Collaborative Software Development Approach Used To Deliver the New Shuttle Telemetry Ground Station

This software affords enhanced capabilities for utilizing telemetric data.

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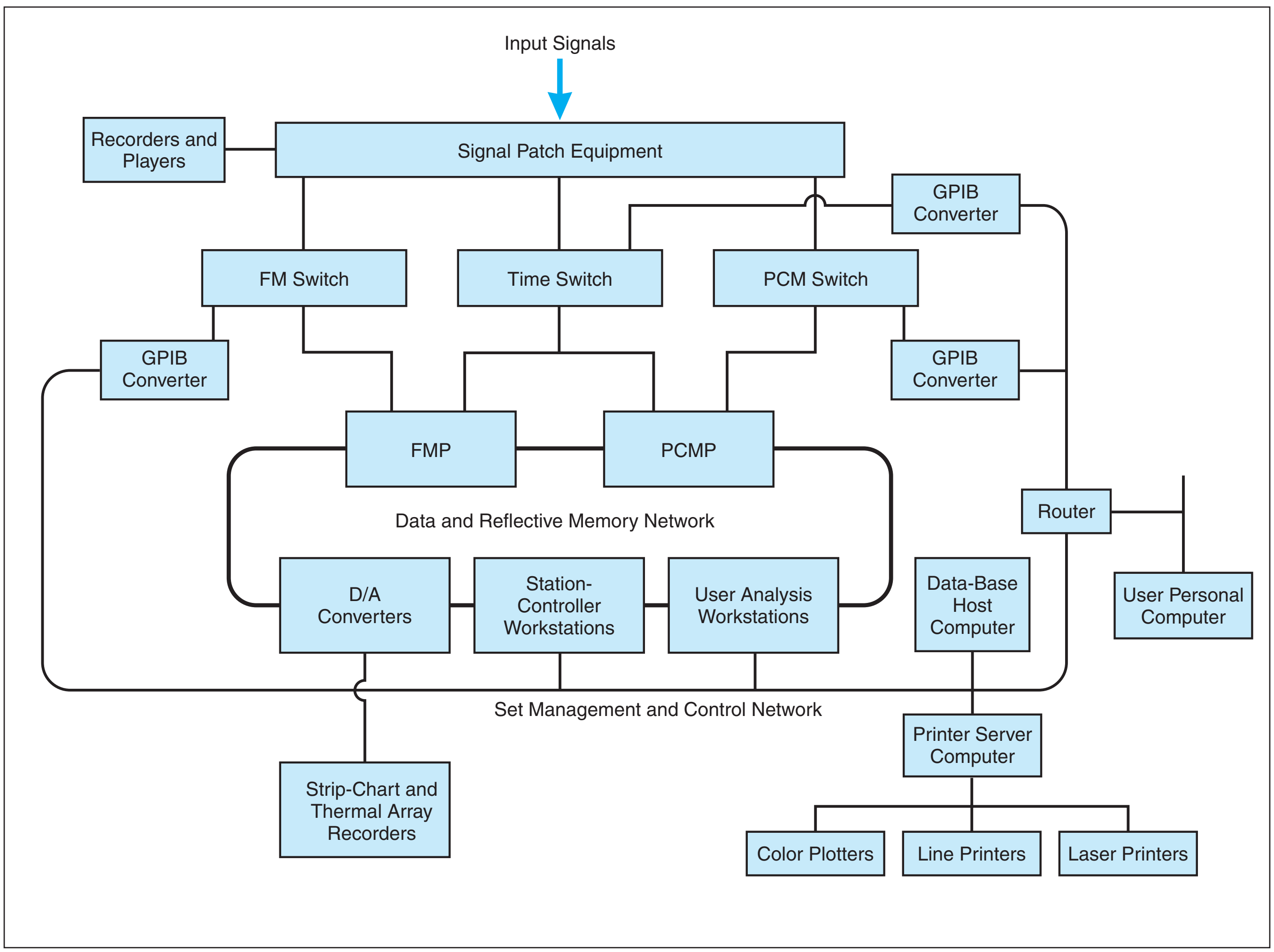
United Space Alliance (USA) developed and used a new software development method to meet technical, schedule, and budget challenges faced during the development and delivery of the new Shuttle Telemetry Ground Station at Kennedy Space Center. This method, called Collaborative Software Development, enabled KSC to effectively leverage industrial software and build additional capabilities to meet shuttle system and operational requirements. Application of this method resulted in reduced time to market, reduced development cost, improved product quality, and improved programmer competence while developing technologies of benefit to a small company in California (AP Labs Inc.). Many modifications were made to the baseline software product (VMEwindow), which improved its quality and functionality. In addition, six new software capabilities were developed, which are the subject of this article and add useful functionality to the VMEwindow environment. These new software programs are written in C or VXWorks and are used in conjunction with other ground station software packages, such as VMEwindow, Matlab, Dataviews, and PVWave.

