DEVELOPMENT OF A MULTIPLE TIME SOURCE COMPARISON SYSTEM FOR DISSEMINATIVE SERVICES IN TAIWAN

C. C. Lin, S. Y. Lin, and C. S. Liao
National Standard Time and Frequency Laboratory
Telecommunication Laboratories, Chunghwa Telecom Co., Ltd.
P. O. Box 71, Chung-Li, Taiwan 320, Republic of China
Tel: 886-3-4245483, Fax: 886-3-4245474
E-mail: cclin@ms.chttl.com.tw, sylin@ms.chttl.com.tw, csliao@ms.chttl.com.tw

Abstract

A multiple time source comparison system (MTCS) has been implemented that is enhancing the reliability of the time source of our time disseminative service, including the Network Time Protocol (NTP) server, Taiwan's Computer Time Service (TCTS), and the Speaking Clocks Service. The time sources of MTCS are two HP-5071A cesium-beam clocks with a micro-phase-stepper and an IRIG-B time-code generator in two shielded rooms; the other source is GPS. We designed an algorithm to make sure that at least two time sources agree. If any time source is different from the others, a switch will block its output and issue an alarm. The time difference among all three sources will stay within 20 microseconds.

INTRODUCTION

At present, IRIG-B signals are widely utilized for disseminative services at TL, Taiwan. We use the IRIG-B signal to synchronize the controllers with national standard time and disseminate

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that standard time code via public time services such as NTP server (Network Time Protocol server; disseminates code by Internet), Taiwan's Computer Time Service (TCTS, the same system as NIST ACTS; requires modem and PSTN to get ASCII Time codes), and Speaking Clocks (disseminate voice timing signal via PSTN; dialing number is 117) (Figure 1).

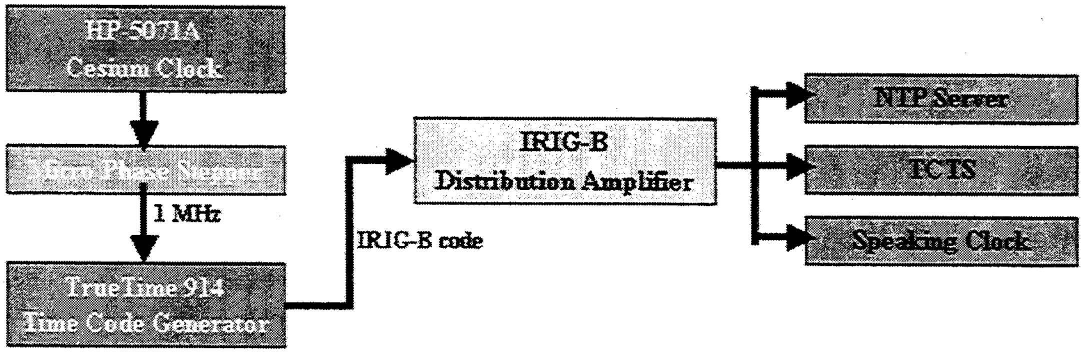

Figure 1

These services provide about two million requests in one day. The most popular service is NTP, about 1.5 requests millions per day; speaking clock 0.5 million; and the rest is TCTS. Just because those services are so important, using a unique timing source to provide timing signals must take a little risk; we may send inaccurate time code when any link of this system fails or terminates. A multiple time source compare system (MTCS) was designed to enhance the reliability of the time sources of our time dissemination services. We use 2 sets of HP-5071A cesium-beam clock, micro-phase-stepper, and time-code generator to generate 2 sets of IRIG-B time code, and we use the GPS time to make judgment. That is, except when 2 of 3 sets of time sources (2 sets of IRIG-B, 1 set of GPS) show the same time error, we will always provide the correct and accuracy time source to our services.

In this paper, we will discuss the system architecture, hardware configuration, control procedures, and software programming of MTCS, and give a conclusion.

