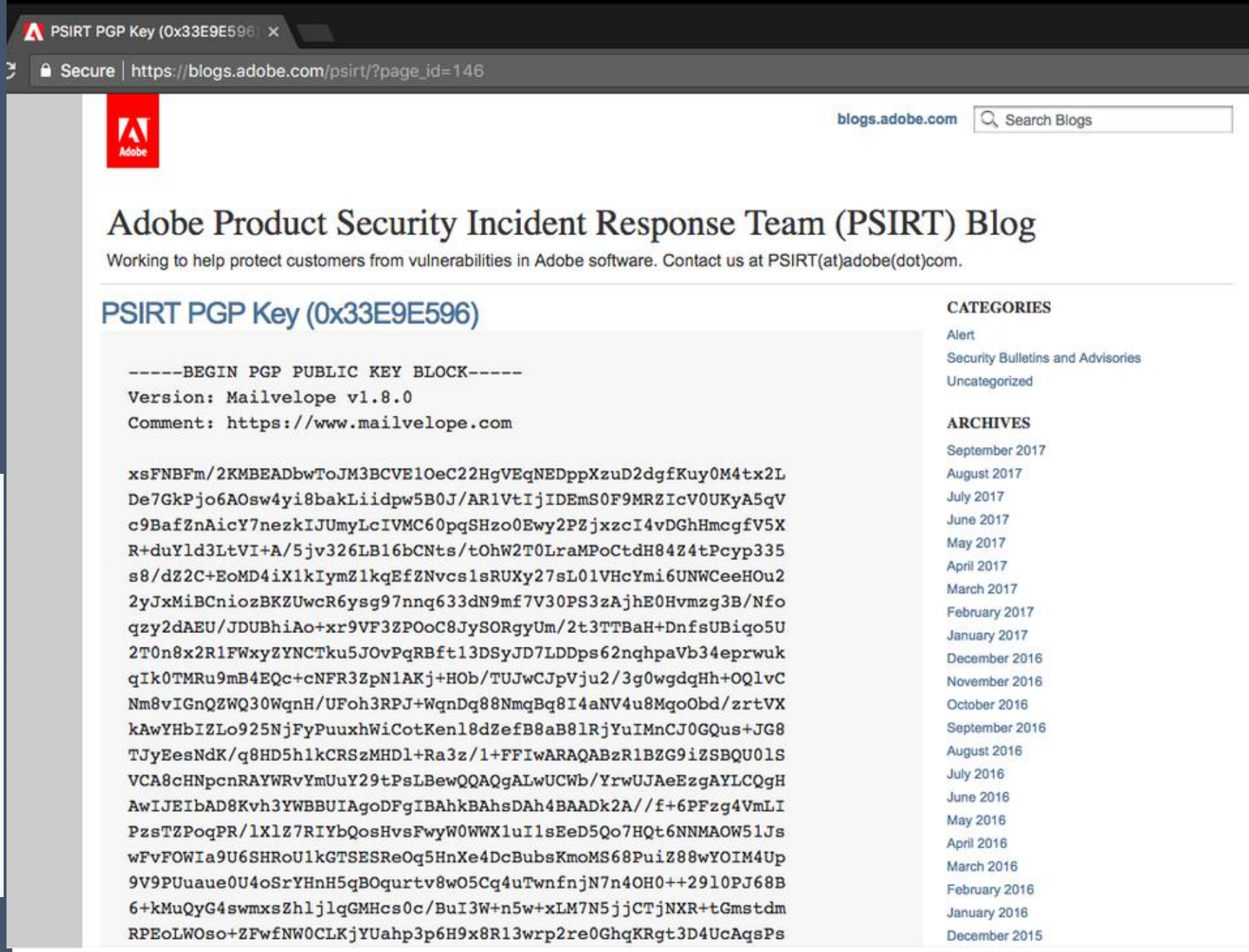

Photo credit: Juho Nurminen @jupenur



# Though we must be careful to post ONLY the public key…

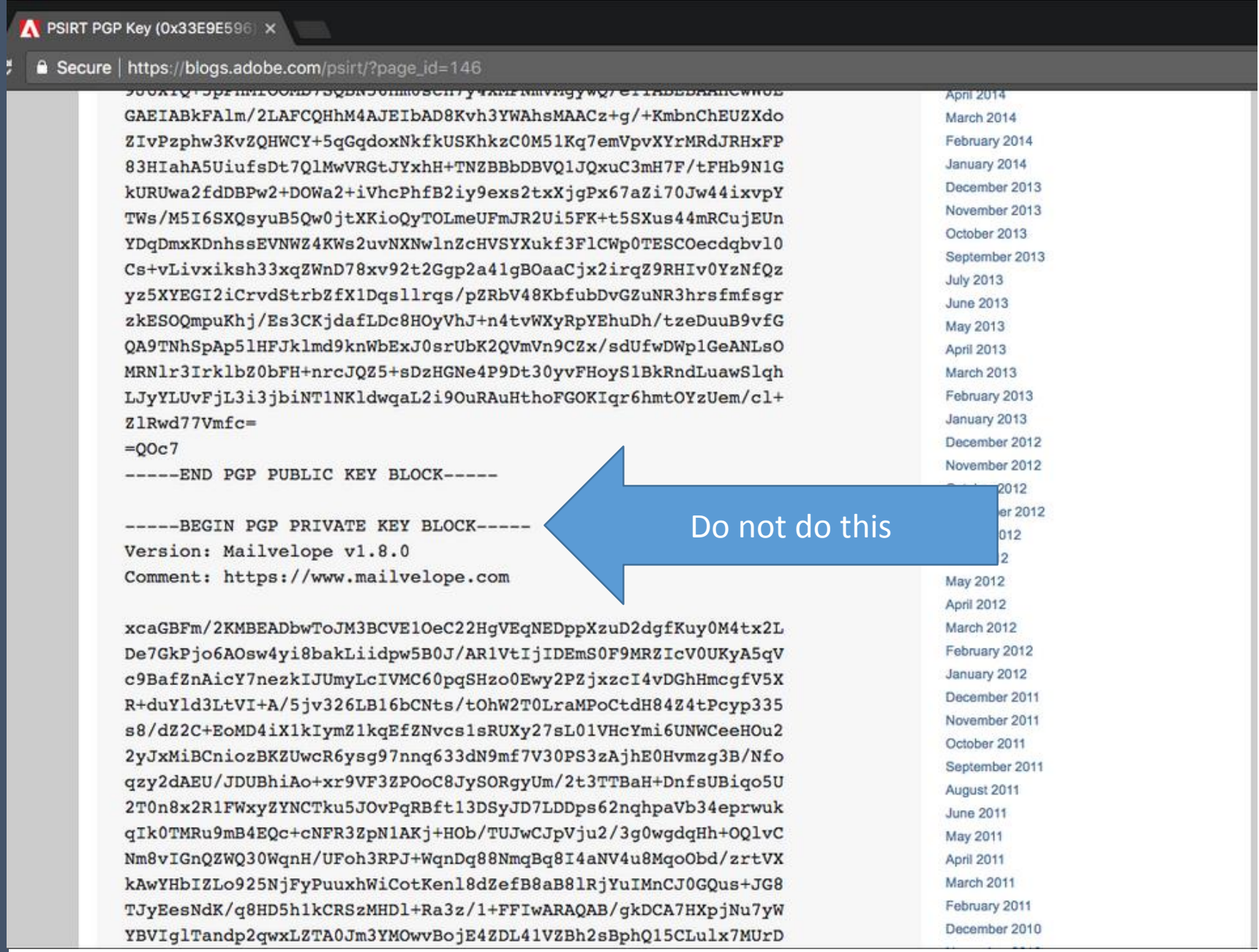



Photo credit: Juho Nurminen @jupenur

**Nice idea, but it does not scale.**

**Also a chicken-and-egg problem. How do we find a place guaranteed to be from us without using cryptography?**

**Idea 2: What if everyone did a few verifications. We could slowly build a web of verifications like:**

**Alice verified Bob's key**
**Bob verified Charlie's key**
**so**
**Alice can trust