DISTRIBUTED ARCHITECTURE FOR A GLOBAL TT&C NETWORK

Fredric W. Martin

ABSTRACT

Use of top-down design principles and standard interface techniques provides the basis for a global telemetry data collection, analysis, and satellite control network with a high degree of survivability via use of distributed architecture. Use of Commercial Off-The-Shelf (COTS) hardware and software minimizes costs and provides for easy expansion and adaption to new satellite constellations. Adaptive techniques and low cost multiplexers provide for graceful system wide degradation and flexible data distribution.

KEYWORDS

Anomaly Resolution, Graceful System Degradation, Table Driven Software, Statistical Multiplexer, Baseband Data, Compressed Data, Open Architecture, Distributed System, Topdown Structuring, Distributed Architecture, Algorithmic Scheduling, Stepwise Refinement, Rapid Prototyping.

INTRODUCTION

Platform management of satellites involves supplying power and proper orientation to satellite payloads; many commercial and government organizations are responsible for managing multiple satellite constellations. This involves periodic satellite health checks, anomaly resolution, battery reconditioning for eclipse periods, and maneuvers (delta velocity) for geosynchronous satellites. In this time of fiscal reductions and increasing requirements, satellite management orgainizations have had to automate and build a global network of earth stations that: operate in a "lights out" environment, have graceful system degradation, and operate in a network environment as well as being capable of autonomous operation. The goals of these networks are:

1. Maintain current status of satellite constellations.
2. Perform routine contacts automatically.
3. Operate at minimum cost consistent with requirements.
4. Graphical/simplified human computer interfaces.
5. Graceful network/system wide degradation.
6. Use of open architecture for future expansion.

Following is a description a network based system developed to fulfill all of the preceding requirements.

DESCRIPTION OF THE SYSTEM ARCHITECTURE

All stations should be configured exactly alike, the lone exception is the antenna sub-systems because some sites may already have an existent antenna sub-system or the management of a new constellation has required that a new antenna be purchased.

In order to meet the mission goals, any site must be capable of coordinating the entire network of earth stations, controlling the collection and distribution of a site that does not have its processing capability available, and providing a full suite of processing capability (both archival based and realtime). The station architecture requirements are met as illustrated in Figure 1.

As can be seen in Figure 1, all interfacing to the telemetry collection equipment is via a Station Interfacing Unit (SIU). The software drivers/handlers unique to each piece of equipment are contained in the, SIU; this provides for a standard interface to the station for purposes of command, control, and antenna steering. When station equipment is added or modified, the only change in software in the SIU. Via use of data base and table driven software, the site processor (SP) has its configuration tables edited with operational parameters; only the SIU software has to be expanded or modified when new equipment is added or existent equipment is modified. All interfacing between the SIU and the station equipment (including the SP and statistical multiplexer) is standard RS-232. The protocol between the SP and the SIU is an ASCII protocol. For example, it is required to setup the receiver for a contact; the SP outputs a table with a header indicating this is a receiver configuration table, it contains the information necessary to setup the receiver. The SP contains a configuration table for each satellite that specifies the settings for all of the telemetry collection equipment along with the antenna pointing angles or the command to implement autotrack along with the initial and intermediate pointing angles and the autotrack initiation and maintenance criteria.

In the event that the SP is not available, the telemetry collection equipment and the antenna can be controlled from the statistical multiplexer by another station with dial-up capability; the collected baseband telemetry data is sent to the controlling site via the statistical multiplexer. In the nominal configuration, SP and global network available, the controlling station or Satellite Operations Center (SOC) will send scheduling information, configuration tables for each satellite, validation tables, Keplers, and other information necessary for the site to operate; the site sends data to the SOC using data compression in a packetized manner, alarms due to received telemetry indicating an anomalous condition, alarms due to failure to obtain signal acquisition or telemetry lockup, and other information requested or routinely sent.

As depicted in Figure 2, the global network allows all stations to communicate with one another using a packetized protocol. In the event the link is broken, dial-up communications can be utilized. A leased line is capable of higher data rates than the dial-up links. However the dial-up links are only passing information applicable to a single data collection point. The use of the network to send compressed data is not always satisfactory because some users require baseband data. The SOC can reconstruct baseband data from the compressed data (at the cost of processing bandwidth for other SOC tasks) or the users requiring baseband data can dial-up the site performing the contact and receive the data directly from a baseband distribution unit (BDU) or from the statistical multiplexer.

