

# NASA TECH BRIEF

## NASA Pasadena Office



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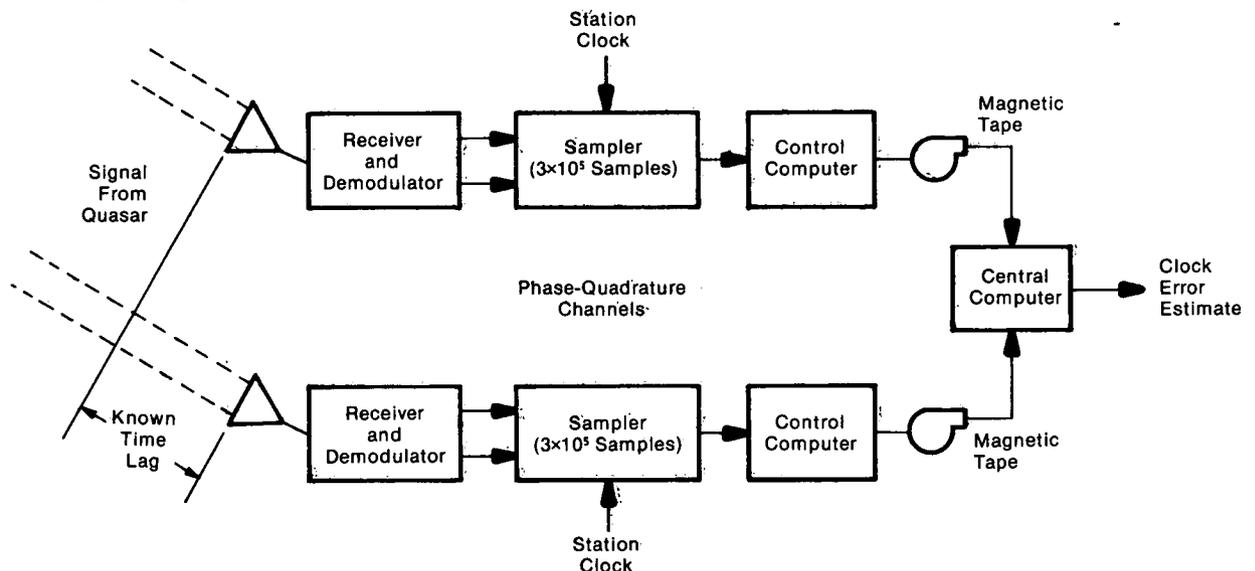
### Quasars as Very-Accurate Clock Synchronizers

A new system using quasars as a time standard can be employed to synchronize global data communications, geophysical measurements, and atomic clocks. It is potentially two to three orders of magnitude better than the presently-used Moon-bounce system. The pulsed microwave radiation emitted by certain radio stars called quasars is recorded at distant stations and placed on tapes, together with pulses from the station clocks. This information is then sent to a central processor where comparisons between the quasar and clock pulses are used to develop correction or synchronization factors for the station clocks.

The synchronizer is essentially a very-long baseline, radio interferometry system. Since the major operational costs are data-acquisition time and transmission of the data from the two stations to the processing computer, maximum-likelihood estimations are used to minimize the data requirements. Thus, in a prototype system, an efficient combination

of high statistical accuracy and a minimal amount of data has produced an accuracy of 100 ns. The accuracy can be improved by increasing system bandwidth until the fundamental limitations due to baseline and source-position uncertainties and atmospheric effects are reached. These limitations are under 10 ns for transcontinental baselines and 0.1 ns may be achievable with extensive calibrations.

A simplified block diagram of the synchronizer is shown in the figure. The quasar signals, which are approximately-flat spectrum microwave noise, are demodulated in two phase-quadrature channels. The signals are then filtered, quantized to a single bit, and written onto digital magnetic tape by the control computer. The data tapes are then mailed to a centrally located computer where the data are processed. All of the data-acquisition electronics are contained in one small chassis.



Very-Long Baseline; Clock-Synchronization System

(continued overleaf)

In the central computer, the data recordings are optimally aligned and cross correlated. In a more advanced version of the system, the data need not be recorded but could be transmitted to the central computer over high-speed lines to allow nearly real-time processing.

**Note:**

Requests for further information may be directed to:

Technology Utilization Officer  
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**Patent status:**

NASA has decided not to apply for a patent.

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