Charlie's key**

# Web of trust

- Alice hand verifies that Bob's public key really does belong to Bob
- Then Alice "signs" the key by encrypting it with her private key.
- Now anyone that has hand verified Alice's key, can also trust Bob's key (if they trust Alice to do verifications).

# My public key


-----BEGIN PGP PUBLIC KEY BLOCK-----
Version: GnuPG v2

mQENBFHMcgABCAC9WrYDO6K2L3VHyi4eHN6suHLqMpJ+SO+IUTuLEVnUzIoXAUXH
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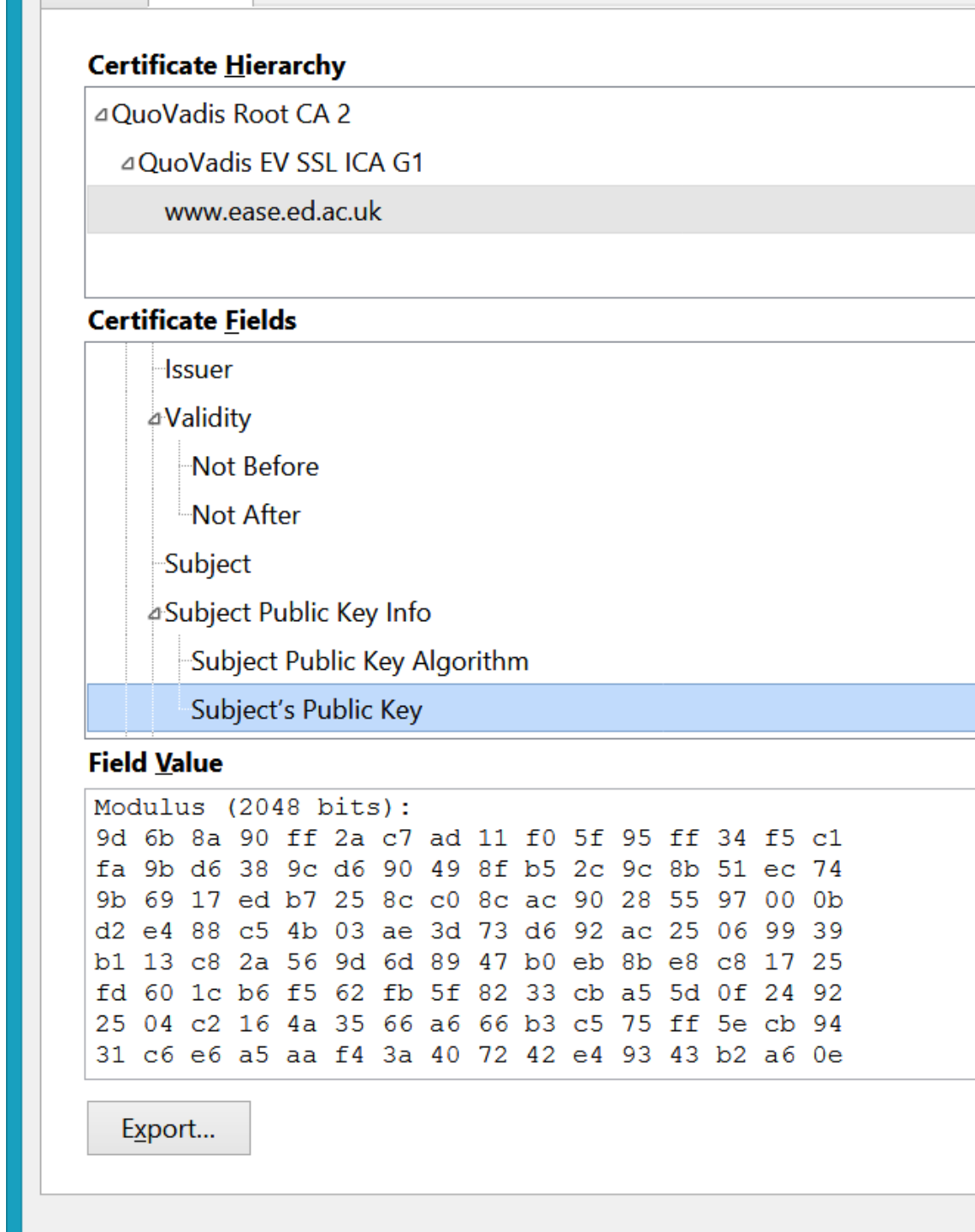
=x5FK
-----END PGP PUBLIC KEY BLOCK-----

