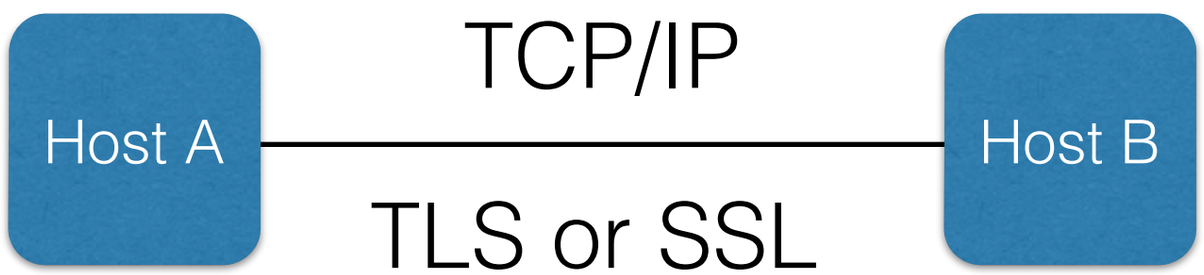
TLS/SSL

- TLS (Transport Layer Security)
  - A suite of protocols to provide secure communication
    - Confidentiality by applying block & stream ciphers
    - Integrity with MACs
    - Authenticity with certificates
  - Predecessor: SSL (secure sockets layer)
    - TLS was proposed as an upgrade
    - All versions of SSL are considered insecure (recently, the POODLE—padding oracle—attack)



TCP/IP: Host A and B can send packets to one another

TLS/SSL: operate “over” TCP/IP to ensure security/authenticity

TLS/SSL protocol (high level)

Browser
(initiates connection)

Server
(authenticates itself)

Client hello

Version, crypto options, *nonce*

Server hello + server cert (PKs)

Version, crypto options, *nonce*,
Signed certificate containing
the server's public key PKs

Server key exchange (when using DH)

Client key exchange

PreMaster secret encrypted with server's PKs

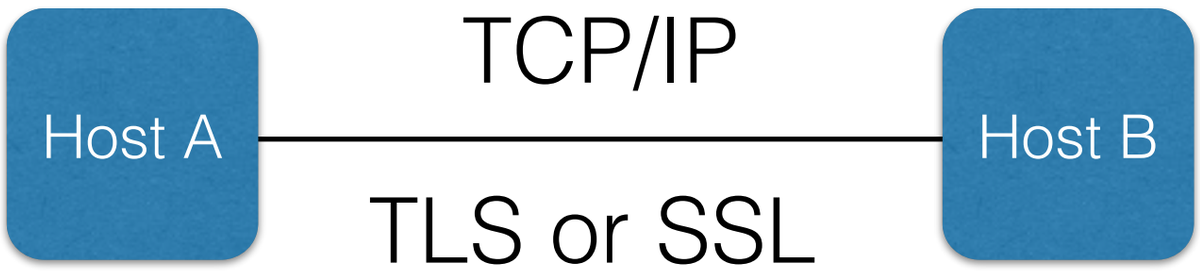
Compute
K based
on nonces &
PreMaster

Compute
K based
on nonces &
PreMaster

~~~~~~~~Switch to negotiated cipher~~~~~~~~

Data transmission
~~~~~~~~

