

# Attacks on TLS

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Target	Attack Name	Year	Reference
<b>Core cryptography</b>			
RSA PKCS#1v1.5 decryption	Side channel – Bleichenbacher	1998*, 2014	[12]*, [38]
DES	Weakness – brute force	1998	[21]
MD5	Weakness – collisions	2005	[33]
RC4	Weakness – biases	2000*, 2013,15	[24, 35]*, [4, 49, 34]
RSA export keys	FREAK	2015	[8]
DH export keys	Logjam	2015	[2]
RSA-MD5 signatures	SLOTH	2016	[11]
Triple-DES	Sweet32	2011*, 2016	[45]*, [10]
<b>Crypto usage in ciphersuites</b>			
CBC mode encryption	BEAST	2002*, 2011	[39]*, [20]
Diffie–Hellman parameters	Cross-protocol attack	1996*, 2012	[51]*, [37]
MAC-encode-encrypt padding	Lucky 13, Lucky microseconds	2013,15	[5, 3]
CBC mode encryption + padding	POODLE, ZombiePoodle, GoldenDoodle	2014,19	[40, ?]
<b>TLS protocol functionality</b>			
Support for old versions	Jager et al., DROWN	2015, 2016	[27, 6]
Negotiation	Downgrade to weak crypto	1996, 2015	[51, 8, 2]
Termination	Truncation, Cookie Cutter	2007,13,14	[7, 46, 9]
Renegotiation	Renegotiation attack	2009	[43]
Compression	CRIME, BREACH, HEIST	2002*, 2012,16	[28]*, [44, 42, 48]
Session resumption	Triple-handshake attack	2014	[9]
Pre-shared keys	Selfie <sup>†</sup>	2019	[19]
<b>Implementation – libraries</b>			
OpenSSL – RSA	Side-channel	2005, 2007	[41, 1]
Debian OpenSSL	Weak RNG	2008	[47]
OpenSSL – elliptic curve	Side-channel	2011–14	[15, 14, 52]
Apple – certificate validation	goto fail;	2014	[32]
OpenSSL – Heartbeat extension	Heartbleed	2014	[16, 17]
Multiple – certificate validation	Frankencerts	2014	[13]
NSS – RSA PKCS#1v1.5 signatures	BERserk (Bleichenbacher)	2006*, 2014	[23]*, [31]
Multiple – state machine	CCS injection, SMACK	2014, 2015	[29, 8]
GnuTLS – session resumption	High-STEKs <sup>†</sup>	2020	[30]
<b>Implementation – HTTP-based applications</b>			
Netscape	Weak RNG	1996	[26]
Multiple – certificate validation	“Most dangerous code”, MalloDroid	2012	[25, 22]
<b>Application-level protocols</b>			
HTTP	SSL stripping	2009	[36]
HTTP server virtual hosts	Virtual host confusion	2014	[18]
IMAP/POP/FTP	STARTTLS command injection	2011	[50]

\* denotes theoretical basis for a later practical attack; <sup>†</sup> denotes TLS 1.3-specific attack.

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