**Wonderful idea in theory. But verifying those long keys is hard… also I don’t actually trust most of you to do a thorough job of it….**

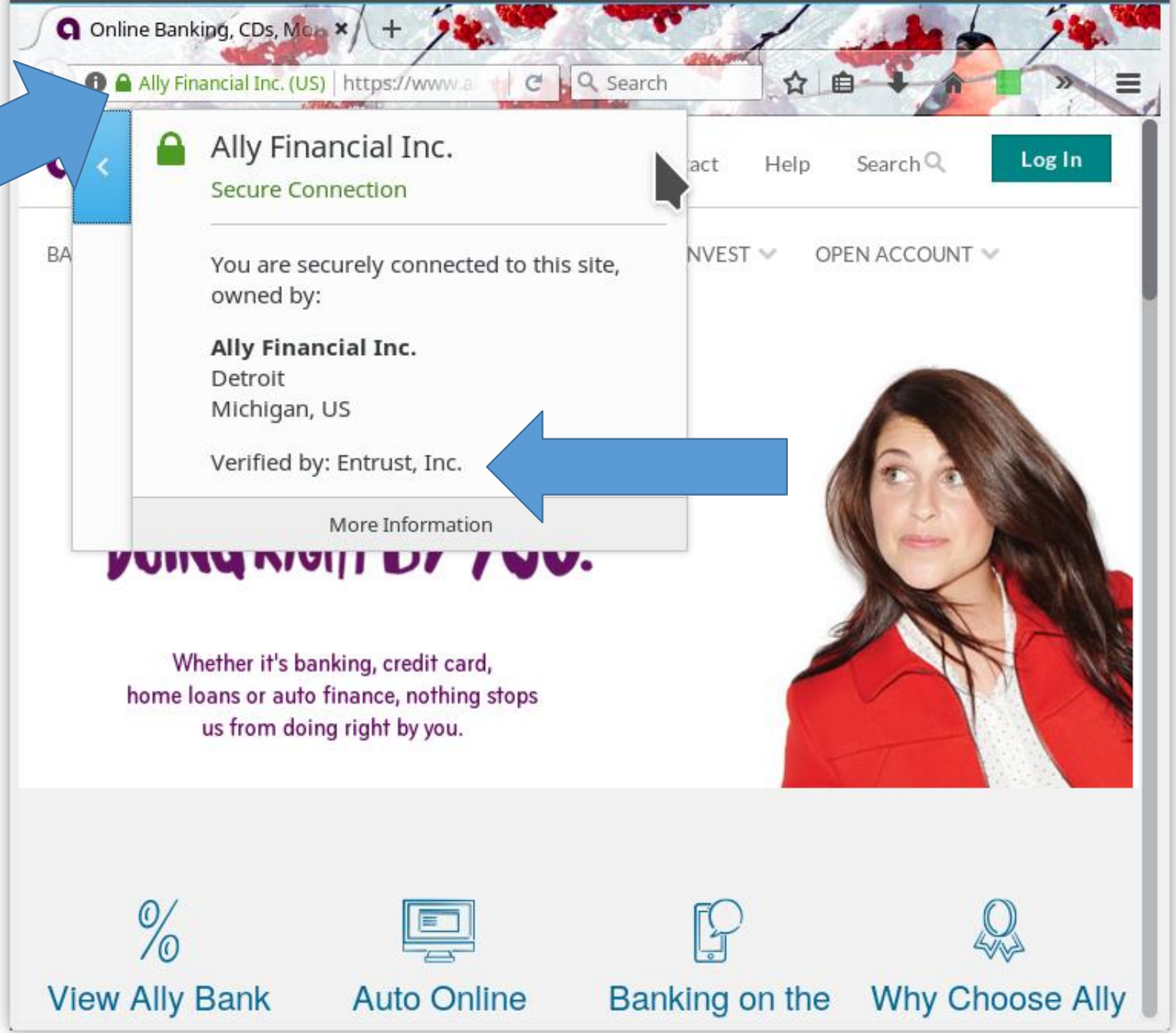
**Idea 3: What if a couple of trusted groups did the verifications. Then they could have high standards and everyone could just trust them.**