HTTPS



TCP/IP: Host A and B can send packets to one another

TLS/SSL: operate “over” TCP/IP to ensure security/authenticity

HTTPS is HTTP operating on top of TLS/SSL

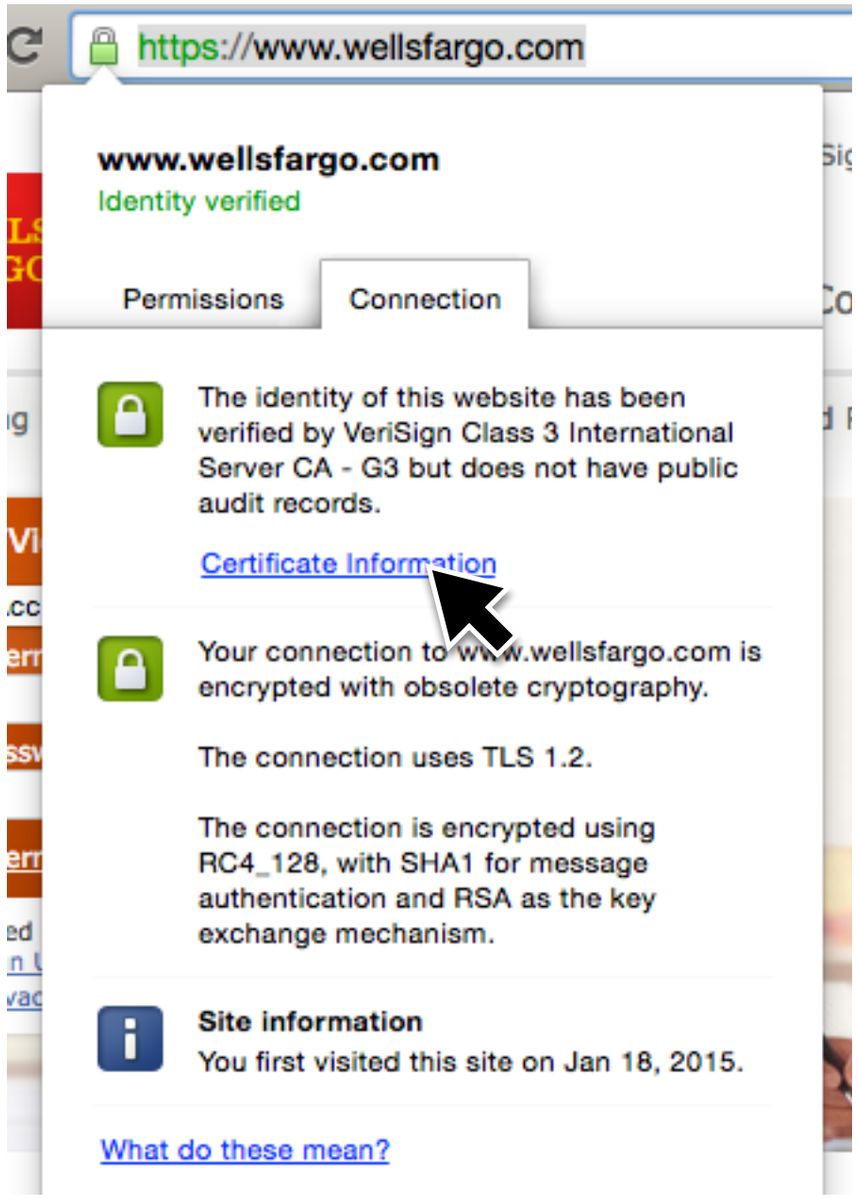
Why not HTTPS everywhere?

