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Precision Synchronization of Computer Network Clocks

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Abstract

This report builds on previous work involving the Network Time Protocol, which is used to synchronize computer clocks in the Internet. It describes a series of incremental improvements in system hardware and software which result in significantly better accuracy and stability, especially in primary time servers directly synchronized to radio or satellite time services. These include novel interfacing techniques and operating system features. The goal in this effort is to improve the synchronization accuracy for fast computers and networks from the tens of milliseconds regime of the present technology to the submillisecond regime of the future.

In order to assess how well these improvements work, a series of experiments is described in which the error contributions of various modern Unix system hardware and software components are calibrated. These experiments define the accuracy and stability expectations of the computer clock and establish its design parameters with respect to time and frequency error tolerances. The report concludes that submillisecond accuracies are indeed practical, but that further improvements will be possible only through the use of temperature-compensated clock oscillators.

Keywords: disciplined oscillator, computer clock, network time synchronization.

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