RSA Conference2016
San Francisco | February 29 – March 4 | Moscone Center

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TLS Certificates on the Web – The Good, The Bad and The Ugly

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#RSAC

TLS Certificates

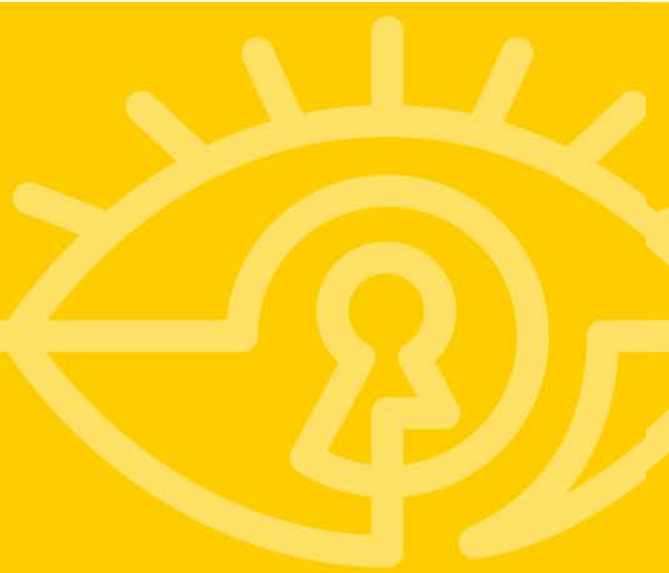
- TLS Ecosystem is almost 20 years old
- Recently endured three certificate-based migrations:
  - Away from MD2 and MD5 to SHA-1
  - Away from small RSA keys to 2048-bit keys or larger
  - Away from SHA-1 to SHA-256

What's Driving These Migrations?

- Relentless march of attacks (only getting better)
- CA/Browser Forum
  - Baseline Requirements
  - EV Guidelines
  - Certification Authorities
  - Browser vendors

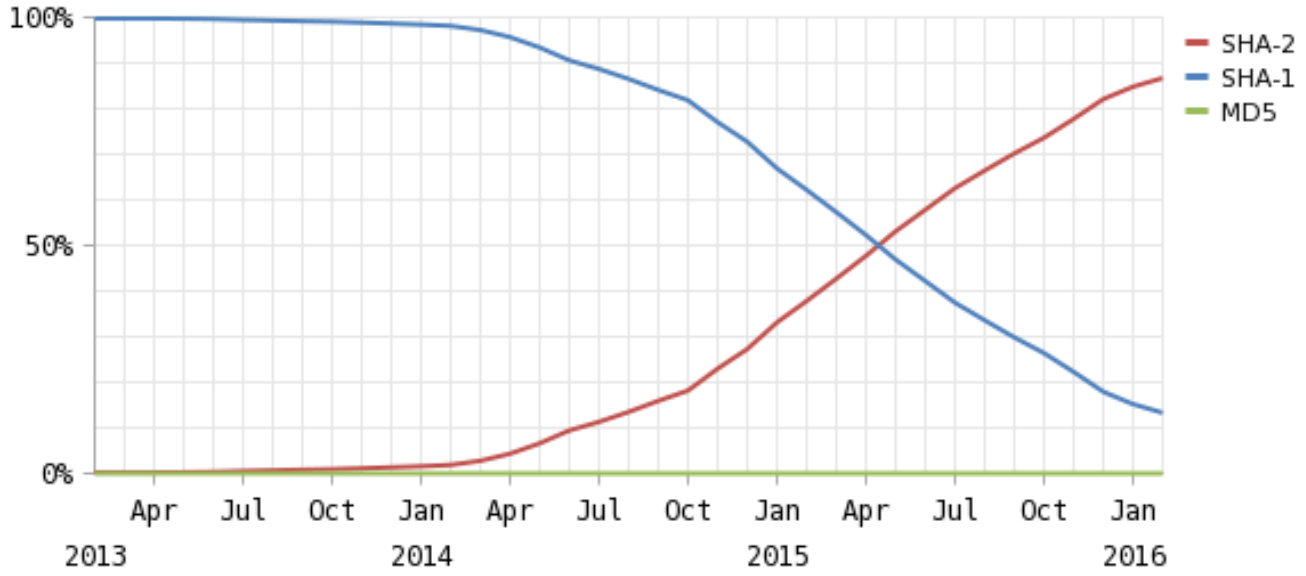
What's Slowing These Migrations?