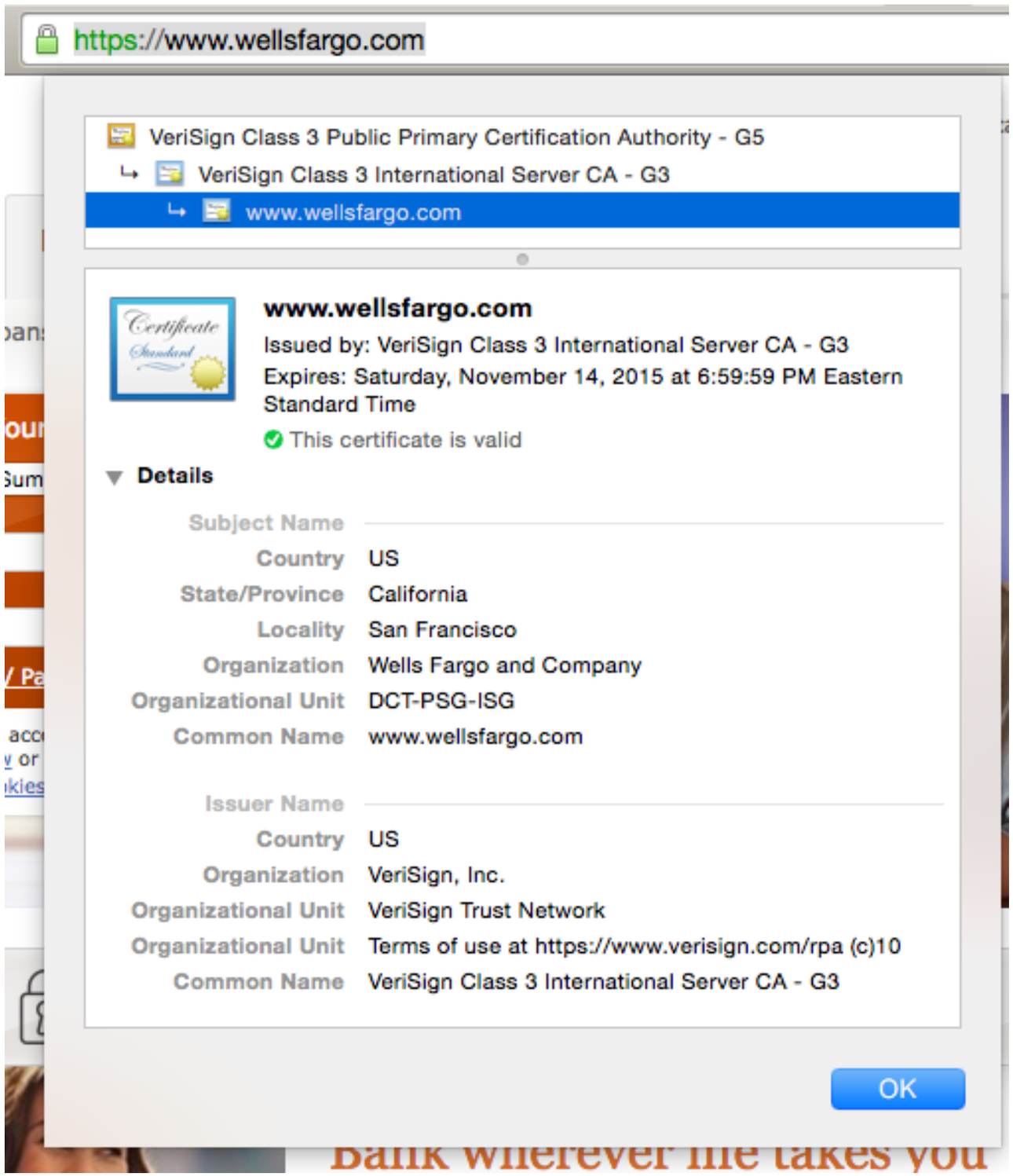
HTTPS everywhere?

- Takes more time to initiate connections
- In-network services want to look at the traffic
  - To compress it (cannot compress encrypted traffic)
  - To cache it (especially if it's static content)
  - To stick their own ads into it (i.e., there is pushback)
  - Any other ideas?
- Google has moved its services over to https (even the ones you're not logged into)
  - Didn't want others "transcoding" (reducing the quality of) their videos, or sticking in their own ads

Certificates in the wild

The lock icon indicates that the browser was able to authenticate the other end, i.e., validate its certificate





Certificate chain

Subject (who owns the public key)

- **Common name:** the URL for which this cert is valid (can contain wildcards, e.g., *.wellsfargo.com)

Issuer (who verified the identity and signed this certificate)

Wildcard certificates

Certificates with wildcards are “wildcard certs”.
Wildcards (*) only match a single level of a domain