# Certificate Authorities

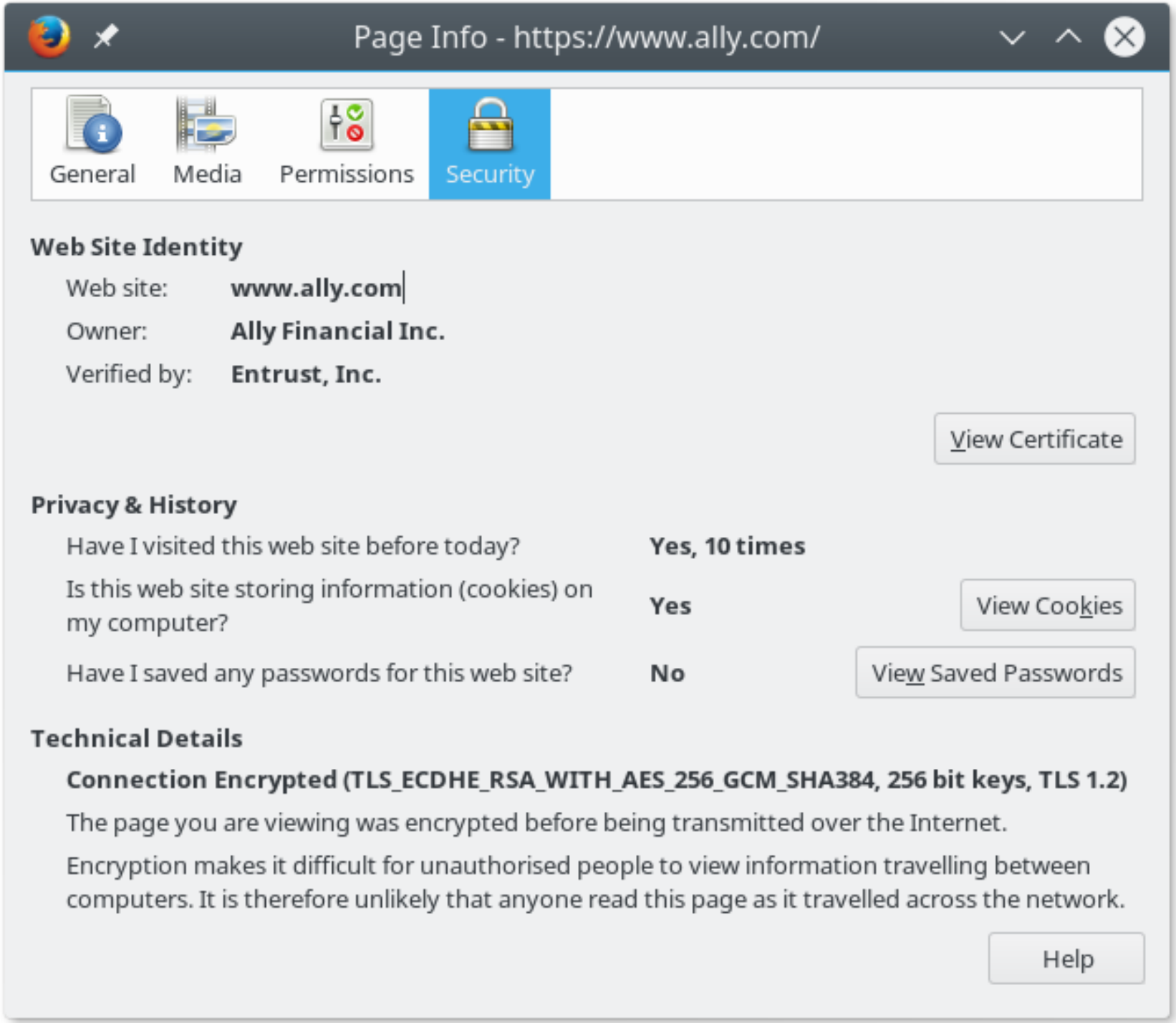
- A certificate authority verifies some properties of a person/organization and issues a “certificate” signed by their private key.
- Certificates can be quite detailed about what has been verified, and what they have been verified to do.

