

Network Working Group  
Internet-Draft  
Updates: [5905](#) (if approved)  
Intended status: Standards Track  
Expires: May 2, 2017

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October 29, 2016

NTP Client Data Minimization  
draft-dfranke-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.

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October 2016

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## [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 synchronizaton. 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, SHALL be set to 0x23 (LI = 0, VN = 4, Mode = 3).

The Transmit Timestamp field SHALL 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.

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

## [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 because this field conveys no

information that an observer could not otherwise obtain simply by observing the actual interval between requests. Since in the NTP reference implementation servers copy the poll field from the client's request into their response, if clients rely on the value of the poll field in the response then zeroing the poll field of the request may result in adverse behavior.

#### [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 analagous 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.](#) References

##### [6.1.](#) Normative References

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## [6.2](#). Informative References

- [RFC4086] Eastlake 3rd, D., Schiller, J., and S. Crocker, "Randomness Requirements for Security", [BCP 106](#), [RFC 4086](#), DOI 10.17487/RFC4086, June 2005, <<http://www.rfc-editor.org/info/rfc4086>>.

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- [RFC6973] Cooper, A., Tschofenig, H., Aboba, B., Peterson, J., Morris, J., Hansen, M., and R. Smith, "Privacy Considerations for Internet Protocols", [RFC 6973](#), DOI 10.17487/RFC6973, July 2013, <<http://www.rfc-editor.org/info/rfc6973>>.

## [Appendix A](#). Acknowledgements

The authors thank Prof. Sharon Goldberg and Miroslav Lichvar for calling attention to the issues addressed in this memo.

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