The site processing unit utilizes a distributed architecture as shown in Figure 3. The SP is responsible for: realtime anomaly detection, communicating with the global network, archiving data, real and post time analysis, trending, contact scheduling, and editing of tables. In the event that the global network is not operational, the site processing system continues to schedule the contacts via an algorithmic scheduler. The station can also edit the schedule files to perform discrete contacts as well. The software for performing a contact, scheduling, realtime validation, and other high priority tasks is available in all of the processors/workstations comprising the SP; when an element of the SP is not available, the high priority tasks can be activated in anyone of the SP elements, thereby preserving the autonomous operational capability of the site.

CONCLUSION

It is possible to establish a robust global satellite communications network to meet mission goals at minimal cost. Use of stepwise refinement, top down structuring, "is does, as does" documentation, and formal requirement, design and interfacing specifications have contributed to minimize technical and developmental risk. Rapid prototyping provides the means for insuring that the user understands what the system is and will be capable of, allows the users to define the display requirements, and eliminates or greatly races the "fine tuning".

Distributed and open system architecture provides for local and system wide robustness. Inhouse development and maintenance races life-cycle costs and insures rapid response to minimize meantime to repair failures. By using standard interfacing techniques, new components can be placed on-line with minimum impact. Unique interfacing requirements are met by using an inhouse designed and implemented processing unit, the SIU based upon a standard PC. As new equipment and processing systems become available, integrating them into the network environment will be facilated with minimum impact due to standard hardware and well defined software interfaces.