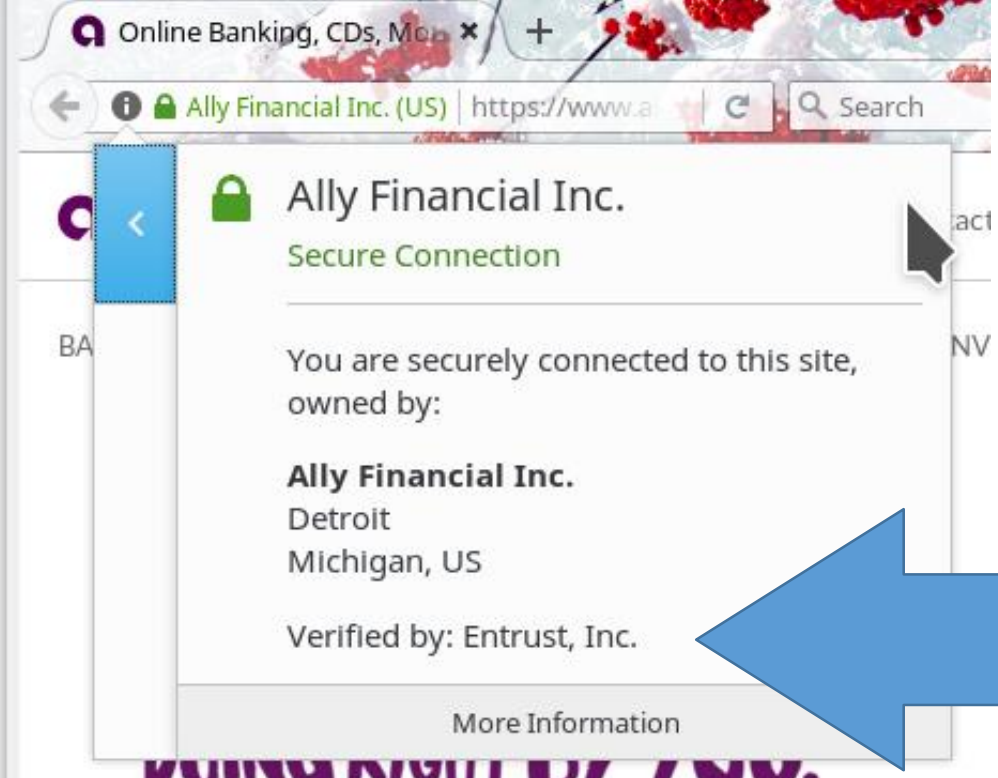


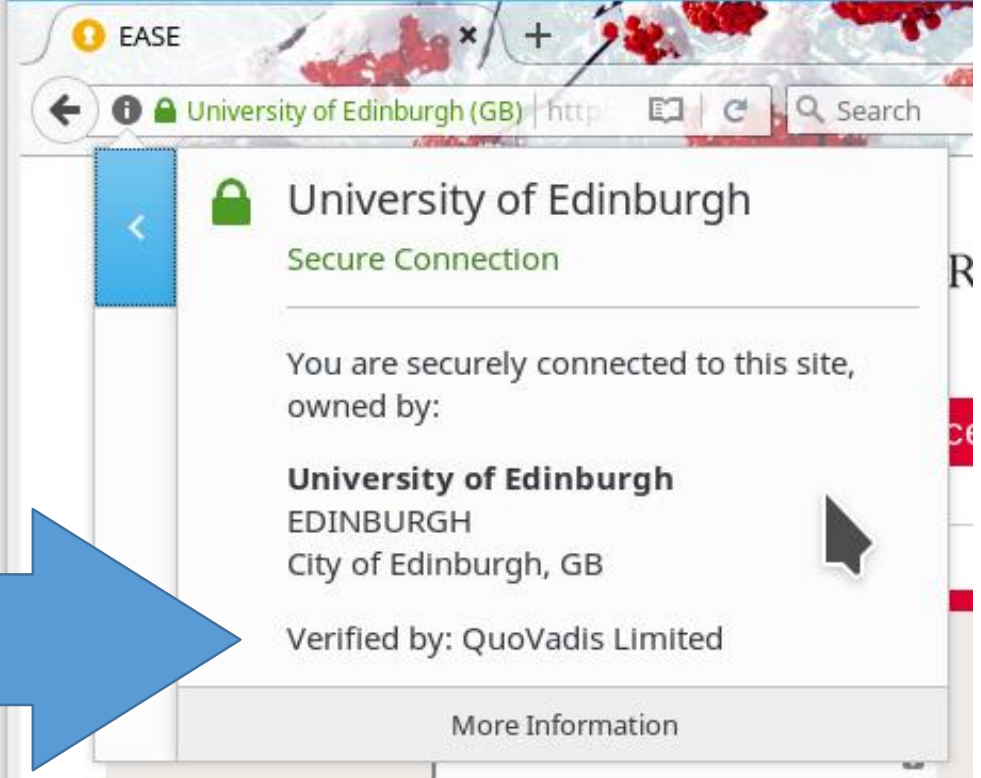
# Certificate Authorities are used by browsers to verify identity



