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Internet Time Synchronization: the Network Time Protocol

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Abstract

This paper describes the Network Time Protocol (NTP) designed to distribute time information in a large, diverse internet system operating at speeds from mundane to lightwave. It uses a return-able-time architecture in which a distributed subnet of time servers operating in a self-organizing, hierarchical, master-slave configuration synchronizes local clocks within the subnet and to national time standards via wire or radio. The servers can also redistribute time information within a network via local routing algorithms and time daemons.

The architectures, algorithms and protocols which have evolved to NTP over several years of implementation and refinement are described in this paper. The synchronization subnet which has been in regular operation in the DARPA/NSF Internet for the last several years is described along with performance data which shows that timekeeping accuracy throughout most portions of the Internet can be ordinarily maintained to within a few tens of milliseconds, even in cases of failure or disruption of clocks, time servers or networks.

Keywords: network clock synchronization, standard time distribution, fault-tolerant architecture, maximum-likelihood estimation, disciplined oscillator, internet protocol.

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Table of Contents

1. Introduction . . . 1
1.1. Performance Requirements . . . 2
1.2. Discussion of Approaches . . . 2
2. Time Standards and Distribution . . . 4
3. Network Time Protocol . . . 5
3.1. Implementation Model . . . 6
3.1.1. Modes of Operation . . . 7
3.1.2. Data Formats . . . 8
3.1.3. State Variables . . . 9
3.2. Procedures . . . 10
3.3. Robustness Issues . . . 11
4. Sample Processing and Selection Operations . . . 12
4.1. Data Filtering . . . 12
4.2. Peer Selection . . . 15
5. Local Clock Design . . . 17
6. NTP in the Internet System . . . 19
6.1. Time Servers . . . 19
6.2. Synchronization Subnet . . . 20
6.3. Performance Analysis . . . 21
7. Future Directions . . . 22
8. References . . . 23

List of Figures

Figure 1. Implementation Model . . . 6
Figure 2. NTP Packet Header . . . 8
Figure 3. Calculating Delay and Offset . . . 10
Figure 4. Offset vs Delay . . . 13
Figure 5. Phase-Lock Loop Model . . . 17
Figure 6. Raw Offsets . . . 20
Figure 7. Filtered Offsets . . . 21
Figure 8. Error Distribution . . . 21

List of Tables

Table 1. Outlyer Selection Procedure . . . 16