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Internet Time Synchronization: the Network Time Protocol

Abstract

This memo 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 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.

This memo describes the Network Time Protocol, which is specified as an Internet Standard in RFC-1119. Distribution of this memo is unlimited.

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

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