SSL/TLS: Still Alive?

Pascal Junod // HEIG-VD

26-03-2015

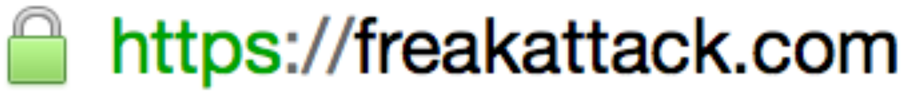
heig-vd
HAUTE ÉCOLE
D'INGÉNIERIE ET DE GESTION
DU CANTON DE VAUD
www.heig-vd.ch

COLLABORATIVE
TECHNOLOGY
WATCH
TECH
MEETINGS

Agenda

- SSL/TLS Protocol
- Attacks
- What's next ?

SSL/TLS Protocol



https://freakattack.com

SSL/TLS Protocol

- Family of cryptographic protocols offering following functionalities:
  - Entity authentication (uni- or bi-directional, via X.509v3)
  - Communications confidentiality and integrity
  - Cipher suites negotiation
  - Key session management
  - Compression

SSL/TLS Implementations

NSS
mozilla

GnuTLS

cryptlib
- the developer's choice!

MatrixSSL

JSSE
Java

Bouncy Castle

BSAFE
RSA

Secure Transport
Developer

OpenSSL
Cryptography and SSL/TLS Toolkit

libreSSL

Botan

Schannel
Microsoft

mbed TLS
ARMmbed

wolfSSL (formerly cyaSSL)

History of SSL/TLS

SSL v1.0	Netscape	1993 (?)	Never published
SSL v2.0	Netscape	1995	Many security flaws
SSL v3.0	Netscape	1996	RFC 6101
TLS 1.0	IETF	1999	RFC 2246. Most frequent
TLS 1.1	IETF	2006	RFC 4346. Fixes security issues related to CBC
TLS 1.2	IETF	2008	RFC 5246 and RFC 6176. Supports SHA-256
TLS 1.3	IETF	N/A	Under development

PKI

TIME

POODLE

Heartbleed

Lucky13

Attacks

BEAST

RC4

CRIME

BREACH

FREAK

Attacks against PKIs (1)

- Issuing fake certificates:
  - Verisign / 2001: fake Microsoft code-signing
  - Thawte / 2008: fake certificate for login.live.com issued to security researcher
- CA breached:
  - StartCom / 2008: website breached, validation for any domain
  - Comodo / 2008: validation for any domain
  - Comodo resellers / 2011: breach, issue of 9 fake certificates for popular domain names
  - StartCom / 2011: breach, no fraudulent certificate issued (?)
  - DigiNotar / 2011: complete breach, voluntary bankruptcy

Attacks against PKIs (2)

- Cryptography breached or too weak:
  - RapidSSL / 2008: rogue certificate exploiting MD5 flaws
  - Flame malware / 2011: rogue certificate exploiting MD5 flaws
  - Digicert / 2011: issuing very weak certificates
- Rogue intermediate CAs:
  - Turktrust / 2012: rogue certificated issued
  - ANSSI / 2013: subordinate CA has been found in transparent interception device
- …

Protocol Attacks
Insecure Renegociation

- aka TLS Authentication Gap
- Discovered by Marsh Ray and Steve Dispensa in 2009
- Leads to a MitM attack
- Mitigation: either disable renegotiation or use Renegotiation Indication extension (2010)

Protocol Attacks
BEAST

- Discovered by Duong and Rizzo in 2011
- Exploits a (previously-known) weakness of predictable IVs for the CBC mode of operations
- Allows to decrypt communications (but not so easily), such as session tokens
- Mitigation: 1/n-1 split, TLS compression *helps*

Protocol Attacks
Compression Side Channels

- Old attacks known about how compression interacts with encryption (Kelsey, 2002)
- Attacks applied on TLS by Duong and Rizzo in 2012 (CRIME), improved by Be'ery in 2013 (TIME), and by Gluck et al. in 2013 (BREACH)
- Mitigation: SSL/TLS compression *must die*!

Protocol Attacks
Padding Oracles

- Attack invented in 2001-2002 (Vaudenay, Canvel et al.)
- Al Fardan and Paterson applied it to TLS in 2013 (Lucky13)
- Mitigation: avoid CBC cipher suites

Protocol Attacks
RC4

- Old statistical attacks against RC4 known since 2001 (Mantin and Shamir)
- Recycled against TLS by Al Fardan et al. in 2013

Protocol Attacks
POODLE

- Attack discovered by Möller, Duong and Kotowicz in 2014
- Man-in-the-middle attack taking advantage of fallback to SSL v3 and padding oracles
- Variants even work on TLS for some implementations
- Mitigation: never use SSL v3 again !

Implementation Attacks

Heartbleed

- Implementation flaw in OpenSSL discovered in August 2014
- Leak of internal memory of OpenSSL library (including private keys, passwords, etc.)
- Mitigation: patch, change private keys, etc.

Implementation Attacks
FREAK

- Announced in 2015 by several researchers, notably from INRIA

- Allows an attacker to force a downgrade to export-grade cipher suites on a TLS link

- Bug present in several libraries

In Summary…

- Following SSL/TLS security is not a « long fleuve tranquille »

- Complexity of SSL/TLS does not help, functionality is an enemy of security

- Poor implementation/review quality on (very) popular SSL/TLS libraries, mainly due to catastrophic funding of the projects

- Many, many different ways to defeat SSL/TLS!

Thank you !

🐦 `@cryptopathe`