SYSTEM ARCHITECTURE AND DESIGN

We modified the old system into a 3-source system (Figure 2). One is IRIG-B code of Taiwan Local time generated from HP-5071A cesium-beam clock and True Time 914 time-code generator; another one is UTC IRIG-B time code generated from the other set of cesium clock and time-code generator; the last one is GPS time from a True Time PC-SG2 GPS receiver. All three codes are decoded and compared in the comp. unit. Those compared results will

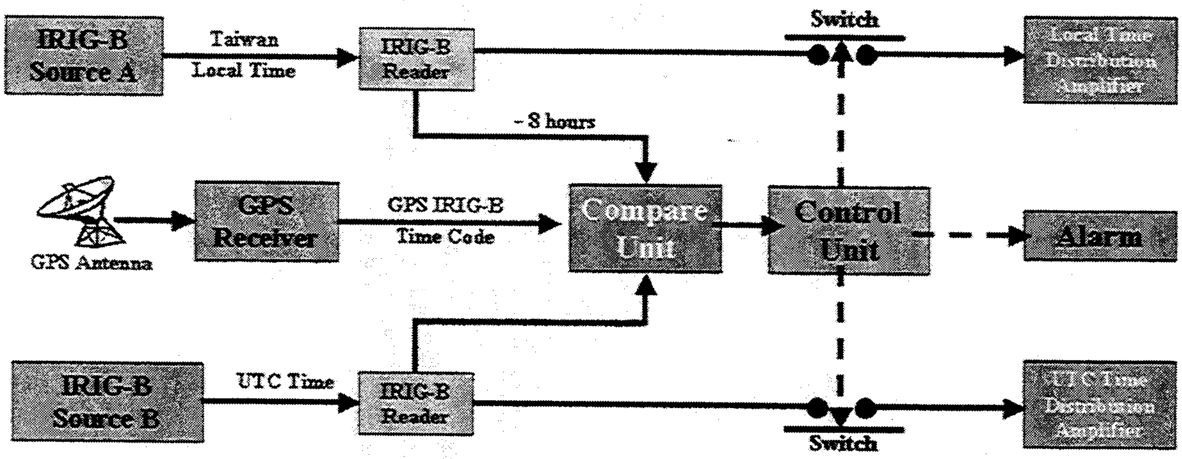

Figure 2

be sent into control unit to judge that the two switches are on or off. If the time difference between source A and B is less than 10 μs, the controller unit will let both switch on and output the IRIG-B code to distribution amplifiers; if not, both two sources will be compared with GPS time to decide which switch will be on. When any source is different from the other two, the control unit will alarm to let people check which link's in error. The detailed algorithm is listed in Table 1.

Input Time Source			Event
$\lvert A-B \rvert$	$\lvert B-C \rvert$	$\lvert C-A \rvert$	
$\geqq 10\mu s$	$\geqq 10\mu s$	$\geqq 10\mu s$	**Output forbidden and Alarm**
$\geqq 10\mu s$	$< 10\mu s$	$\geqq 10\mu s$	**UTC Switch on, Local time switch off, Alarm**
$\geqq 10\mu s$	$\geqq 10\mu s$	$< 10\mu s$	**Local time Switch on, UTC switch off, Alarm**
$< 10\mu s$	$< 10\mu s$	$\geqq 10\mu s$	**Local time and UTC switch on, Alarm**
$< 10\mu s$	$< 10\mu s$	$< 10\mu s$	**Local time and UTC switch on**

A: IRIG-B source from Cesium A, Taiwan Local Time
B: IRIG-B source from Cesium B, UTC(TL) Time
C: GPS Time

Table 1

There exist some cases that the difference between source A and B is larger than 10 microseconds, but A, C and B, C is less than 10 microseconds. For example, $|A-B|$ is equal to 18 microseconds, $|B-C|$ and $|A-C|$ are equal to 9 microseconds. In such case, we still allow the switch on, but alarm follows.

Figure 3 shows the screen display when control software executes. We monitor the sync and switch status; green color is means normal state; red color means alarm. We also show the time display and time difference between each other, normally less than 3 microseconds.