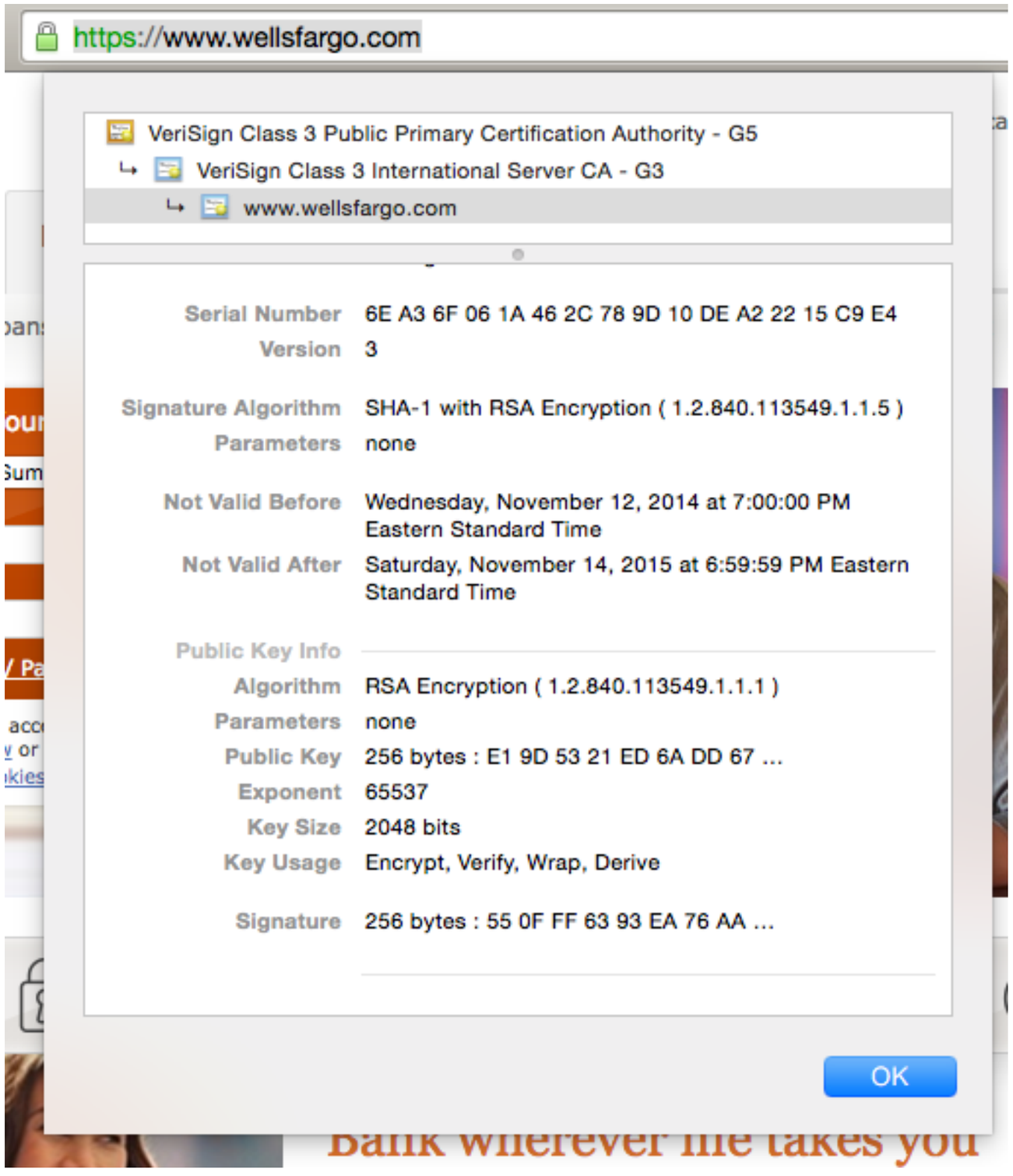
*.bar.com

✔ foo.bar.com

✘ not.this.bar.com

The X.509 protocol (which defines the format of these certificates) advises wildcard policies

(e.g., don’t allow *.*)

