ATTITUDE COMPUTATION SYSTEM

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Over the past ten years, spacecraft mission requirements for attitude determination and attitude control have been increasing.

The types of attitude sensors from mission to mission are varied but may be broken into classes such as horizon detectors, sun sensors, magnetic field detectors, and star sensors. Likewise, the control systems vary from mission to mission but in general use gas thrusters or magnetics to perform spin axis precession. Because of the commonality of the basic attitude determination and control concepts, a broad base of experience can be carried from mission to mission.

The Attitude Determination Office was charged with the responsibility of attitude determination and control for a number of unmanned satellite mission. To meet these commitments, the use of large scale computers became a necessity.

However, the use of large scale, general purpose computers presents problems when used for attitude support activities.

Figure 1 presents the three major obstacles which had to be overcome:

1. NEED TO GET PERTINENT ATTITUDE DATA TO ATTITUDE COMPUTER.
2. NEED TO OPERATE WITH PROGRAMS IN AN INTERACTIVE ENVIRONMENT.
3. NEED FOR CENTRAL ATTITUDE SUPPORT AREA.

Figure 1. Problems faced using large scale computers for attitude support.

- Because the attitude determination functions require the processing of spacecraft telemetry data, it is necessary to get this data to the attitude computer in a timely manner. The use of printout is undesirable due to data volume: the use of magnetic tape requires the completion of an event (pass) before data can be transferred, thus limiting response time.

- In a batch processing environment, it is very difficult to satisfy a rapid response requirement for job submission via card decks, and for reviewing results via hard copy printout. This is even further complicated by the decision making processes which must be included in the various attitude programs which could be better handled by other techniques.

- Because of the general support nature of the computer environment, it is difficult to maintain a central point of contact between the various attitude related functions. The attitude activities for any mission are dynamic by nature and require the continuous updating of attitude results and attitude commands. The contact necessary to accomplish this type of support requires a central area of activity.

With the launch of SAS-1, an attitude computation system became a reality. Figure 2 depicts the important items which make up the attitude computation system.

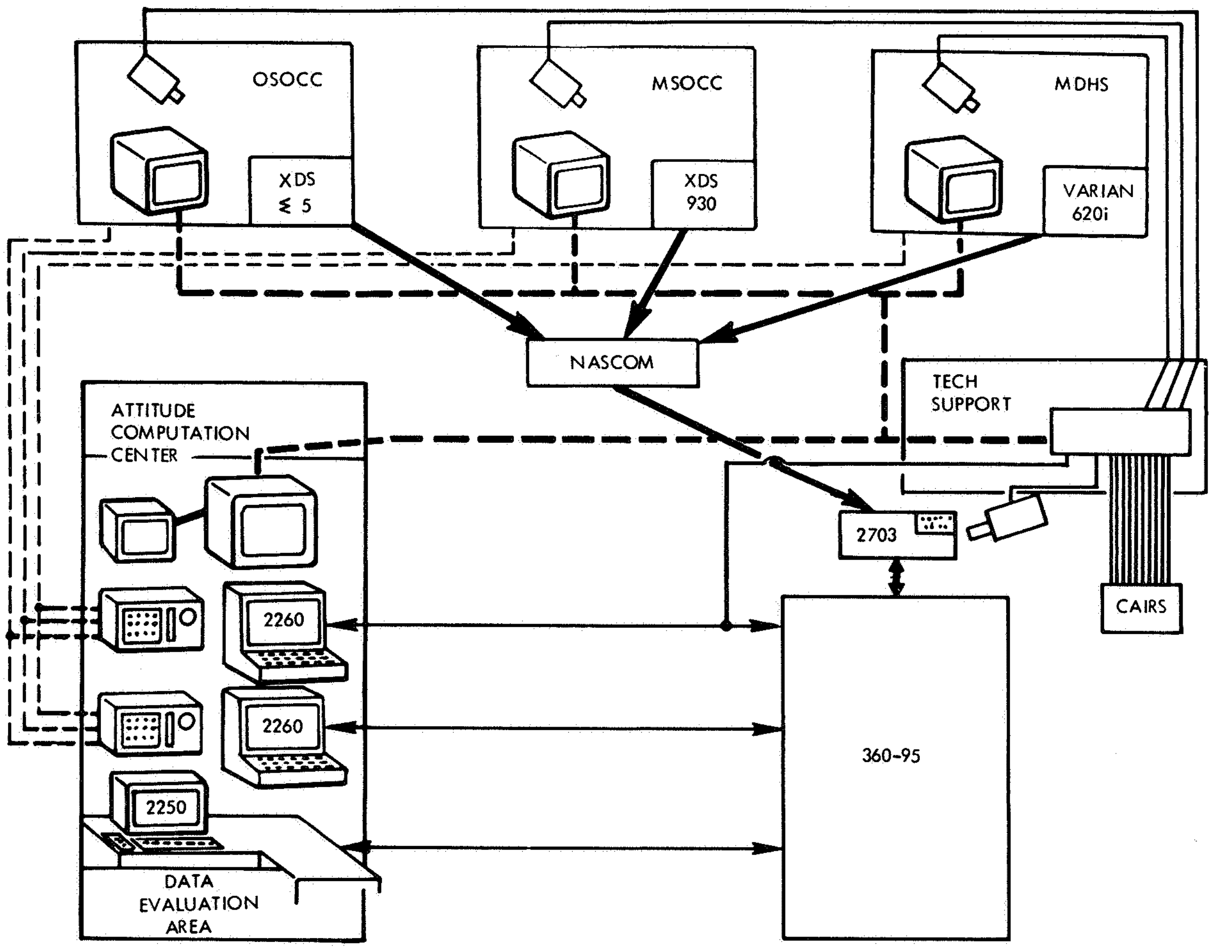

Figure 2. Attitude computation facilities.