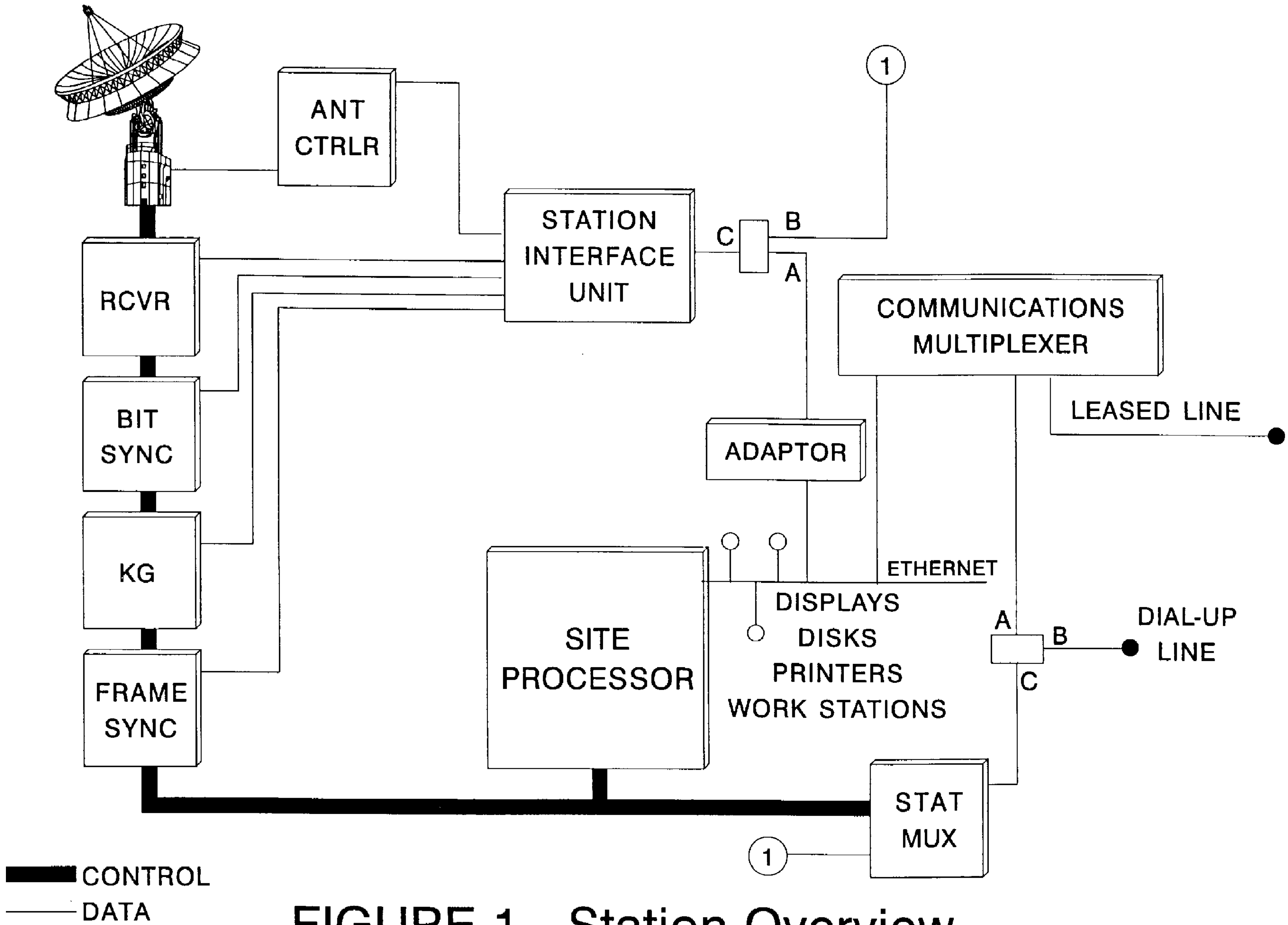

FIGURE 1 - Station Overview

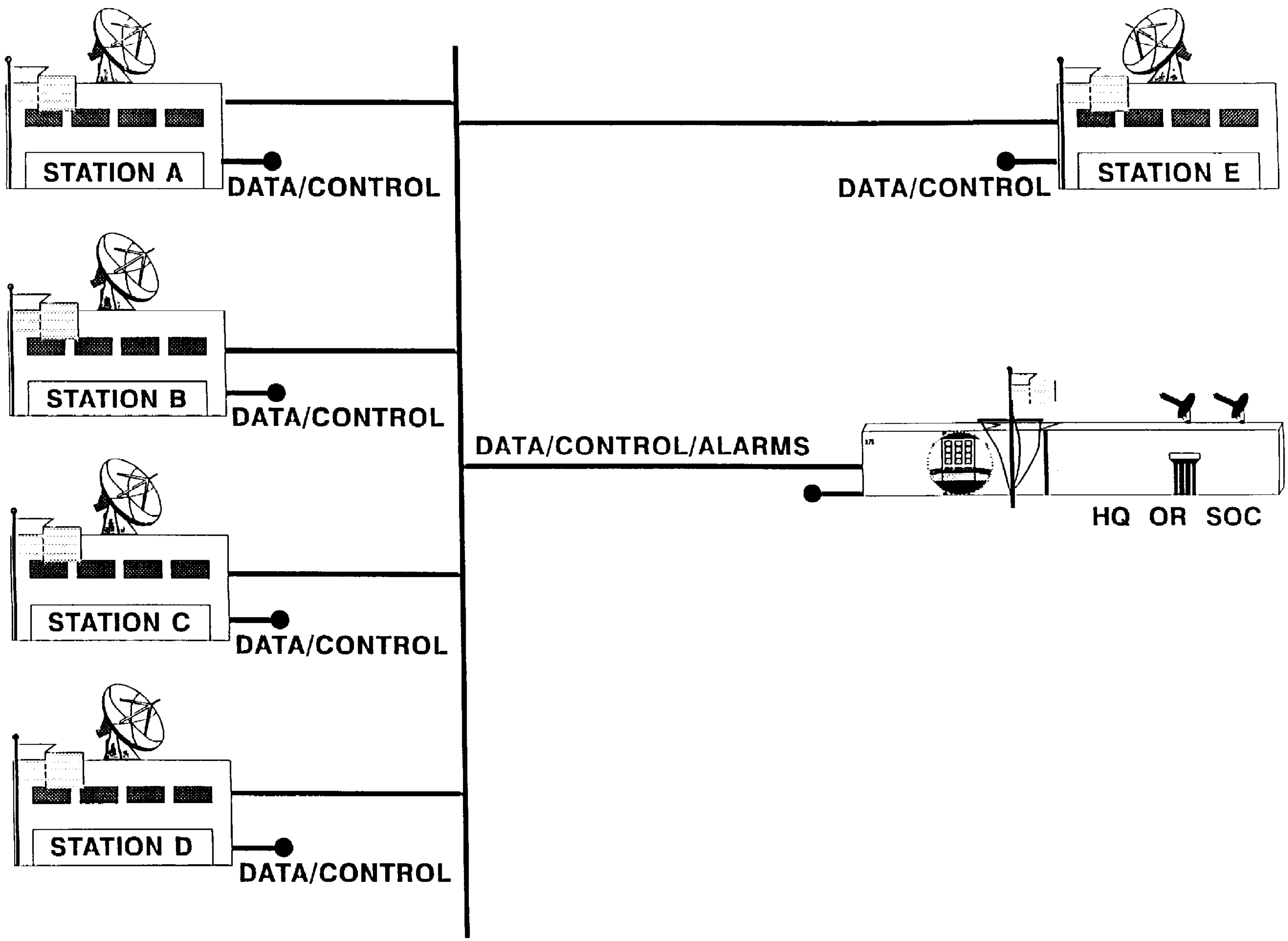