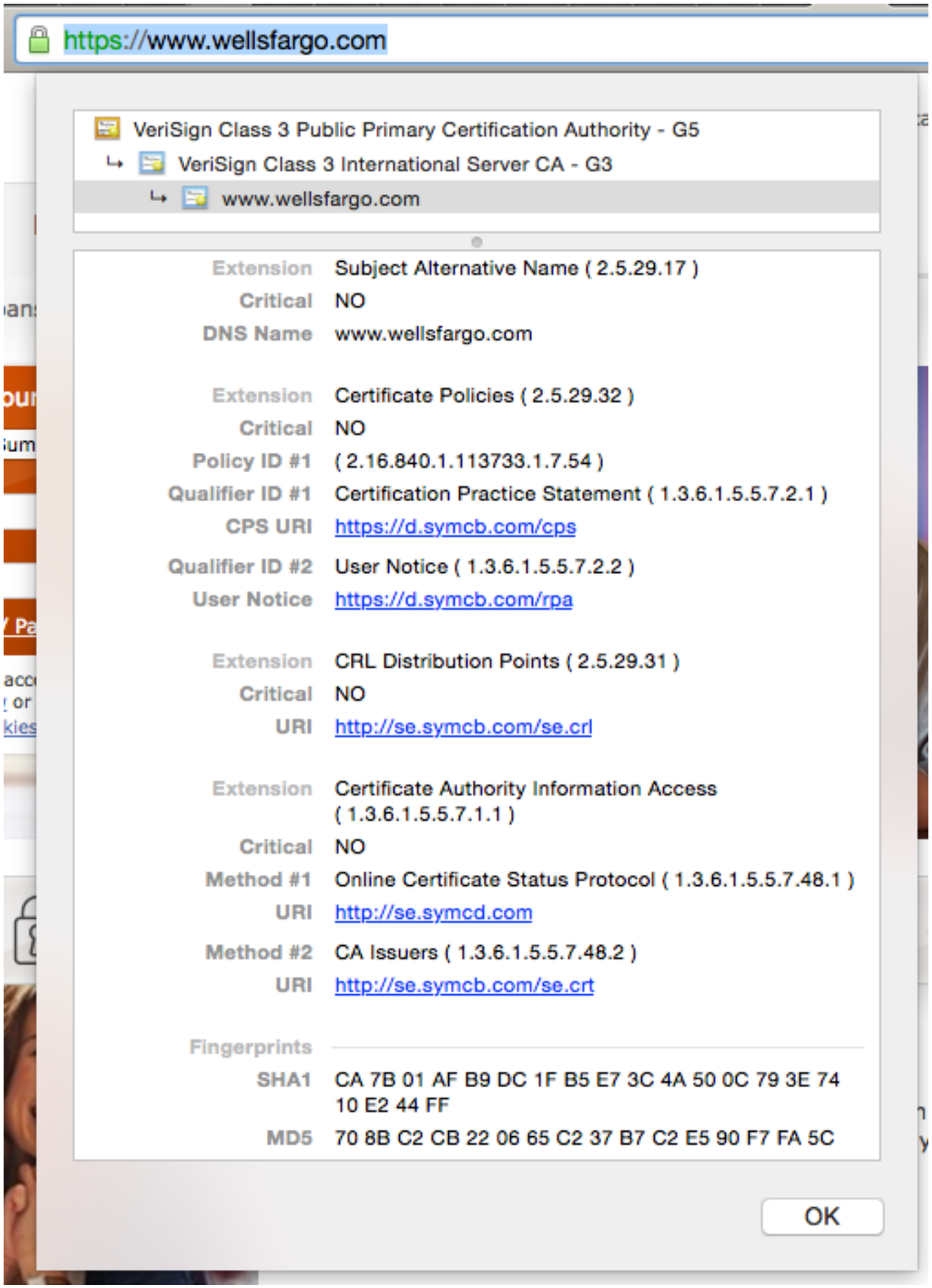


Serial number: Uniquely identifies this cert with respect to the issuer (look for this in CRLs)

Signature algorithm: How the issuer will sign parts of the cert

Not valid before/after: When to start and stop believing this cert (start & expiration dates)

