PREFERRED
RELIABILITY
PRACTICES

GLOBAL POSITIONING SYSTEM TIMING SYSTEM

Practice:

Use of the Global Positioning System (GPS) to provide a timing system with improved reliability and accuracy over the previous system.

Benefits:

In addition to improving the timing system's overall reliability by utilizing multiple timing sources, the upgrade from the previous Apollo-era designed system (using LORAN and WWV) provides improvements in the accuracy, monitoring and feedback capabilities. The timing system is used to provide timing commonality between instrumentation systems so data can be referenced with respect to time. Improving the reliability and accuracy of this system improves the time reference capabilities.

Programs Which Certified Use:

Space Shuttle Program
Kennedy Space Center (KSC) Launch Control Center (LCC) Timing System

Center to Contact for More Information:
Kennedy Space Center (KSC)

Implementation Method:

The primary time sources of the GPS Timing System are two GPS receivers and an Eastern Test Range UHF timing receiver. Each receiver's output feeds a Time Code Generator whose output feeds an Error Detection and Switching System. The inputs from different receivers are compared for bit error and phase error. Switching to a secondary input is performed if a fault is detected. The output is fed to Distribution Amplifiers for distribution throughout the KSC launch area (see Figure 1).

The GPS Timing System is equipped with a computer system that allows the operator to monitor all timing outputs including the signal source, signal level, distribution communication circuit number and end user. The timing signal is also displayed on an oscilloscope. This allows operators to quickly identify any distribution problems.

GLOBAL POSITIONING SYSTEM (GPS) TIMING SYSTEM

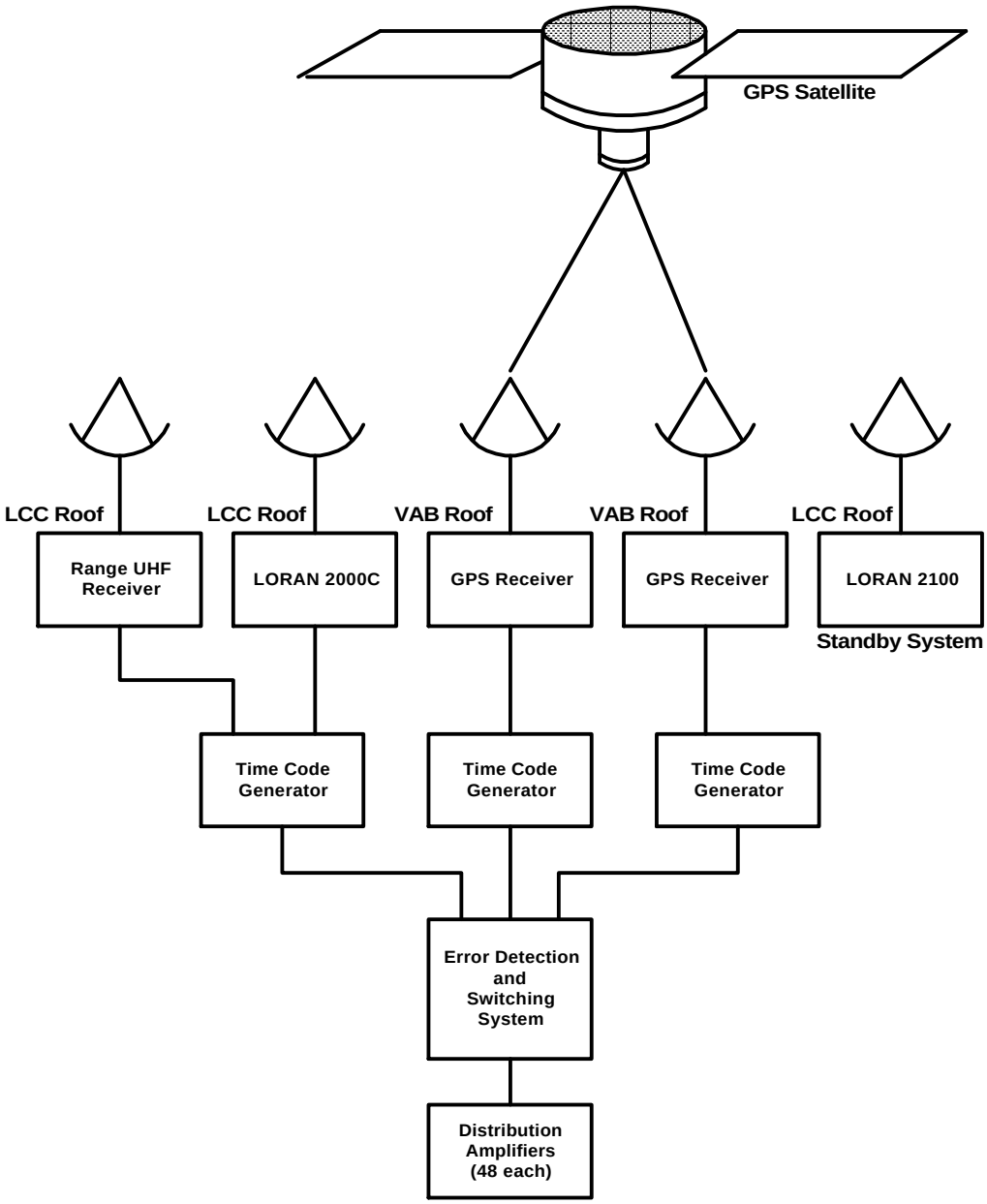

Figure 1. GPS Timing Block Diagram

On a daily basis, operators can page through every timing signal distributed from the LCC, checking the code and level of each signal. After checking all signals, the operator places the computer in auto mode, and the computer automatically checks the time difference between a cesium clock and all other timing units (two GPS receivers, the Eastern Test Range UHF timing receiver, two LORAN receivers, the Communication Instrumentation Facility time, ETR time and a portable clock time).

GLOBAL POSITIONING SYSTEM (GPS) TIMING SYSTEM

The time differences are logged on a printer along with the following information from each GPS receiver:

- Greenwich Mean Time
- Satellites being tracked
- Oscillator control voltage
- Satellites selected
- Satellites deselected
- Antenna status

The printout can then be reviewed by the operator and filed as part of the station log for historical purposes.

The computer system is also equipped with a program that monitors the Timing Station at night and during other unmanned periods. The program pages through each time unit every 10 minutes, checking the time difference between the units and the Cesium clock. The time difference is logged on disk for use during the next work period when it is imported to a software application that can generate graphs for system analysis.

Technical Rationale:

Engineers at Kennedy Space Center require timing commonality between instrumentation systems so data can be referenced with respect to time. The development of the GPS allowed for the development of a timing system that is more accurate, more reliable and provides greater monitoring and feedback capabilities than the Apollo-era design it replaces. That system, using LORAN and WWV, resolved time to an accuracy of +\- 1 microsecond. The GPS system is accurate to within +\- 200 nanoseconds. Another advantage is that unlike LORAN, GPS satellites are capable of supplying the time and need not be used in conjunction with any other system.

Impact of Nonpractice:

The use of an older, less accurate timing system would not provide the reliability, accuracy and the monitor and feedback capabilities that may be required or desired for timing of some present-day systems.

References:

1. KSC Drawing - G79K20503, "KSC Timing System Diagram"
2. KSC Drawing - 80K54337, "LCC, Rm 2P22, Timing System"