FIGURE 2 - Global Network Overview

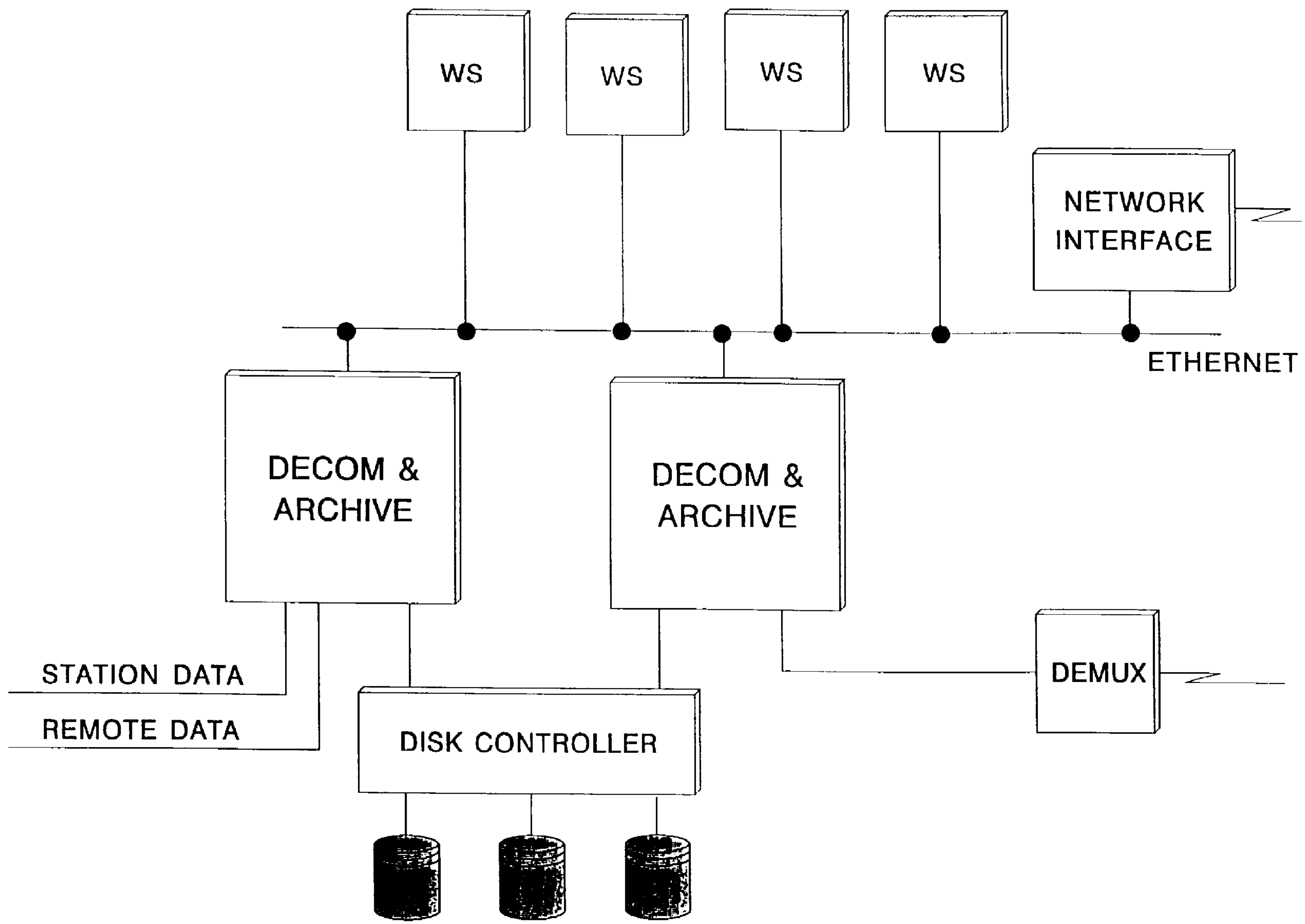

FIGURE 3 - Site Processor