The public key: And the issuer's signature of the public key



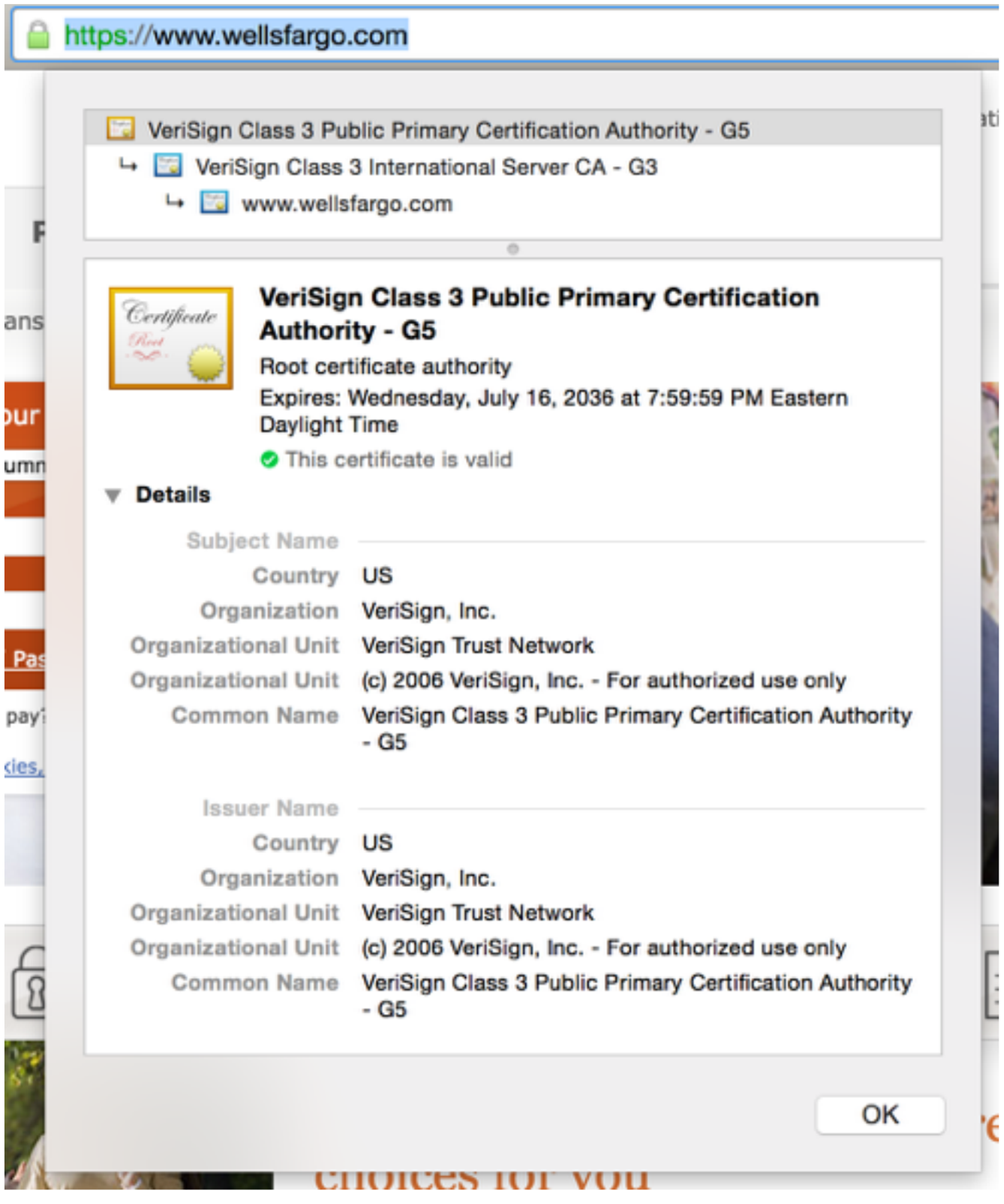
Subject Alternate Names:
Other URLs for which this cert should be considered valid. (wellsfargo.com is not the same as www.wellsfargo.com)

Can include wildcards, e.g., *.google.com

CRL & OCSP:
Where to go to check if this certificate has been revoked

Non-cryptographic checksums

Root certificates



Keychain Access

Click to unlock the System Roots keychain.

Search

Keychains
- login
- iCloud
- System
- System Roots

Category
- All Items
- Passwords
- Secure Notes
- My Certificates
- Keys
- Certificates

VeriSign Class 3 Public Primary Certification Authority - G5
Root certificate authority
Expires: Wednesday, July 16, 2036 at 7:59:59 PM Eastern Daylight Time
This certificate is valid

