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Time Transfer based on the satellite digital TV broadcasting system

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Time transfer using television (TV) signal transmitted over microwave link was first demonstrated by Tolman et. al [1] and utilizing that technique they could set the clocks to microsecond accuracy. Similar level of accuracy was also achieved with another timing system via television networks employed Line-10 as a passive time synchronization technique [2]. TV signals through geostationary satellites are also been used for precise time transfer between remote clocks [3]. With the advent of technologies, all analog TV are being replaced with digital ones and developing an easy deployable and accurate time transfer technique utilizing digital TV signal will be extremely useful for many of the applications like estimating clock offset or drift among servers and clocks. In this article we described a very simple and inexpensive method of time transfer based on the digital TV signal from the geostationary satellites. The basic principle of this kind of time transfer is that it identifies a specific part of the digital TV signal as the time marker and every time the marker signals arrive at any particular station, its time of arrival being recorded with respect to the local clock. Consider two such clocks located at two different places (Fig. 1) A and B and recording time of arrival of the marker signal from a commonly viewed geostationary satellite. If τ_A and τ_B considered to be the travelling time or delay of the marker signal from the satellite to the position A and B respectively and T_A and T_B to be the local time of arrival of that marker signal. The time offset (∇T_{AB}) between the two local clocks can be estimated as

$$\nabla T_{AB} = (T_A - T_B) + (\tau_A - \tau_B) \qquad (1).$$

Components that contribute to $(\tau_A - \tau_B)$ include delay differences between the two sites caused by ionospheric and tropospheric delays, multipath signal reflections, environmental conditions, etc. In case both the stations are located very close to each other the difference of travelling time of the signal will be very much similar.

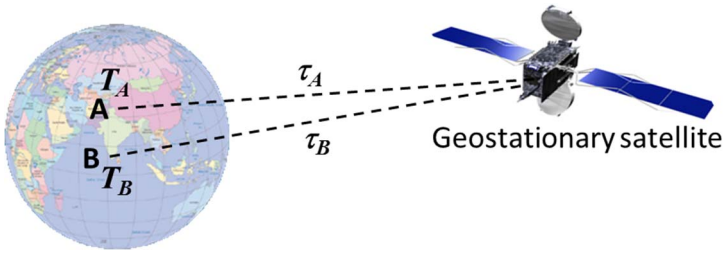

Figure 1. Principle of time transfer through satellite digital TV signals

In our study we have continuously recorded the time of arrival of the marker signal at two different servers over a period of several hours and estimated the clock offset and also the drift between the two clocks.

1. J. Tolman, V. Pâtĉek, A. Souček, and R. Stecher, "Microsecond clock comparison by means of TV synchronization pulses" *IEEE Trans. Instrumentation and Measurement*, **51**, September 1967, pp 247-254

2. D. D. Davis, B. E. Blair, and J. F. Barnaba, "Long-term continental U.S. timing system via television networks," *IEEE Spectrum*, **8**, August 1971, pp. 41-52.

3. F.Meyer, "One-way Time Transfer Using Geostationary Satellite TDF2", *IEEE Transactions on Instrumentation and Measurement,* **44** February 1995, pp103-106.