

Two-Way Time and Frequency Transfer

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Time and frequency transfer is an important component of modern technology. Applications range from remotely setting the time on consumer clocks and time tagging financial transactions, to synchronizing navigation and telecommunications systems. At NIST we also remotely calibrate high performance clocks and frequency standards. There are a number of ways to transfer time and frequency, but two-way time and frequency transfer is among the best since it either measures or cancels the propagation path delay. However, two-way transfer tends to make relatively high demands on resources. In this tutorial we will review the basics of two-way time and frequency transfer and examine several techniques for evaluating the accuracy and stability of the transfer process. The various factors that play a role in degrading the accuracy and stability of time and frequency transfer will be examined. A comparison will be made of the performance of a number of two-way systems, including some where the expectation is time transfer at the 100 millisecond level, and others where the transfer stability achieved is better than 100 picoseconds. How this relates to frequency transfer accuracy will be discussed. Comparisons will also be made with some common one-way techniques.