NTP Client Data Minimization
draft-ietf-ntp-data-minimization-01

Abstract

This memo proposes backward-compatible updates to the Network Time Protocol to strip unnecessary identifying information from client requests and to improve resilience against blind spoofing of unauthenticated server responses.

Status of This Memo

This Internet-Draft is submitted in full conformance with the provisions of BCP 78 and 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 http://datatracker.ietf.org/drafts/current/.

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 January 28, 2018.

Copyright Notice

Copyright (c) 2017 IETF Trust and the persons identified as the document authors. All rights reserved.

This document is subject to BCP 78 and the IETF Trust’s Legal Provisions Relating to IETF Documents (http://trustee.ietf.org/license-info) 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 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.
1. Introduction

Network Time Protocol (NTP) packets, as specified by RFC 5905 [RFC5905], carry a great deal of information about the state of the NTP daemon which transmitted them. In the case of mode 4 packets (responses sent from server to client), as well as in broadcast (mode 5) and symmetric peering modes (mode 1/2), most of this information is essential for accurate and reliable time synchronization. However, in mode 3 packets (requests sent from client to server), most of these fields serve no purpose. Server implementations never need to inspect them, and they can achieve nothing by doing so. Populating these fields with accurate information is harmful to privacy of clients because it allows a passive observer to fingerprint clients and track them as they move across networks.

This memo updates RFC 5905 to redact unnecessary data from mode 3 packets. This is a fully backwards-compatible proposal. It calls for no changes on the server side, and clients which implement these updates will remain fully interoperable with existing servers.

2. Requirements Language

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in RFC 2119 [RFC2119].

3. Client Packet Format

In every client-mode packet sent by a Network Time Protocol [RFC5905] implementation:
The first octet, which contains the leap indicator, version number, and mode fields, SHOULD be set to 0x23 (LI = 0, VN = 4, Mode = 3).

The Transmit Timestamp field SHOULD be set uniformly at random, generated by a mechanism suitable for cryptographic purposes. [RFC4086] provides guidance on the generation of random values.

The Poll field MAY be set to the actual polling interval as specified by RFC 5905, or else MAY be set to zero.

The Precision field SHOULD be set to 0x20.

All other header fields, specifically the Stratum, Root Delay, Root Dispersion, Reference ID, Reference Timestamp, Origin Timestamp, and Receive Timestamp, SHOULD be set to zero.

Servers MUST allow client packets to conform to the above recommendations. This requirement shall not be construed so as to prohibit servers from rejecting conforming packets for unrelated reasons, such as access control or rate limiting.

4. Security and Privacy Considerations

4.1. Data Minimization

Zeroing out unused fields in client requests prevents disclosure of information that can be used for fingerprinting [RFC6973].

While populating any of these fields with authentic data reveals at least some identifying information about the client, the Origin Timestamp and Receive Timestamp fields constitute a particularly severe information leak. RFC 5905 calls for clients to copy the transmit timestamp and destination timestamp of the server’s most recent response into the origin timestamp and receive timestamp (respectively) of their next request to that server. Therefore, when a client moves between networks, a passive observer of both network paths can determine with high confidence that the old and new IP addresses belong to the same system by noticing that the transmit timestamp of a response sent to the old IP matches the origin timestamp of a request sent from the new one.

Zeroing the poll field is made optional (MAY rather than SHOULD) so as not to preclude future development of schemes wherein the server uses information about the client’s current poll interval in order to recommend adjustments back to the client. Putting accurate information into this field has no significant impact on privacy.
since an observer can already obtain this information simply by observing the actual interval between requests.

4.2. Transmit Timestamp Randomization

While this memo calls for most fields in client packets to be set to zero, the transmit timestamp is randomized. This decision is motivated by security as well as privacy.

NTP servers copy the transmit timestamp from the client’s request into the origin timestamp of the response; this memo calls for no change in this behavior. Clients discard any response whose origin timestamp does not match the transmit timestamp of any request currently in flight.

In the absence of cryptographic authentication, verification of origin timestamps is clients’ primary defense against blind spoofing of NTP responses. It is therefore important that clients’ transmit timestamps be unpredictable. Their role in this regard is closely analogous to that of TCP Initial Sequence Numbers [RFC6528].

The traditional behavior of the NTP reference implementation is to randomize only a few (typically 10-15 depending on the precision of the system clock) low-order bits of transmit timestamp, with all higher bits representing the system time, as measured just before the packet was sent. This is suboptimal, because with so few random bits, an adversary sending spoofed packets at high volume will have a good chance of correctly guessing a valid origin timestamp.

5. IANA Considerations

[RFC EDITOR: DELETE PRIOR TO PUBLICATION]

This memo introduces no new IANA considerations.

6. Implementation status - RFC EDITOR: REMOVE BEFORE PUBLICATION

This section records the status of known implementations of the protocol defined by this specification at the time of posting of this Internet-Draft, and is based on a proposal described in RFC7942. The description of implementations in this section is intended to assist the IETF in its decision processes in progressing drafts to RFCs. Please note that the listing of any individual implementation here does not imply endorsement by the IETF. Furthermore, no effort has been spent to verify the information presented here that was supplied by IETF contributors. This is not intended as, and must not be construed to be, a catalog of available implementations or their
features. Readers are advised to note that other implementations may exist.

As of today the following vendors have produced an implementation of the NTP Client Data Minimization recommendations described in this document.

OpenNTPD

7. References

7.1. Normative References


7.2. Informative References


7.3. URIs

Appendix A. Acknowledgements

The authors would like to gratefully acknowledge Henning Brauer for pioneering NTP data minimization techniques as early as June 2004 [1] as part of an NTP implementation for the OpenBSD Project.

The authors would like to thank Prof. Sharon Goldberg and Miroslav Lichvar for encouraging standardisation of the approach described in this document.

Authors’ Addresses

Daniel Fox Franke
Akamai Technologies, Inc.
150 Broadway
Cambridge, MA  02142
United States

Email: dafranke@akamai.com
URI: https://www.dfranke.us

Aanchal Malhotra
Boston University
111 Cummington St
Boston, MA/  02215
United States

Email: aanchal4@bu.edu