# You can see lots of details about any encrypted connection.



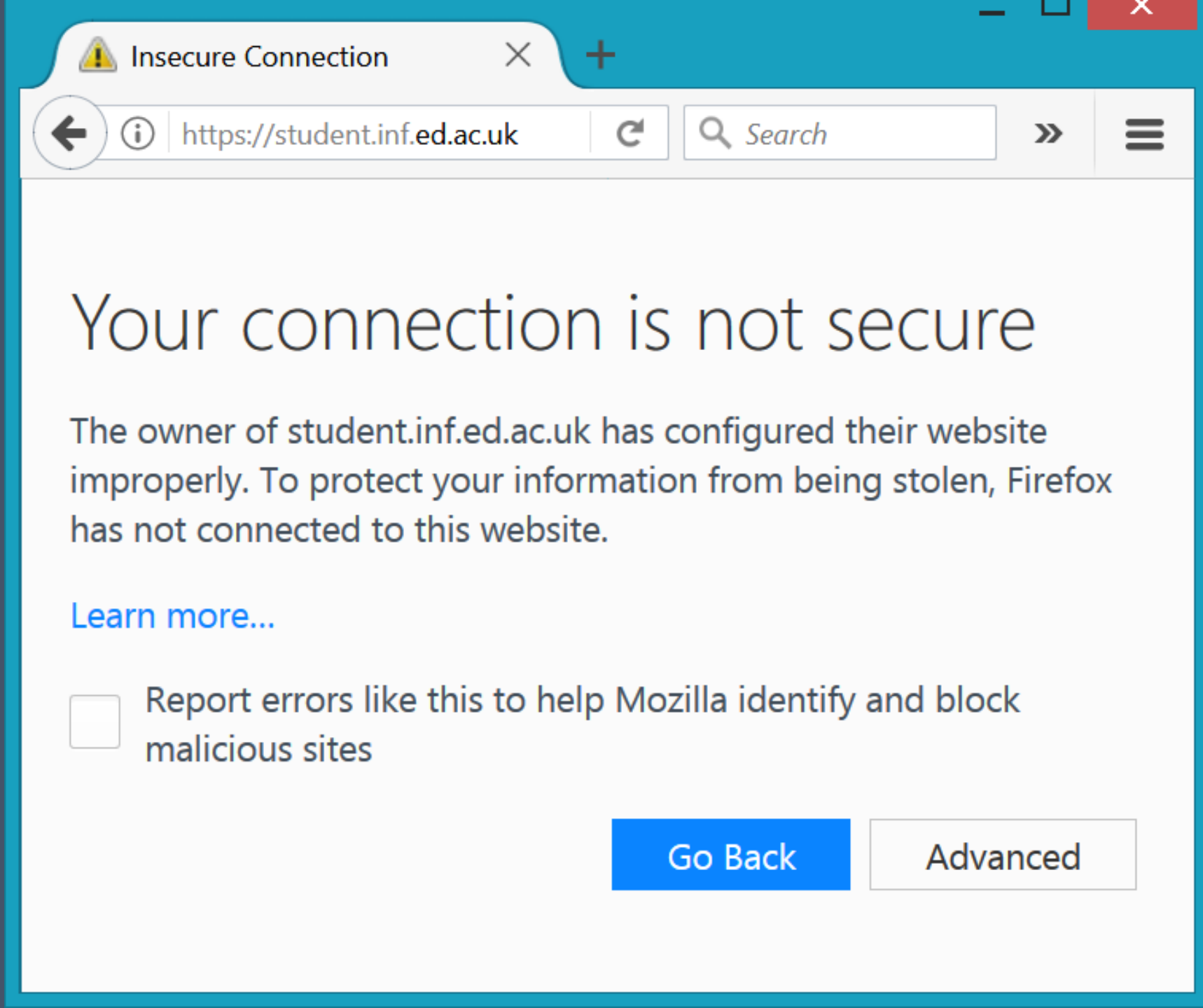


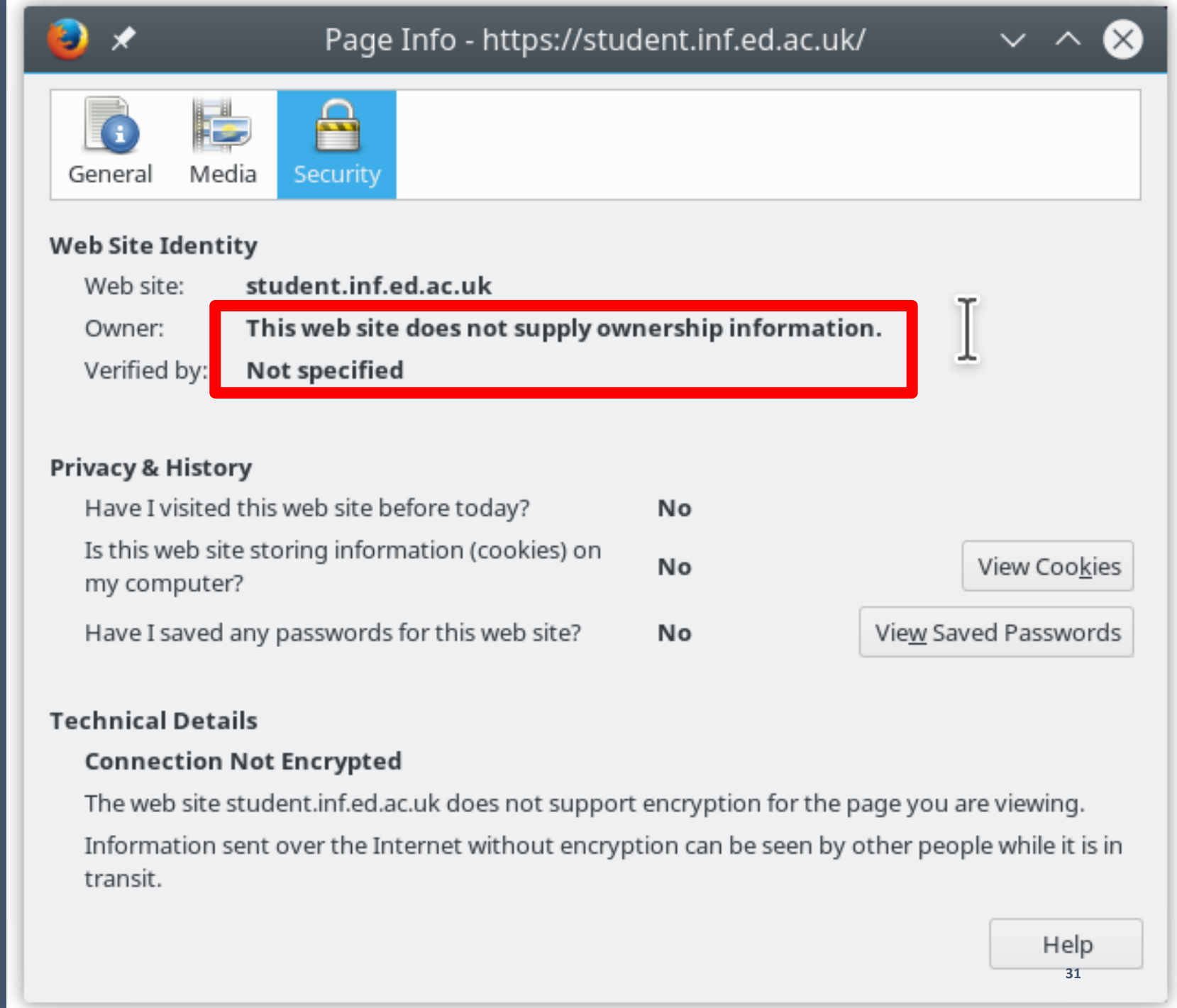

But now don't we just have the same problem again?

How does the browser know which Certificate Authorities to trust?

Clearly some Certificate Authorities are trusted and some are not.