The Space Shuttle Telemetry Ground Station receives frequency-modulation (FM) and pulse-code-modulated (PCM) signals from the shuttle and support equipment. The hardware architecture (see figure) includes Sun workstations connected to multiple PCM- and FM-processing VersaModule Eurocard (VME) chassis. A reflective memory network transports raw data from PCM Processors (PCMPs) to the programmable digital-to-analog (D/A) converters, strip chart recorders, and analysis and controller workstations.

The first new program provides VMEwindow access to the reflective



The **Upgraded RPS** includes, notably, a reflective memory network that serves as the primary means of transport of raw data.

memory via a Sun Sbus interface. This program makes it possible to acquire and display data from multiple real-time telemetry processors, with deterministic, minimal latency, at any of the ground-station Sun workstations.

Another program prompts the user to enter a mission number, parameters and measurement names for a specific PCM telemetry stream. The program then queries an Oracle database and creates a flat file with the appropriate information for setup of VME chassis. This file is then automatically imported to the setup configuration in VMEwindow. Prior to this development, the user was required to enter all stream parameters via a keyboard. This was an extremely time-consuming and laborious process, which was very prone to error. The program also retrieves and loads data to automatically generate trigger parameters, derived parameters, and mathematical formulas needed to process the retrieved data.

The third program affords capabilities for setting up and controlling a general-purpose interface bus (GPIB) circuit board to perform special FM-signal-processing functions. These functions include snapshots that provide average, minimum, and maximum values of 100 samples of data, and calibrations that provide an average of 5 samples at each of the 0-, 25-, 50-, 75-, and 100-percent data levels. The setup enables individual control of the discriminator and the switch, along with automated control of snapshots and calibrations. The setup functions of this program are integrated into the VMEwindow telemetry-control software and are accessible via an icon in a VMEwindow display. The control functions of this program are exerted via the driver software of the GPIB circuit board.

The fourth program provides for the setup and control of a digital-to-analog converter. As in the case of the third program, the setup functions of this program are integrated into the VMEwindow telemetry-control software and are accessible via an icon in a VMEwindow display. Control is provided by a driver subprogram that interprets the setup and controls the board accordingly to make it generate the required output.

The fifth program provides the ability to reconstitute major frames of data from single minor frame PCM data output from the PCMP decom. Shipping minor frames of data was required to provide minimum data latency and loss to the strip chart recorders in the event of a loss of the telemetry signal. Major frames of minor frame data are fed to VMEwindow engineering conversion icons in order to take advantage of the displays and processing capabilities of VMEwindow.

The final software innovation "thus far" provides the capability to record selected parameters in real time and output this data to a formatted text file. This file can be viewed displaying near-time history of parameter values with associated time tags. The data can be displayed in decimal, hexadecimal, octal, binary, and engineering converted formats and either all data or change data can be stored.

The baseline ground station development effort spawned the first four of these innovations discussed. The last two discussed were developed under a continuing collaborative relationship between USA and AP Labs Inc., designed to improve shuttle processing and foster continued technological innovation.

This work was done by Randy L. Kirby, David Mann, Stephen G. Prenger, Wayne Craig, Andrew Greenwood, Jonathan Morsics, and Charles H. Fricker of United Space Alliance and Son Quach and Paul Lechese of AP Labs for **Kennedy Space Center**. *Further information is contained in a TSP (see page 1).*
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