- Use of TLS in non-browser applications
  - Mail, XMPP and other non-web servers
  - POS and other devices
  - Lack of auto-update capabilities
- Institutional inertia
  - Companies wait years to perform a server refresh



TLS Certificates – the Good

Deployment of SHA-2 Certificates

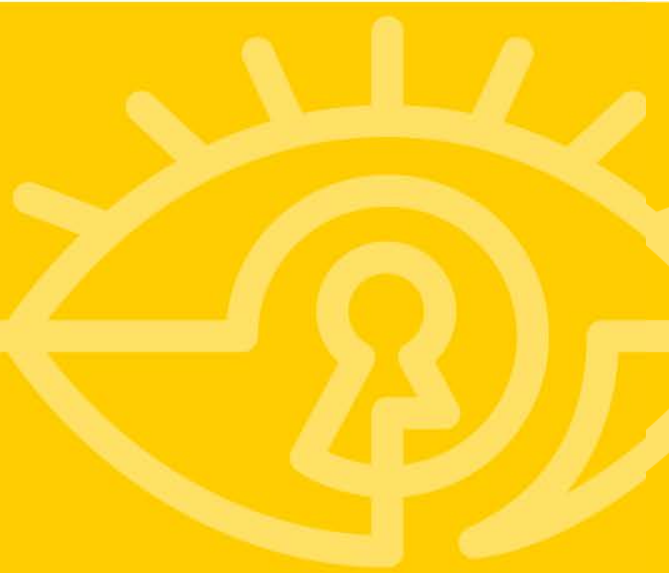


TLS Certificates – the Good

Trajectory of SHA-2 deployment is encouraging (Netcraft)

TLS Certificates – the Good

- 99.98% of certificates contain RSA 2048-bit, ECC 224-bit or larger keys (Netcraft)
- 200K certs with keys >= RSA 4096 bits (Netcraft)
- BR Compliance
  - Responsible for standardizing certificate profiles
- 10.7% of sites use EV (TIM)



TLS Certificates – the Bad

TLS Certificates – the Bad

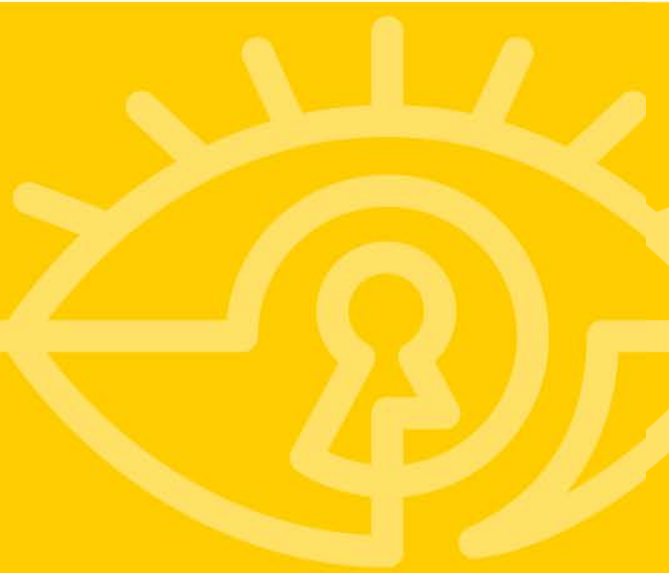
- Remaining SHA-1 certs will not work in browsers after 2016:
  - 13.3% (Netcraft)
  - 11.6% (TIM)
- US DOD still issuing SHA-1 certificates
  - http://news.netcraft.com/archives/2016/01/08/us-military-still-shackled-to-outdated-dod-pki-infrastructure.html
- More than 1,000 with < RSA 2048-bit or ECC 224-bit (Netcraft)
- Browsers continue to add compliance checks

TLS Certificates – the Bad

- EV violations
  - ~6% of all EV certificates (Netcraft)
  - Most don't have a valid Subject Business Category (unlikely to cause usability problems)
  - Thousands don't provide EV treatment in Chrome (customer doesn't benefit from the extra cost of EV)
- BR violations
  - ~3% of all certificates found (Netcraft)
  - Most are policy violations (CN must appear in SAN, invalid Subject State or Country, etc.) unlikely to cause usability problems

TLS Certificates – the Bad

- Strong keys signed by weaker keys (a dozen or so) don't provide the cryptographic protection expected by the certificate owner:
  - ECC P-384 signed by ECC P-256
  - ECC P-384 signed by RSA 2048
  - RSA 4096 and 8192 signed by RSA 2048
- Certificate expiration is embarrassing
  - http://news.netcraft.com/archives/2015/04/30/instagram-forgets-to-renew-its-ssl-certificate.html
- Almost 4% of sites serve an incomplete certificate chain (TIM)
  - Most browsers don't try to fetch missing subordinate CA