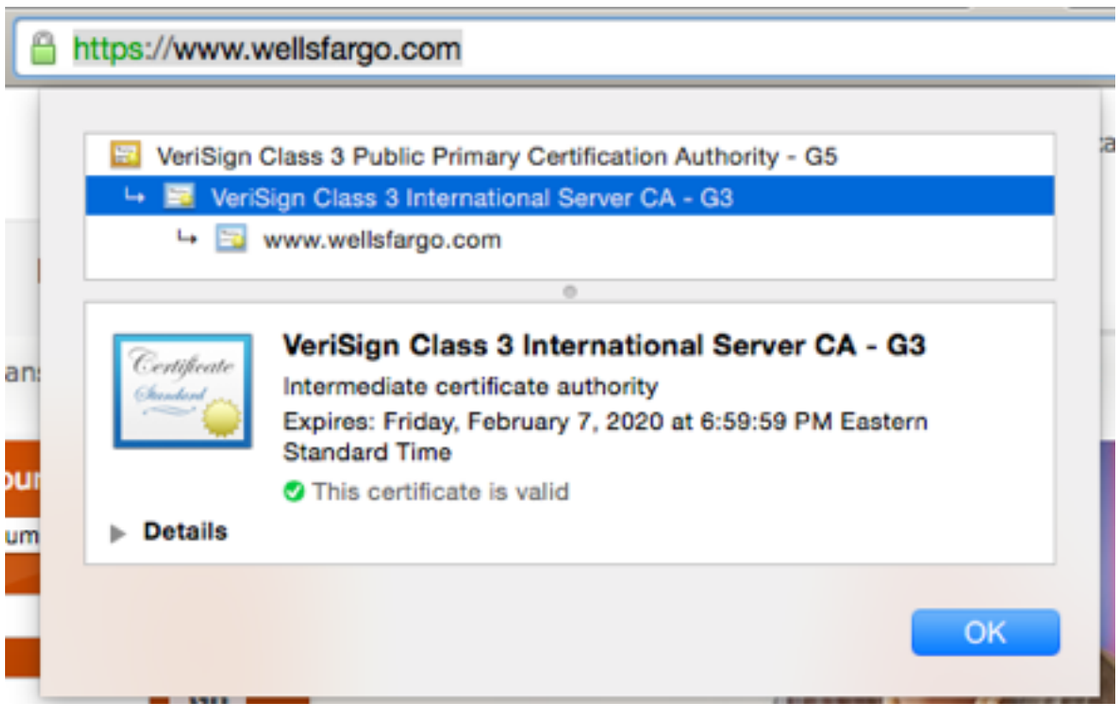
Name	Kind	Expires	Keychain
TRUST2408 OCES Primary CA	certificate	Dec 3, 2037, 8:11:34 AM	System Roots
Trusted Certificate Services	certificate	Dec 31, 2028, 6:59:59 PM	System Roots
Trustis FPS Root CA	certificate	Jan 21, 2024, 6:36:54 AM	System Roots
TÜBİTAK UEKAE Kök S…İzmet Sağlayıcısı - Sürüm 3	certificate	Aug 21, 2017, 7:37:07 AM	System Roots
TÜRKTRUST Elektronik Sertifika Hizmet Sağlayıcısı	certificate	Sep 16, 2015, 6:07:57 AM	System Roots
TÜRKTRUST Elektronik Sertifika Hizmet Sağlayıcısı	certificate	Dec 22, 2017, 1:37:19 PM	System Roots
TWCA Global Root CA	certificate	Dec 31, 2030, 10:59:59 AM	System Roots
TWCA Root Certification Authority	certificate	Dec 31, 2030, 10:59:59 AM	System Roots
UCA Global Root	certificate	Dec 30, 2037, 7:00:00 PM	System Roots
UCA Root	certificate	Dec 30, 2029, 7:00:00 PM	System Roots
UTN - DATACorp SGC	certificate	Jun 24, 2019, 3:06:30 PM	System Roots
UTN-USERFirst-Client Authentication and Email	certificate	Jul 9, 2019, 1:36:58 PM	System Roots
UTN-USERFirst-Hardware	certificate	Jul 9, 2019, 2:19:22 PM	System Roots
UTN-USERFirst-Network Applications	certificate	Jul 9, 2019, 2:57:49 PM	System Roots
UTN-USERFirst-Object	certificate	Jul 9, 2019, 2:40:36 PM	System Roots
VAS Latvijas Pasts SSI(RCA)	certificate	Sep 13, 2024, 5:27:57 AM	System Roots
VeriSign Class 1 Public…Certification Authority - G3	certificate	Jul 16, 2036, 7:59:59 PM	System Roots
VeriSign Class 2 Public…Certification Authority - G3	certificate	Jul 16, 2036, 7:59:59 PM	System Roots
VeriSign Class 3 Public…Certification Authority - G3	certificate	Jul 16, 2036, 7:59:59 PM	System Roots
VeriSign Class 3 Public…Certification Authority - G4	certificate	Jan 18, 2038, 6:59:59 PM	System Roots
VeriSign Class 3 Public…Certification Authority - G5	certificate	Jul 16, 2036, 7:59:59 PM	System Roots
VeriSign Class 4 Public…Certification Authority - G3	certificate	Jul 16, 2036, 7:59:59 PM	System Roots
VeriSign Universal Root Certification Authority	certificate	Dec 1, 2037, 6:59:59 PM	System Roots
Visa eCommerce Root	certificate	Jun 23, 2022, 8:16:12 PM	System Roots
Visa Information Delivery Root CA	certificate	Jun 29, 2025, 1:42:42 PM	System Roots
VRK Gov. Root CA	certificate	Dec 18, 2023, 8:51:08 AM	System Roots
WellsSecure Public Root Certificate Authority	certificate	Dec 13, 2022, 7:07:54 PM	System Roots
XRamp Global Certification Authority	certificate	Jan 1, 2035, 12:37:19 AM	System Roots