The system's major components include: the ability to transfer the attitude data from the control center to the attitude computer at a rate of 2400 bps; an attitude computation center which houses communications, closed circuit TV, graphics devices, and a data evaluation area; and the use of interactive graphics devices to schedule jobs and to control program flow.

The attitude computation system has been able to take advantage of computational power which exists at GSFC in a rapid response environment to support the requirements of a number of spacecraft missions. This system is located near the control centers and we believe it is utilizing the existing facilities in a highly efficient and effective manner.

A most recent example of the need for this type of support was demonstrated at the launch of SSS-1 when the spacecraft experienced nutation build-up at the rate of about three degrees per day, and could have resulted in mission failure. Figure 3 depicts the functions which were performed to implement an active nutation damping operation.

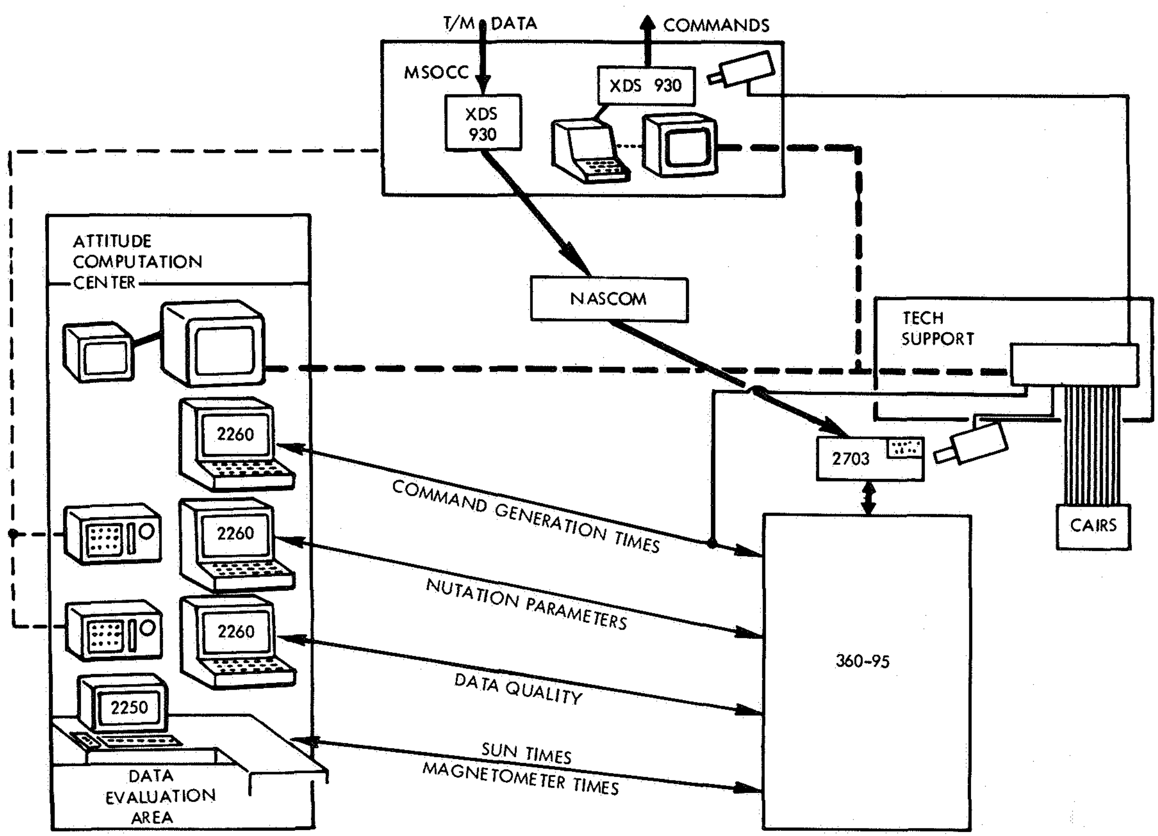

Figure 3. SSS-1 nutation control.

The SSS Attitude System was designed to determine attitude, using optical aspect and SCADS data. This system was modified to display magnetometer and sun times as seen from spacecraft telemetry. Nutation phase and amplitude parameters were computed by the system and displayed on a second device. A third was used to evaluate the quality of the telemetry data. And a fourth was used to combine the results of the other processing functions to generate the command times, which were necessary to activate a magnetic coil at a precise time within the 16-second spin period and were returned to the control center via CCTV. The attitude computation center was temporarily expanded to meet the graphics requirements.

The resources available to the attitude computation system provided a base from which the contigency support could be readily developed within 24 hours and was instrumental in mission success.