The Web, PKI, and Certificates

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- Field CTO for Vercara, an Infrastructure and Cybersecurity Cloud Provider (DNS, DDoS Mitigation, WAF, CDN, Bot Management)
- Former Akamai Security CTO for Asia-Pacific, Europe, Media, and Carrier
- Founder and Former Director of Akamai's Customer Security Incident Response Team
- 20+ years of web server, DNS, and infrastructure administration
- Part-time programmer
- CISSP-ISSEP and CISM certifications

Agenda

09:00 – 10:30	Theory: What are all These Cryptography Terms? Exercise: Exploring TLS and Certificates on Popular Websites Theory: The CA Hierarchy and the Browser CA Keychain
10:30 – 10:45	Break
10:45 – 12:00	Theory: The Certificate Creation Process Exercise: Creating Your Own CA Exercise: Building a Webserver with TLS
12:00 – 13:30	Lunch
13:30 – 14:45	Theory: LetsEncrypt Exercise: Deploying Certificates to Non-Web Services Theory: Cloud Service Providers and Certificates
14:45 – 15:00	Break
15:00 – 16:00	Exercise: Using SSL Labs

Session 1

Theory: What are all These Cryptography Terms?

Exercise: Exploring TLS and Certificates on Popular Websites

Theory: The CA Hierarchy and the Browser CA Keychain

Why Study TLS and PKI?

- TLS and PKI tie in to our previous web defense topic
- This is the easiest way in IT to make mistakes
- Browsers use TLS by default now
- Vulnerability scanners love to find TLS problems
- Good hands-on practice with implementing a cryptographic system from scratch
- Acronyms are fun!!!!

Some of my “Claims to Fame”

- My job at Akamai for 3+ years was to explain certificate management to CDN customers
- I’ve worked on several SSL protocol errors: Heartbleed, POODLE, Logjam, etc
- I explain TLS and PKI concepts at least monthly at Vercara
- I used OpenSSL command-line tools to create the digital signature standard for the plane ticket you used to get here

2 Types of Ciphers

- Symmetric
  - Both sides of the conversation have the same key
  - Faster
  - Uses less CPU and RAM
  - Problems with key distribution and replacement
  - Examples: DES, 3DES, AES
- Asymmetric
  - Uses a public key and private key
  - Slower
  - Lots of CPU usage
  - Easier key distribution and replacement
  - Examples: RSA, ECC

Hashing Algorithms

- A one-way algorithm that “adds up the bits” in a non-reversible way
- Used as a one-way password store (/etc/shadow), identifier (malware samples), or an integrity control (ISO file downloads)
- Examples: MD5, SHA, SHA-2, SHA-256

Message Authentication Code

- Signature on a message
- Requires asymmetric encryption
- Provides integrity and non-repudiation
- TLS uses HMAC: keyed-hash message authentication code or hash-based message authentication code
- Message => hash it => encrypt the hash with your private key

Key Exchange in TLS

- We want to do a “handshake” to create a symmetric key to encrypt our conversation
- Called “Diffie-Hellman” key exchange
- There are a ton of variants:
  - Elliptic-curve D-H
  - Anonymous D-H
  - Fixed D-H
  - Ephemeral D-H
- Perfect Forward Secrecy (PFS) is where we create a new key for each session instead of reusing a previous key

X509 Certificates

- How you identify a server but sometimes a client
- Has a “signature chain” back to a “trusted” Certificate Authority
- Private key plus context:
  - Issued and expiration dates
  - Signature chain
  - Organization name and address (O)
  - Hostname (CN) and alternate names (SAN)
  - Serial number

X509 Certificates

<Demo>

The Evolution of SSL/TLS

- SSL V1
- SSL V2
- SSL V3
- TLS 1.0
- TLS 1.1
- TLS 1.2
- TLS 1.3

Other Weirdnesses

- Wildcard v/s Subject Alternate Names (SAN)
- Server Name Indicator (SNI)
- HTTP Strict Transport Security (HSTS)
- Certificate Revocation List (CRL)
- Mutual TLS (MTLS)

Session 1

Theory: What are all These Cryptography Terms?

Exercise: Exploring TLS and Certificates on Popular Websites

Theory: The CA Hierarchy and the Browser CA Keychain

Let’s Explore Certificates

- CN
- SAN
- Wildcards
- CA
- Intermediate CA
- Expiration
- Public Key

- Look at These:
  - disney.com
  - amazon.com
  - whatsapp.com
  - qca.com.qa
  - nas.gov.qa
  - qatarenergy.qa
  - moi.gov.qa
  - gco.gov.qa
  - qnb.com

Session 1

Theory: What are all These Cryptography Terms?

Exercise: Exploring TLS and Certificates on Popular Websites

Theory: The CA Hierarchy and the Browser CA Keychain

Certificate Authorities

- CAs pay to be in your browser store
- CAs have a ton of weird security requirements
  - Offline store in a safe
  - 2-person control to sign certificates
  - Ultra-long expiration dates
- All CAs use an intermediate and online CA to sign certificates
- Intermediate CAs can be revoked without publishing them in the browser

Certificate Authorities

- CAs create intermediate CA
- Intermediate CAs might have additional intermediate CAs
- Some companies get intermediate CAs for internal use
- Intermediate CAs sign certificates

Certificate Authorities

<Demo>

Session 2

Theory: The Certificate Creation Process

Exercise: Creating Your Own CA

Exercise: Building a Webserver with TLS

Creating a Certificate

Create a unique private key
Create a certificate signing request (CSR)
Submit the CSR to the CA
The CA signs the CSR with their intermediate CA
Import the signed CSR to make the certificate
Deploy the certificate and private key to the webserver

Generating a Certificate

<Whiteboard>

Session 2

Theory: The Certificate Creation Process

Exercise: Creating Your Own CA

Exercise: Building a Webserver with TLS

DIY Certificate Authority

Create a private key for your CA
Create a certificate from the CA private key
Create a private key for your certificate
Create a certificate for your webserver

Session 1

Theory: The Certificate Creation Process

Exercise: Creating Your Own CA

Exercise: Building a Webserver with TLS

Deploying Certificates to EdgIO

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Deploying Certificate to Our Own Server

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Session 3

Theory: LetsEncrypt

Exercise: Deploying Certificates to Non-Web Services

Theory: Cloud Service Providers and Certificates

LetsEncrypt

Free Public CA
Issues certificates for 90 days
Multiple methods of verification
    Object on the website
    DNS TXT record

LetsEncrypt

<Demo>

Session 3

Theory: LetsEncrypt

Exercise: Deploying Certificates to Non-Web Services

Theory: Cloud Service Providers and Certificates

TLS and Other Services

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Session 3

Theory: LetsEncrypt

Exercise: Deploying Certificates to Non-Web Services

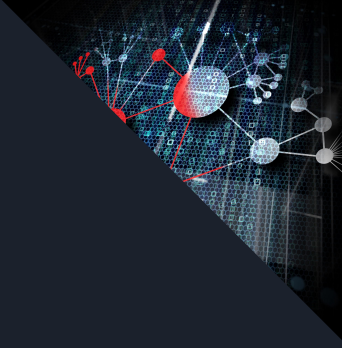
Theory: Cloud Service Providers and Certificates

Cloud Service Providers and CAs

AWS: Certificate Manager
Azure: Key Vault
GCP: Certificate Authority Service

Session 4 Exercise: Using SSL Labs

Qualys SSL Labs



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