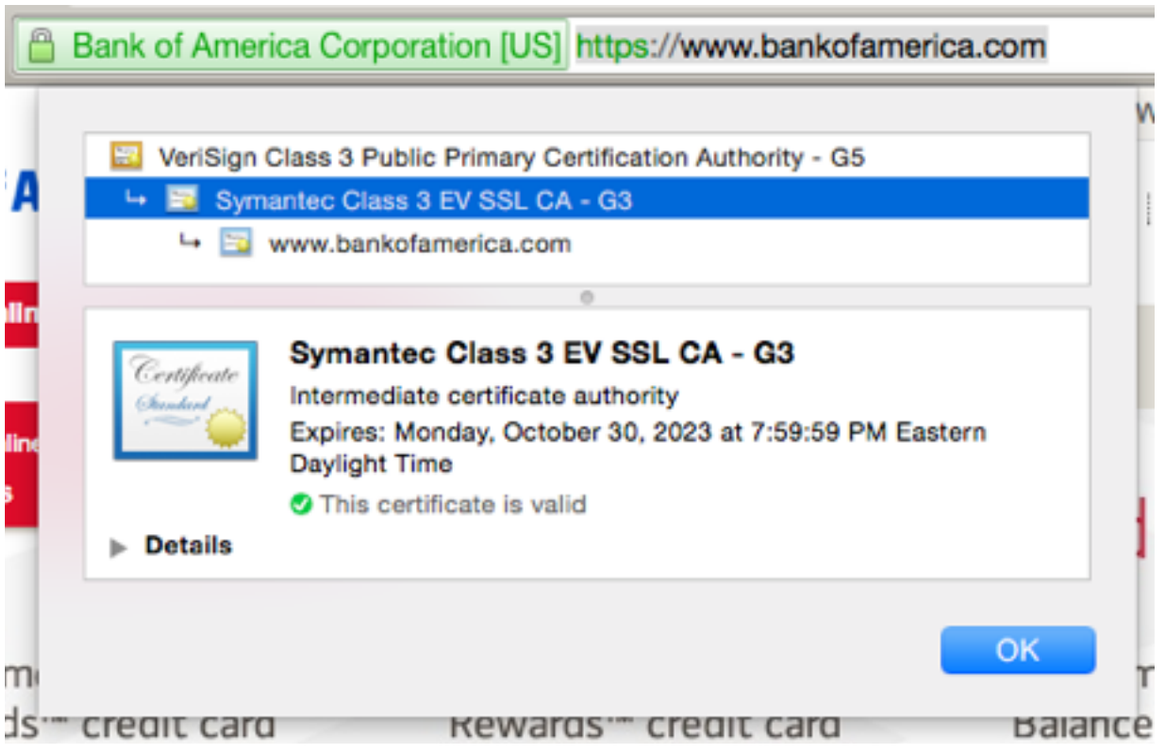
Copy

213 items

Certificate types

Why are these different?





This is an EV (extended validation) certificate; browsers show the full name for these kinds of certs

Proper reaction to Heartbleed

1. Patch the software

2. “Reissue” a new key (get a new one and load it onto your servers)

3. Revoke the old key

<u>Order matters!</u>
If we reissued and then patched,
then our new key would be compromised, too.

If we revoked first, we’d be offline.