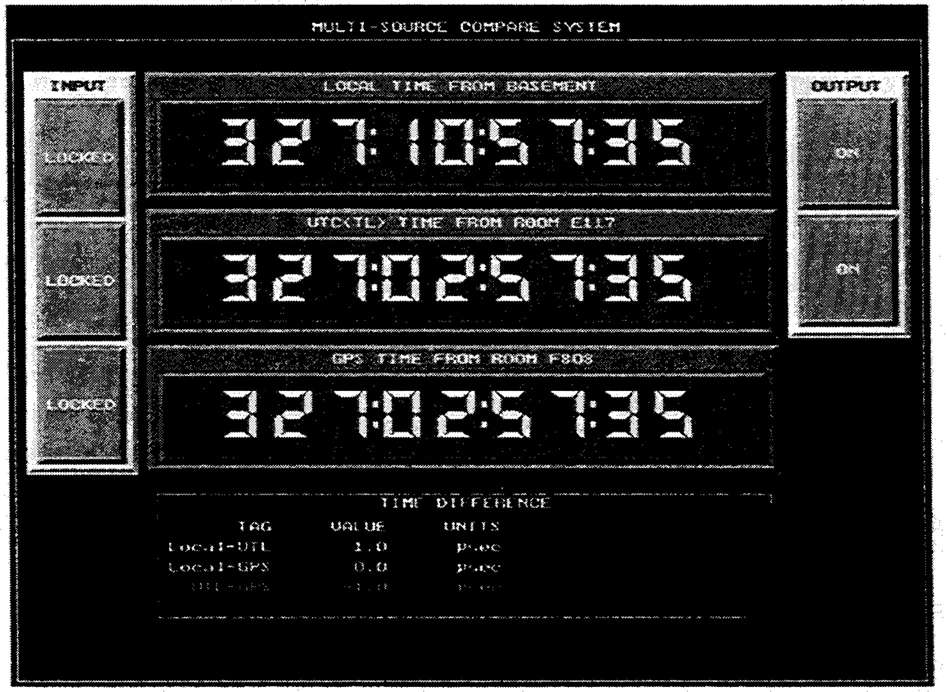

Figure 3

CONCLUSION

In Taiwan, the time disseminative services are getting widely popular. People can use telephone, modem, or Internet to get Taiwan standard time wherever you are; thousands of commercial companies, government organizations, and schools use those time sources to sync their clocks, to support database servers, public transport systems, electric trades, electric documents exchange, networks synchronization, etc. The MTCS can reduce the risk compared to use of the old system. If the error probability is P(error) in the old system, the error probability will be < $[P(error)]^3$ hereafter. Even in error cases, the alarm system will remind engineers to fix the system. We show the time differences of Time source A, B(come from Cesium clock A and B) and GPS; we measured once each 10 seconds, totally 110 times. The most large time difference is kept in 5 microseconds; it is very close to time limitation of the time code decoder and GPS receiver we used.

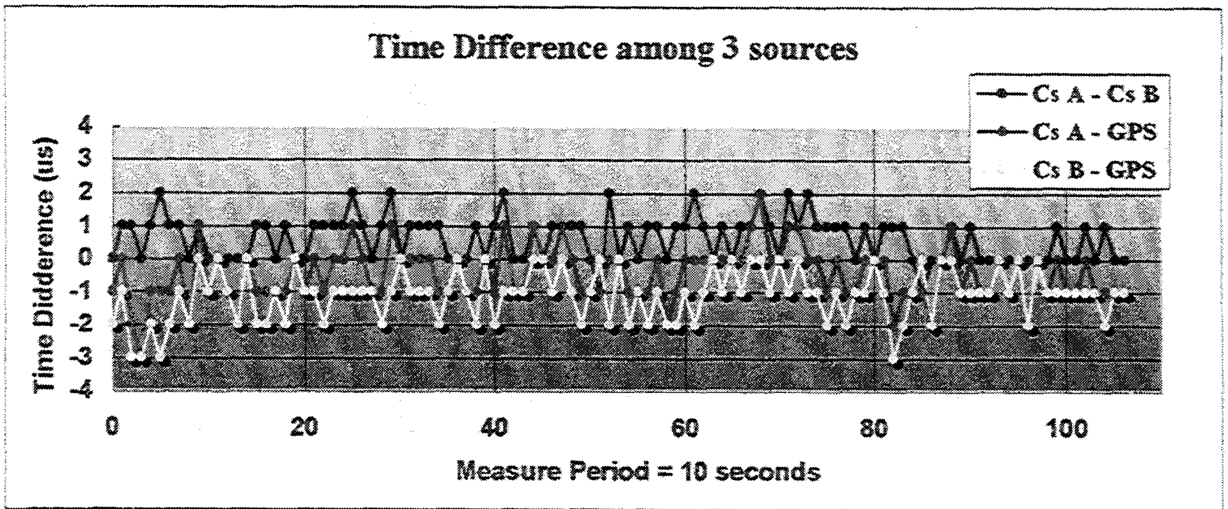

Figure 4

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(1) Lee J. Bain, Max Engelhardt, "Introduction to Probability and Mathematical Statistics," Second Edition, PWS-KENT Com., 1992, p.16- 31.

(2) "Model 560-5503 PC-SG 2 IBM PC/AT Plug-In Card," TrueTime, Inc., 1997.