THE DATA PROCESSOR FROM THE SMALL SCIENTIFIC SATELLITE

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The Small Scientific Satellite, called S^3, was launched on November 15, 1971.

The mission of S^3 is to investigate the inner-magnetosphere of the earth. After a year in orbit, the satellite has been declared an official success, and the experimenters have been extremely happy with the data they have received.

One of the main reasons for this success has been the reprogrammable data system aboard the spacecraft.

Figure 1 shows the approximate duties of a typical spacecraft data system. These duties include sampling the experiments one by one, taking the data in, formatting that data, and preparing it for transmission to the ground.

A typical hard-wired encoder will sample these experiments in order one by one, and then repeat the sequence again and again.

A reprogrammable system such as the one onboard S^3 can rearrange this order in any way desired, so that an experiment which is not giving significant data at the moment can be ignored or can be skipped in a sequence. The sequence can be changed around or an experiment which is giving particularly interesting data at the moment can be sampled repetitively.

In addition to this feature on the S^3 system, experiments are sampled in synchronization with the spin of the spacecraft. This allows the experimenter to know the spin orientation of the spacecraft, and to sample his data at any desired position in the spin.

As shown here, the S^3 system is an in-line system, and it is not a backup system for any other encoder system.

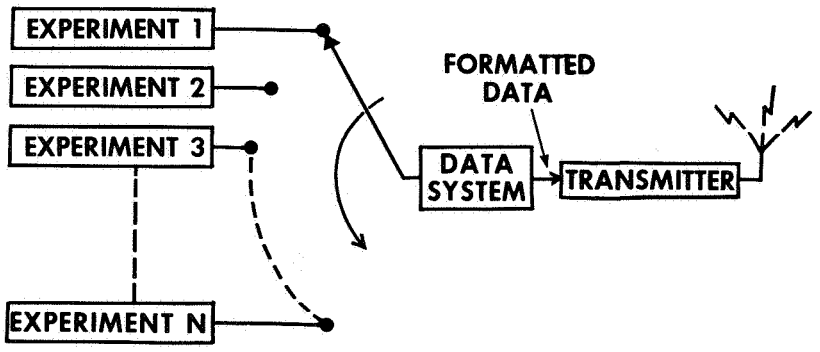

Figure 1. Function of typical spacecraft data system.

You may well ask what makes the S^3 system different from other reprogrammable systems? The main difference results from the small size of the spacecraft. Also, it is designed for multiple missions, which I will explain in more detail later.

The weight of the spacecraft is only 50 kilograms. Therefore, power, weight, and volume constraints were very strict on the data system, as shown in Figure 2 – only 5.65 watts, 3.8 kilograms, and 0.056 cubic meters, respectively.

Figure 3 shows the basic configuration of the S^3 system, which is made up of four boxes. The program memory, where the programs are stored, which is reprogrammable from the

- **REPROGRAMMABLE**
- **DESIGNED FOR MULTIPLE MISSIONS**
- **DESIGNED FOR SMALL SPACECRAFT**
  - **LOW POWER 5.65 W**
  - **LOW HEIGHT 3.81 KG**
  - **LOW VOLUME 0.006 M³**

Figure 2. S^3 data processing system characteristics.

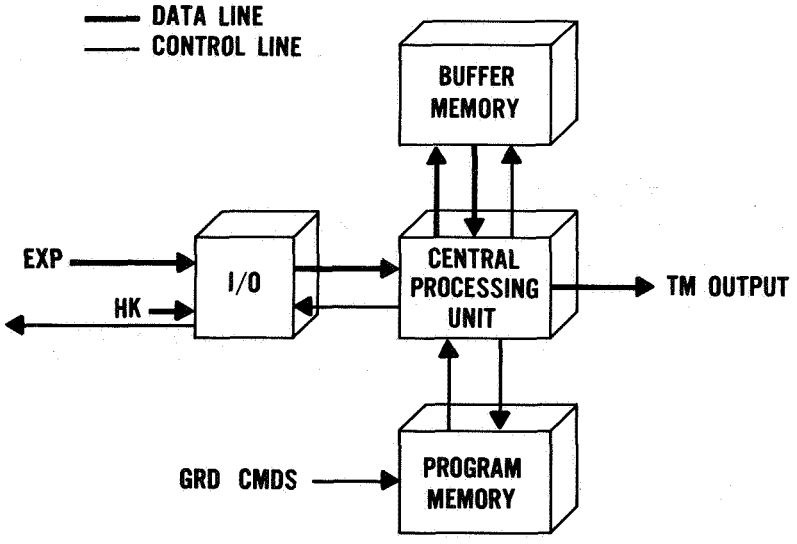

Figure 3. Block diagram S^3 data handling system.

ground. A data memory, which provides buffering because the spacecraft clock times the telemetry output and the spin-synchronous clock times the data coming in. There is an input/output module, which interfaces with the various signal types of the experiments; and a central processing unit which controls the entire system.

To provide flexibility for multiple missions, this system was built modularly so that these three boxes (BM, PM, CPU) would not have to be changed. Only the signal conditioning for the experiments need be changed if a similar type mission were to be flown.

At launch, the reprogrammability of this system proved very valuable to the spacecraft. Right after launch it was discovered that the spacecraft was wobbling, or nutating, and it was found by the spacecraft dynamics people that it was necessary to obtain the magnetic crossing times with a great degree of accuracy in order to correct this nutation problem. Reprogramming the system enabled these people to obtain the information they needed.

It was found after the nutation problem had been solved that in order to maintain a small, stable nutation angle, the spacecraft had to be spinning at almost twice the originally anticipated rate.

Since the original programs had been written so that the experimenters could look at their data synchronized to the spin, it was necessary again to reprogram the system in order to correct for this increased spin rate. As a result of reprogramming, there was no degradation of the data.

In addition to these two examples, the data system has been reprogrammed more than 165 times as of October 25, to accomplish other specific goals. The experimenters feel that this reprogrammability has enabled them to perform several experiments rather than just the one which a hard-wired encoder would have allowed them to do.

Presently, the spacecraft is investigating a magnetic storm by using six different programs on one storm in order to thoroughly drain the scientific data available.

As a result of this type of adaptability, the reprogrammable data system is considered to be the largest contributing factor to a successful S^3 mission.

MEMBER OF THE AUDIENCE:

What is the size of the data memory?

MR. McCAIN:

It is 4096 words, four bits each.