uta Internet-Draft Intended status: Informational Expires: September 28, 2014 Y. Sheffer Porticor R. Holz TUM P. Saint-Andre &yet March 27, 2014

Summarizing Current Attacks on TLS and DTLS draft-ietf-uta-tls-attacks-00

Abstract

Over the last few years there have been several serious attacks on TLS, including attacks on its most commonly used ciphers and modes of operation. This document summarizes these attacks, with the goal of motivating generic and protocol-specific recommendations on the usage of TLS and DTLS.

Status of This Memo

This Internet-Draft is submitted in full conformance with the provisions of $\underline{\text{BCP 78}}$ and $\underline{\text{BCP 79}}$.

Internet-Drafts are working documents of the Internet Engineering Task Force (IETF). Note that other groups may also distribute working documents as Internet-Drafts. The list of current Internet-Drafts is at <u>http://datatracker.ietf.org/drafts/current/</u>.

Internet-Drafts are draft documents valid for a maximum of six months and may be updated, replaced, or obsoleted by other documents at any time. It is inappropriate to use Internet-Drafts as reference material or to cite them other than as "work in progress."

This Internet-Draft will expire on September 28, 2014.

Copyright Notice

Copyright (c) 2014 IETF Trust and the persons identified as the document authors. All rights reserved.

This document is subject to <u>BCP 78</u> and the IETF Trust's Legal Provisions Relating to IETF Documents (<u>http://trustee.ietf.org/license-info</u>) in effect on the date of publication of this document. Please review these documents carefully, as they describe your rights and restrictions with respect to this document. Code Components extracted from this document must

Sheffer, et al. Expires September 28, 2014

[Page 1]

TLS Attacks

include Simplified BSD License text as described in Section 4.e of the Trust Legal Provisions and are provided without warranty as described in the Simplified BSD License.

Table of Contents

$\underline{1}. Introduction \dots \dots$	· <u>2</u>
$\underline{2}$. Attacks on TLS	. <u>2</u>
<u>2.1</u> . BEAST	. <u>3</u>
<u>2.2</u> . Lucky Thirteen	. <u>3</u>
<u>2.3</u> . Attacks on RC4	. <u>3</u>
2.4. Compression Attacks: CRIME and BREACH	. <u>3</u>
<u>3</u> . Security Considerations	. <u>4</u>
<u>4</u> . IANA Considerations	. <u>4</u>
5. Acknowledgements	. <u>4</u>
<u>6</u> . References	. <u>4</u>
<u>6.1</u> . Normative References	. <u>4</u>
<u>6.2</u> . Informative References	. <u>4</u>
Appendix A. Appendix: Change Log	. <u>5</u>
<u>A.1</u> . <u>draft-ietf-uta-tls-bcp-00</u>	. <u>5</u>
<u>A.2</u> . <u>draft-sheffer-uta-tls-bcp-00</u>	. <u>6</u>
Authors' Addresses	. <u>6</u>

1. Introduction

Over the last few years there have been several major attacks on TLS [RFC5246], including attacks on its most commonly used ciphers and modes of operation. Details are given in <u>Section 2</u>, but suffice it to say that both AES-CBC and RC4, which together make up for most current usage, have been seriously attacked in the context of TLS.

This situation motivated the creation of the UTA working group, which is tasked with the creation of generic and protocol-specific recommendation for the use of TLS and DTLS.

"Attacks always get better; they never get worse" (ironically, this saying is attributed to the NSA). This list of attacks describes our knowledge as of this writing. It seems likely that new attacks will be invented in the future.

For a more detailed discussion of the attacks listed here, the interested reader is referred to [<u>Attacks-iSec</u>].

2. Attacks on TLS

This section lists the attacks that motivated the current recommendations. This is not intended to be an extensive survey of TLS's security.

While there are widely deployed mitigations for some of the attacks listed below, we believe that their root causes necessitate a more systemic solution.

2.1. BEAST

The BEAST attack [BEAST] uses issues with the TLS 1.0 implementation of CBC (that is, the predictable initialization vector) to decrypt parts of a packet, and specifically shows how this can be used to decrypt HTTP cookies when run over TLS.

2.2. Lucky Thirteen

A consequence of the MAC-then-encrypt design in all current versions of TLS is the existence of padding oracle attacks [<u>Padding-Oracle</u>]. A recent incarnation of these attacks is the Lucky Thirteen attack [<u>CBC-Attack</u>], a timing side-channel attack that allows the attacker to decrypt arbitrary ciphertext.

2.3. Attacks on RC4

The RC4 algorithm [<u>RC4</u>] has been used with TLS (and previously, SSL) for many years. Attacks have also been known for a long time, e.g. [<u>RC4-Attack-FMS</u>]. But recent attacks ([<u>RC4-Attack]</u>, [<u>RC4-Attack-AlF</u>]) have weakened this algorithm even more. See [<u>I-D.popov-tls-prohibiting-rc4</u>] for more details.

2.4. Compression Attacks: CRIME and BREACH

The CRIME attack [CRIME] allows an active attacker to decrypt cyphertext (specifically, cookies) when TLS is used with protocollevel compression.

