Status Report of Time and Frequency Activities of National Physical Laboratories, New Delhi, India

1. Maintenance of UTC(NPL1)

UTC (NPL1) is maintained with the help of a bank commercial cesium clocks (all HP

5071). The second pulse of the cesium clock is compared with GPS time regularly following BIPM schedule with the help of a single channel GPS timing receiver (TTR6 of M/S AOA). The frequency offset of UTC (NPL1) with respect to UTC is 1.6×10^{-13} according to the feedback from BIPM. NPL joins the APMP GPS calibration programme.

2. Time Dissemination

NPL has two types of dissemination services for users of Indian subcontinent. One is Standard time and frequency signal (STFS) dissemination via Indian Domestic Geostationary satellite (INSAT) and the other is digital time data service via telephone network (TELECLOCK service).

2.1 STFS Dissemination via INSAT

We have designed and developed a high accuracy coded Standard Time & frequency Signal (STFS) broadcast system via a geostationary satellite. The STFS broadcast can be received reliably anywhere in coverage zone of INSAT, which spans the entire Indian subcontinent, using a small dish antenna and receiving system and decoded automatically using a microprocessor controlled decoder to provide an accurate on line time synchronization of 10 microseconds and 10^{-12} level of frequency calibration. We have designed and developed the complete microprocessor based system for encoding and the decoding the STFS broadcast signal and performed elaborate orbit modeling to accurately determine the instantaneous position of geostationary satellites in presence of natural perturbations due to the sun, moon solar radiation pressure etc. The results of this study have been incorporated into the STFS broadcast to enhance it accuracy to better than 20 s. The only other geostationary satellite based time dissemination service in the world is the American GOES broadcast, which gives accuracy level of 100 s.

By using the concept of differential mode it has been possible to reduce the synchronization error to a sub-microsecond level. This service has been operation for the last three years and is useful for strategic applications needing exceptionally high accuracy.

2.2 Teleclock Service

NPL has started digital time data service via telephone network in the name of TELECLOCK NPL transmits time data containing current time (hour, minute and second) through telephone line. Users, on dialing the number, can get access to this time data through NPL developed TELECLOCK receiver. Teleclock receiver has got the sanction of USA Patent .

Teleclock service can also be used to set RTC of a computer. The computer should be connected to a telephone line through a modem. Just by running NPL developed software, the RTC may be set to IST. This service provides an easy and simple means for setting all public display systems to IST.

3. Research and Developmental Activities

3.1 GPS and GLONASS programme

Reliability and availability of GPS in India had been studied by monitoring GPS signals simultaneously at seven sites. A detail report giving the exhaustive analysis of the recorded data and the corresponding conclusions has been published in the form of a book. This book contains very useful information regarding the utility of GPS in India.

A model to counter the deteriorating effects of Selective Availability on timing has been developed. With the prior knowledge of the precise coordinates of the location, the error in position solution may be utilized to improve timing. This has been found to improve the timing accuracy considerably. Though SA has now been removed but this model still will show some improvement in timing.

With the advent of GLONASS the effort has been made to study the potentiality of using both GPS and GLONASS in optimum combination for getting better accuracy in both positioning and timing. The outcome of this study has also been published in the form of a book

3.2 R&D Activities on Atomic Clock

An active H-maser has been designed and developed in collaboration with NIST, USA. Preliminary measurement indicates that short-term stability in the range of 10 – 1000s follows the behavior $7.7*10^{-14}*\tau^{-1/2}$.Long term operation and evaluation of H-maser is being tried at present.

A new approach to synthesising the Cs hyperfine frequency of 9.192xx GHz has been designed and developed in collaboration with NIST, USA.

NPL has plans to develop a Cs fountain frequency standard. At present work is in progress to develop the frequency stabilisation of the 852nm diode lasers. We are exploring possibilities for the funding of the main project.