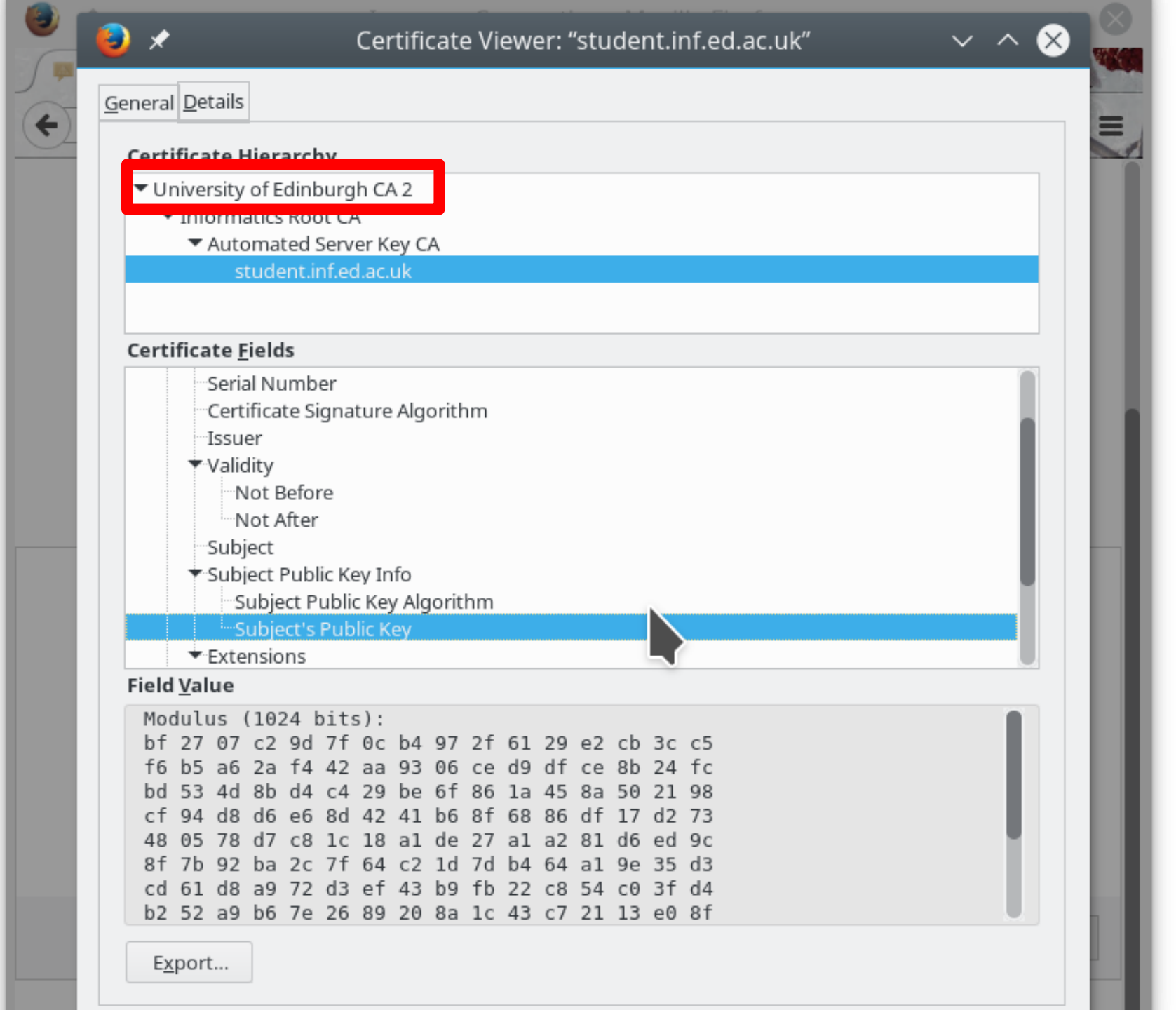


# Errors on student.inf.ed.ac.uk are a bit easier to understand though, identity information is missing…



This site is “self signed” which means that the University created its own Certificate Authority and used it to sign all the sites keys.

Why? It costs money to get a signed certificate.



**DICE machines will never give you an error on student.inf.ed.ac.uk but your personal laptop will.**

**What is the difference?**

**Your operating system and your browser both maintain lists of Certificate Authorities that they trust.**

**These lists differ between operating systems, browsers, and organizations.**

Each organization makes its own trust decisions about Certificate Authorities



INFOWORLD TECH WATCH

By Fahmida Y. Rashid, Senior Writer, InfoWorld | MAR 24, 2017

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# Google to Symantec: We don't trust you anymore

## Admins need to consider whether they still want to use Symantec after its repeated mistakes with issuing TLS certificates

geralt via pixabay

Security teams, network administrators, and operations teams have busy days ahead. Google's Chrome development team is fed up with Symantec as a certificate authority and has announced plans to no longer trust current Symantec certificates.

In the past 18 months, Google has tangled repeatedly with Symantec over the way it issues transport layer security (TLS) certificates, with Symantec promising to do better. The latest incident—an investigation into 127 mis-issued certificates—ballooned into "at least 30,000, issued over a period spanning several years," Ravi Sleevi, a software engineer on the Google

ars technica

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# Lenovo PCs ship with man-in-the-middle adware that breaks HTTPS connections [Updated]

Superfish may make it trivial for attackers to spoof any HTTPS website.

