Web Security
What should be the Threat Model for the Web?
Goal and Threat Model

- Much can go wrong on the web!
  - Clients encounter malicious content
  - Web servers are target of break-ins
  - Fake content/servers trick users
  - Data sent over network is stolen...
Goal and Threat Model (2)

• Goal of HTTPS is to secure HTTP
• We focus on network threats:
  1. Eavesdropping client/server traffic
  2. Tampering with client/server traffic
  3. Impersonating web servers
HTTPS Context

- HTTPS (HTTP Secure) is an add-on
  - Means HTTP over SSL/TLS
  - SSL (Secure Sockets Layer) precedes TLS (Transport Layer Security)
HTTPS Context (2)

• SSL came out of Netscape
  • SSL2 (flawed) made public in ‘95
  • SSL3 fixed flaws in ‘96
• TLS is the open standard
  • TLS 1.0 in ‘99, 1.1 in ‘06, 1.2 in ‘08
• Motivated by secure web commerce
  • Slow adoption, now widespread use
  • Can be used by any app, not just HTTP
SSL/TLS Operation

• Protocol provides:
  1. Verification of identity of server (and optionally client)
  2. Message exchange between the two with confidentiality, integrity, authenticity and freshness

• Consists of authentication phase (that sets up encryption) followed by data transfer phase
SSL/TLS Authentication

• Must allow clients to securely connect to servers not used before
  • Client must authenticate server
  • Server typically doesn’t identify client

• Uses public key authentication
  • But how does client get server’s key?
  • With certificates »
Certificates

• A certificate binds pubkey to identity, e.g., domain
• Distributes public keys when signed by a party you trust
• Commonly in a format called X.509

I hereby certify that the public key
19836A8B03030CF83737E3837837FC3s87092827262643FFA8271038282828A
belongs to
Robert John Smith
12345 University Avenue
Berkeley, CA 94702
Birthday: July 4, 1958
Email: bob@superduperernet.com

Signed by CA
PKI (Public Key Infrastructure)

- Adds hierarchy to certificates to let parties issue
- Issuing parties are called CAs (Certificate Authorities)

I certified the ABC website!
PKI (2)

• Need public key of PKI root and trust in servers on path to verify a public key of website ABC
  • Browser has Root’s public key
  • \{RA1’s key is X\} signed Root
  • \{CA1’s key is Y\} signed RA1
  • \{ABC’s key is Z\} signed CA1
PKI (3)

- Browser/OS has public keys of the trusted roots of PKI
  - >100 root certificates!
- Inspect your web browser

Certificate for wikipedia.org issued by DigiCert
• Real-world complication:
  • Public keys may be compromised
  • Certificates must then be revoked
• PKI includes a CRL (Certificate Revocation List)
  • Browsers use to weed out bad keys
TLS handshake

Introduction to Computer Networks
What can attacker (in the network) still learn from an HTTPS connection?

• “Metadata”
Takeaways

• SSL/TLS is a secure transport
  • For HTTPS and more, with the usual confidentiality, integrity / authenticity
  • Very widely used today

• Client authenticates web server
  • Done with a PKI and certificates
  • Major area of complexity and risk

• “Metadata” leaks
  • Use other tools (Tor or VPN) if you want to hide that