Development and performance evaluation of compact and affordable devices for time synchronization over telephone and internet

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CSIR-NPL (NPLI) is a prestigious research and development laboratory in India and a National Metrology Institute (NMI) which has the authority to generate and disseminate Indian Standard Time (IST) and to maintain its traceability to international standards. Accurate measurement, dissemination and synchronization of time with utmost precision play a significant role in almost every domain [1]. Modern technologies like GPS, secure communications, synchronization of telecommunication system, stock markets, power sector, defense, satellite systems and space navigation etc., depend on digital network where precise and accurate time synchronization with time stamping plays a crucial role [2]. Presently, NPLI disseminates time via satellites and internet. Different classes of time dissemination methods and devices are being designed and developed at NPLI which are compact and economical. Two such dissemination methods namely time dissemination over Public Switched Telephone Network (PSTN) named as FonOclock and Network Time Display devices using NPLI's NTP service will be discussed in this paper.

FonOclock is a time dissemination system which has a unique technique to transfer and synchronize fonOclock receiver via Public Switched Telephone Network (PSTN). Its design is indigenous which was developed at NPLI for easier time synchronization over telephone network with commendable synchronization accuracy at low cost. It has mainly three components, namely, the transmitter (time server), a transmission channel (PSTN), and a receiver. It basically has two phases of development. First phase of the development is for the public use where high precision is not much of concern but the device and service has to be economical. It consists of transmitter and receiver which are embedded with a low-cost soft modem (Connexant v.92 56k USB) and a micro-controller (ATmega16). The microcontroller, which is configured with 16MHz crystal oscillator, operates the complete time dissemination and synchronization mechanism. Synchronization accuracy up to ± 10ms is achieved routinely with the system. The drift of crystal oscillator of the device is approximately 300μs/s hence a calibration technique was developed where we can reduce the drift drastically. In the second phase of development we are working towards better precision and accuracy (up to ± 1ms) which is required in many sectors where time stamping is of utmost important and cost is not much of concern. Upon evaluation of the system thoroughly, it was found that uncertainty is solely dependent on the instrumentation, majorly on the modem, rather than PSTN channel. Hence, we are testing various good quality hard modems and working towards performance evaluation to improve the accuracy. A complete performance evaluation of the system and calibration results will be presented in this paper.

Network Time Display (NTD) devices synchronizes itself to UTC(NPLI) from NTP server ('time.nplindia.org'). These devices are designed for the public use where cyber security is not the top priority but the cost of the device. We have developed two Network Time Display (NTD) devices and are working towards its performance optimization. In the first device, Raspberry Pi had been used to access time information from NPLI NTP server, and time is displayed on an LCD. In the second device we have attempted to further lower the cost of the system and hence replaced Raspberry Pi with Wi-Fi ESP module (NodeMCU DEVKIT 1.0) where we have used Arduino based program to operate and synchronize the device to IST via NTP server. A thorough performance evaluation of NTD devices will be presented in this paper.

References

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