TLS Certificates – the Ugly

TLS Certificates – the Ugly

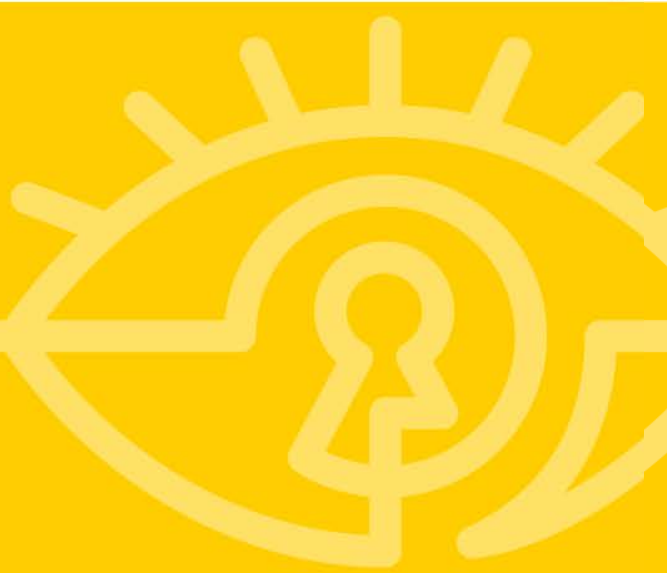
- Invalid Certificates abound
  - In Netcraft's survey, approximately two thirds of all TLS certificates seen are valid, issued by a trusted CA. The remaining one-third are either self-signed, expired, signed by an unknown issuer or contain mismatched names.
- One MD5, 3-year cert issued in 2013 by a public CA (RSA 1024-bit key) it's got 6 other BR violations
- One 512-bit RSA key used by Government of Korea (South), although it's signed using SHA-2 it's got 4 other BR violations
- Browsers block access to such sites

TLS Certificates – the Ugly

- Invalid Public Key Exponent: one certificate with an RSA exponent of 1
  - TLS data is sent in cleartext
- Multiple CNs are prohibited, but Netcraft found certificates with up to 24 CNs
  - 2009 study demonstrated attacks on certs with multiple CNs
- EV certs with fewer than the correct number of SCTs
  - Customer doesn't benefit from the extra cost of EV in Chrome

TLS Certificates – the Ugly, continued

- One cert with RSA 15,424-bit key! (includes 72 SAN values!) It's an Apache server, but not a web site
  - No harm to the Web
- Ten-year end-entity certificates, issued after the BRs became effective
  - Most browsers block public TLS certs with excessive dates
- Certificates with more than 50 SANs (Netcraft)
  - Nothing illegal, but might cause performance problems



Applying What We've Learned

Apply

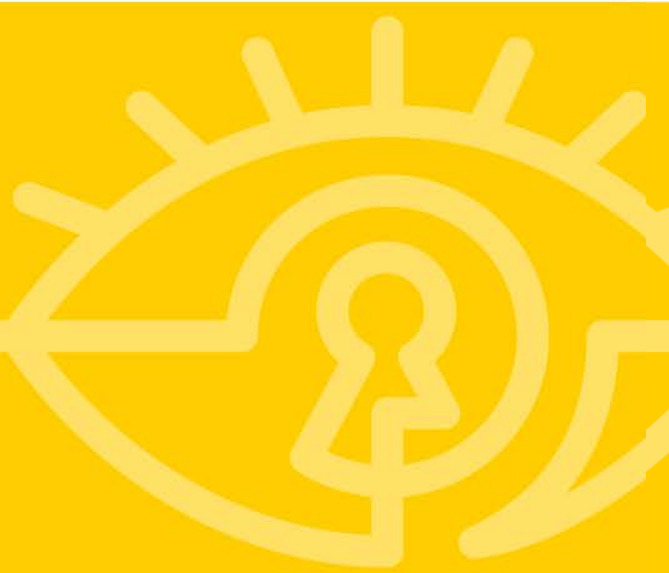
- 2048-bit RSA with SHA-256 is adequate for now
- Keep SANs to a minimum (20 or fewer), and only one CN
- Replace all weak, invalid, revoked or soon-to-expire certificates
- Generate a new key pair every time you replace a certificate
- Make sure your EV certificates have the correct number of SCTs
- Test your certificate with all major browsers (don’t forget mobile)
- Confirm that your CA has correctly issued the certificate

Check Your Work

- Check TLS certificates and configuration on all servers, not just web servers
  - https://cryptoreport.websecurity.symantec.com/checker/
  - https://www.ssllabs.com/ssltest/
- Consider a discovery tool like Certificate Intelligence Center
  - https://www.symantec.com/ssl-certificates/certificate-intelligence-center/
- Certlint from Amazon (open source)
  - https://github.com/awslabs/certlint

Data Sets

- Netcraft
  - http://www.netcraft.com
- ICSI
  - https://notary.icsi.berkeley.edu/
- Trustworthy Internet Movement (TIM) SSL Pulse
  - https://www.trustworthyinternet.org/ssl-pulse/
- Comodo's certificate search tool
  - https://crt.sh



Thank you!