by Dan Goodin - Feb 19, 2015 11:36am EST

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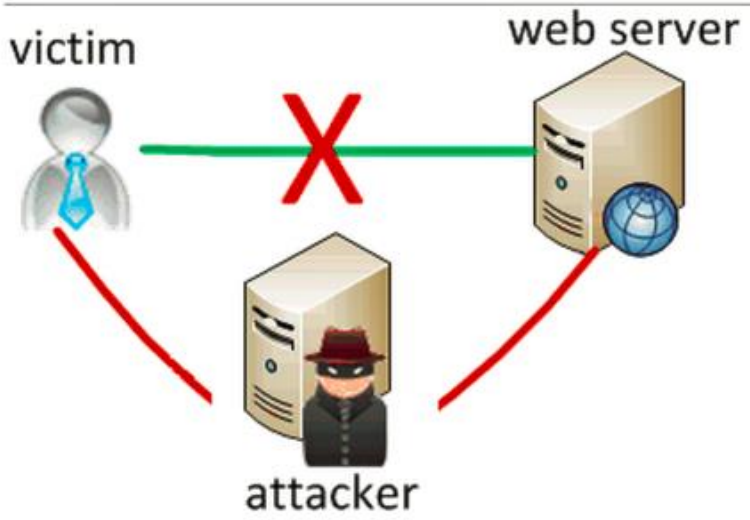
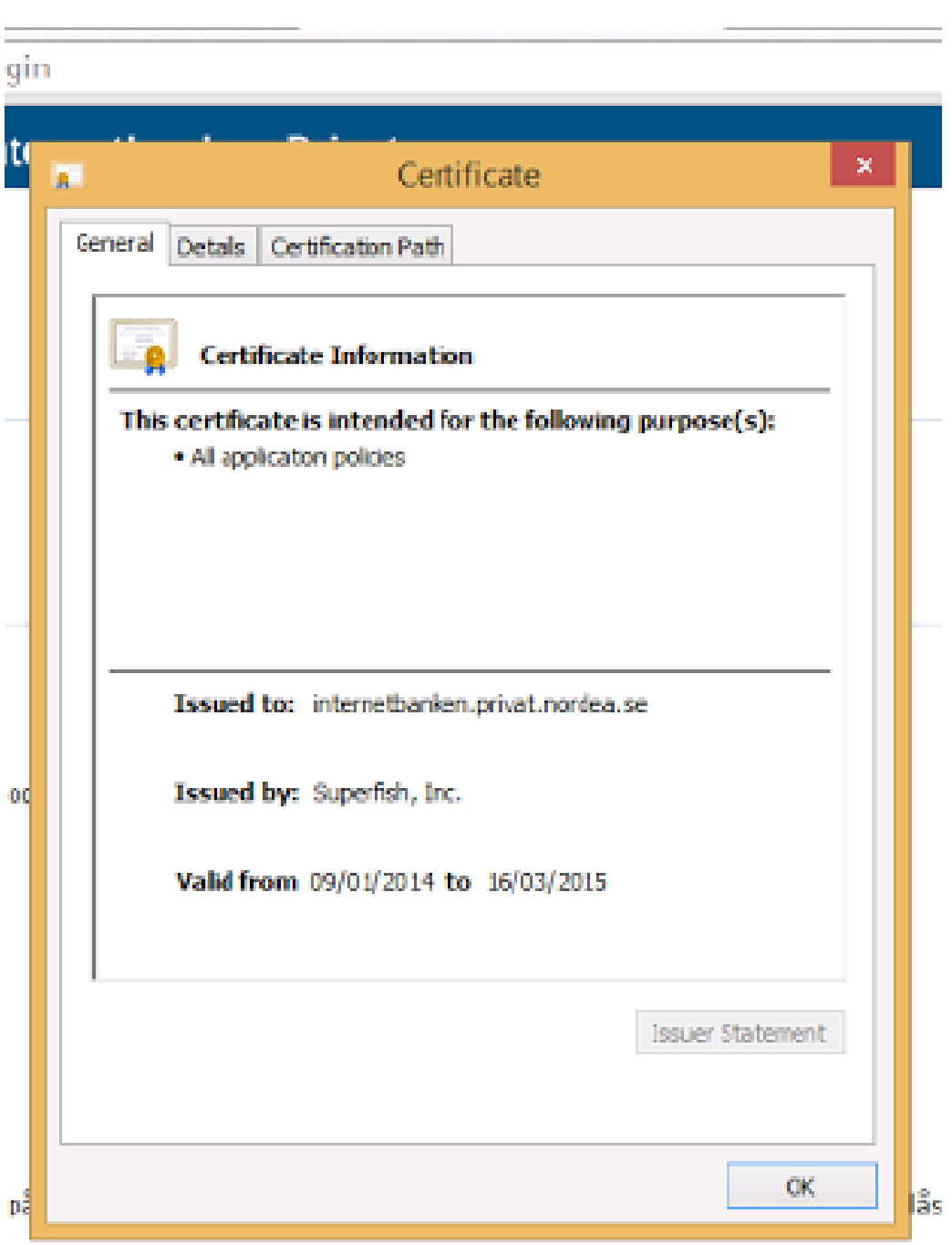
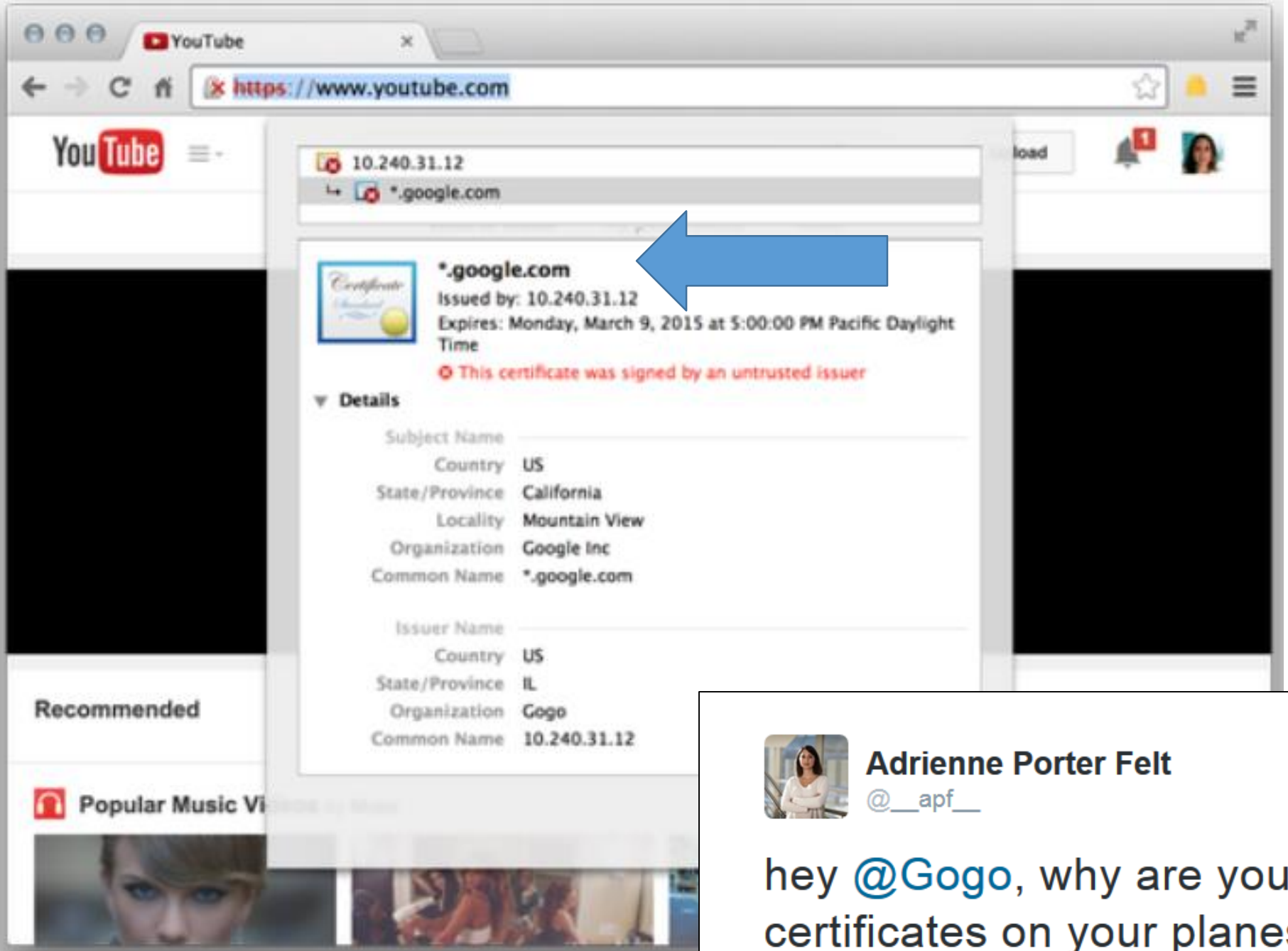



Web Programming Step by Step, 2nd Edition








**Adrienne Porter Felt**
@__apf__

Following

hey @Gogo, why are you issuing *.google.com certificates on your planes?

# Questions?