The TIME attack [TIME] and the later BREACH attack [BREACH] both make similar use of HTTP-level compression to decrypt secret data passed in the HTTP response. We note that compression of the HTTP message body is much more prevalent than compression at the TLS level.

The former attack can be mitigated by disabling TLS compression, as recommended below. We are not aware of mitigations at the protocol level to the latter attack, and so application-level mitigations are needed (see [BREACH]). For example, implementations of HTTP that use CSRF tokens will need to randomize them even when the recommendations of [I-D.ietf-uta-tls-bcp] are adopted.

<u>3</u>. Security Considerations

This document describes protocol attacks in an informational manner, and in itself does not have any security implications. Its companion documents certainly do.

<u>4</u>. IANA Considerations

This document requires no IANA actions.

5. Acknowledgements

We would like to thank Stephen Farrell, Simon Josefsson, Yoav Nir, Kenny Paterson, Patrick Pelletier, and Rich Salz for their review of a previous version of this document.

The document was prepared using the lyx2rfc tool, created by Nico Williams.

<u>6</u>. References

<u>6.1</u>. Normative References

[RFC5246] Dierks, T. and E. Rescorla, "The Transport Layer Security (TLS) Protocol Version 1.2", <u>RFC 5246</u>, August 2008.

<u>6.2</u>. Informative References

[I-D.ietf-uta-tls-bcp]

Sheffer, Y., Holz, R., and P. Saint-Andre, "Recommendations for Secure Use of TLS and DTLS", <u>draft-</u> <u>ietf-uta-tls-bcp-00</u> (work in progress), March 2014.

[I-D.popov-tls-prohibiting-rc4]

Popov, A., "Prohibiting RC4 Cipher Suites", <u>draft-popov-</u> <u>tls-prohibiting-rc4-01</u> (work in progress), October 2013.

[CBC-Attack]

- AlFardan, N. and K. Paterson, "Lucky Thirteen: Breaking the TLS and DTLS Record Protocols", IEEE Symposium on Security and Privacy , 2013.
- [BEAST] Rizzo, J. and T. Duong, "Browser Exploit Against SSL/TLS", 2011, <<u>http://packetstormsecurity.com/files/105499/</u> Browser-Exploit-Against-SSL-TLS.html>.
- [CRIME] Rizzo, J. and T. Duong, "The CRIME Attack", EKOparty Security Conference 2012, 2012.

Internet-Draft

TLS Attacks

- [BREACH] Prado, A., Harris, N., and Y. Gluck, "The BREACH Attack", 2013, <<u>http://breachattack.com/</u>>.
- [TIME] Be'ery, T. and A. Shulman, "A Perfect CRIME? Only TIME Will Tell", Black Hat Europe 2013, 2013, <<u>https://</u> media.blackhat.com/eu-13/briefings/Beery/bh-eu-13-a -perfect-crime-beery-wp.pdf>.
- [RC4] Schneier, B., "Applied Cryptography: Protocols, Algorithms, and Source Code in C, 2nd Ed.", 1996.

[RC4-Attack-FMS]

Fluhrer, S., Mantin, I., and A. Shamir, "Weaknesses in the Key Scheduling Algorithm of RC4", Selected Areas in Cryptography , 2001.

[RC4-Attack]

ISOBE, T., OHIGASHI, T., WATANABE, Y., and M. MORII, "Full Plaintext Recovery Attack on Broadcast RC4", International Workshop on Fast Software Encryption , 2013.

[RC4-Attack-AlF]

AlFardan, N., Bernstein, D., Paterson, K., Poettering, B., and J. Schuldt, "On the Security of RC4 in TLS", Usenix Security Symposium 2013, 2013, <<u>https://www.usenix.org/</u> <u>conference/usenixsecurity13/security-rc4-tls</u>>.

[Attacks-iSec]

Sarkar, P. and S. Fitzgerald, "Attacks on SSL, a comprehensive study of BEAST, CRIME, TIME, BREACH, Lucky13 and RC4 biases", 8 2013, <<u>https://www.isecpartners.com/</u> media/106031/ssl_attacks_survey.pdf.

[Padding-Oracle]

Vaudenay, S., "Security Flaws Induced by CBC Padding Applications to SSL, IPSEC, WTLS...", EUROCRYPT 2002, 2002, <<u>http://www.iacr.org/cryptodb/archive/2002/EUROCRYPT</u> /2850/2850.pdf>.

Appendix A. Appendix: Change Log

Note to RFC Editor: please remove this section before publication.

A.1. draft-ietf-uta-tls-bcp-00

o Initial WG version, with only updated references.

A.2. draft-sheffer-uta-tls-bcp-00

o Initial version, extracted from <u>draft-sheffer-tls-bcp-01</u>.

Authors' Addresses

Yaron Sheffer Porticor 29 HaHarash St. Hod HaSharon 4501303 Israel

Email: yaronf.ietf@gmail.com

Ralph Holz Technische Universitaet Muenchen Boltzmannstr. 3 Garching 85748 Germany

Email: holz@net.in.tum.de

Peter Saint-Andre &yet

Email: ietf@stpeter.im