GENERALIZED TELEMETRY PROCESSING FOR THE AIR FORCE SATELLITE CONTROL NETWORK

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ABSTRACT

A telemetry processing capability is being developed for the Air Force Satellite Control Network which will process telemetry data from Air Force satellites of various families in several Mission Control Complexes using identical hardware and software. A Telemetry Higher Order Language is the key element in allowing this commonality.

INTRODUCTION

The U. S. Air Force Systems Command (at the Air Force Satellite Control Facility) is currently modernizing the Command and Control Segment (CCS) of the Air Force Satellite Control Network (AFSCN), under the Data Systems Modernization (DSM) contract. Figure 1 shows the elements of the AFSCN and the CCS. The existing CCS had evolved over the past 25 years without the benefit of an integrated architecture. This was a primary goal of the DSM procurement, which was awarded in 1980. Prior to the DSM era, as each new program came to the Satellite Control Facility for support, the programs SPO, or the AFSCF and its contractors were required to develop the software to process and display telemetry data. As the number of programs increased, there was an increasing amount of program specific telemetry software (referred to as MODES) to be maintained and upgraded. This became a significant element of cost. It was a constraint upon any proposed designs for the DSM procurement that a single software package be developed, which would support telemetry processing and display for all MCCs and programs at the SCF. This was the driving design constraint upon DSM telemetry.

Since 1980, the contractor team has been engaged in the development, installation, documentation, and integration of the hardware, software, documentation and other products comprising the modernized CCS. The major differences between the current data system and the DSM CCS are shown in Figure 2.

The structure of the Air Force operations at the STC and SOC are shown in Figure 3. Each AF Vehicle Operations office (VO) equates to an individual Mission Control Center (MCC)/ A VO, with an MCC may have responsibility for one or more satellite families. (All data shown is for purposes of illustration only, and is not to be construed as representing actual VO, MCC and program assignments within the AFSCN).

The CCS supports all the activities required for satellite command and control; processing telemetry, supporting commanding, processing tracking data and orbit calculation, and the issuance of directives to configure and control ground system elements. This paper addresses only the support provided by the DSM system to the function of processing, display and routing of telemetry data.

REQUIREMENTS

A fundamental requirement upon the DSM based CCS was that the system which was installed in each MCC within the AFSCN be as nearly identical as possible. Figure 4 illustrates the approach taken to this requirement. A similar kernel of HW is installed in each MCC. For reasons of economy, these are not necessarily identical, as the capacity requirements of MCCs vary considerably. To the software, however, the commercial and the specially developed hardware appear identical from room to room. The software kernel which is installed in each room is precisely identical for each of the MCCs. VO to VO satellite unique requirements, usually orbit related, are accommodated through satellite family unique software modules called Mission Unique Software.

For telemetry processing, the software is identical across all AFSCN MCCs, be they in the Satellite Test Center at Sunnyvale, California, or at the Satellite Operations Center (SOC) at Colorado Springs.

All vehicle supported by the AFSCN must be SGLs compatible. Within this constraint, the CCS telemetry system will support all users.

The CCS telemetry system is data base driven. This means that the user is given baseline capabilities, and must define to the system, through the data base, the mission, satellite and pass/contact specific parameters of his need. It is through the construction of this data base that the user tailors the CCS to his particular needs. The remainder of this paper explains how the system allows the user to define his unique requirements for telemetry processing.

Figure 5 presents, in block diagram, the sequence of logical processing steps which must occur for the processing of any telemetry.

As shown in Figure 5, the overall process operates under the control of the Telemetry module, CPCI 203, TLMPE. This software module is installed in each MCC in an identical form and configuration. The processing for individual vehicles is customized by the user via the CCS data base. The elements of this data base are shown, and the functions performed by each.

All elements of the CCS telemetry data base are written in Telemetry Higher Order Language (THOL), an English-like language which allows the telemetry analyst to define his desired pre-processing and processing functions to the system without having to be a programmer. The Preprocessor Load (PPL), the Telemetry Data Processors (TDPs) and Processed Data Distributors (PDDs) are written in THOL; an example of a TDP written in THOL is shown:

```
STARTUP EXAMPLE;

SELECT A;

SELECT B;

SELECT Y

SELECT P:PSEUDO;

CAL (A,B,y);

A.C = M(A,R) + K        ]
                        ]
B.C = M(B.R) + K        ]    (IN MEASURAND CATALOG)
                        ]
Y.C = M(Y.R) = K        ]

P = A*(B = Y);

ENDTDP
```

(This example is intended only to illustrate syntax, not the range of features within THOL.)

DATA FLOW

As raw TM data enters the MCC, it will enter a Telemetry Contact Support Equipment Group (T-CSEG), which has been loaded with a PPL. Two important elements of the PPL are the wavetrain catalog, (which defines the minor frame synch pattern for frame synchronization, and also defines the position of each measurand in the wavetrain, for the decommutation function), and the compression file, which contains the compression parameters. Following decommutation and compression, the measurands are passed to the TDP, resident in the CPU.

The TDP performs the calibration specified by the user, and any other special processing desired (i.e., derived parameter processing).

The output of the TDP is input to the PDD. The PDD routes the processed measurands and values from the TDP to other software, for transmission for display, for transmission to external users and sources, and other purposes. A PDD routing this data to the display software would make it available to personnel at Commanding positions, for functional verification of commands, as an example.

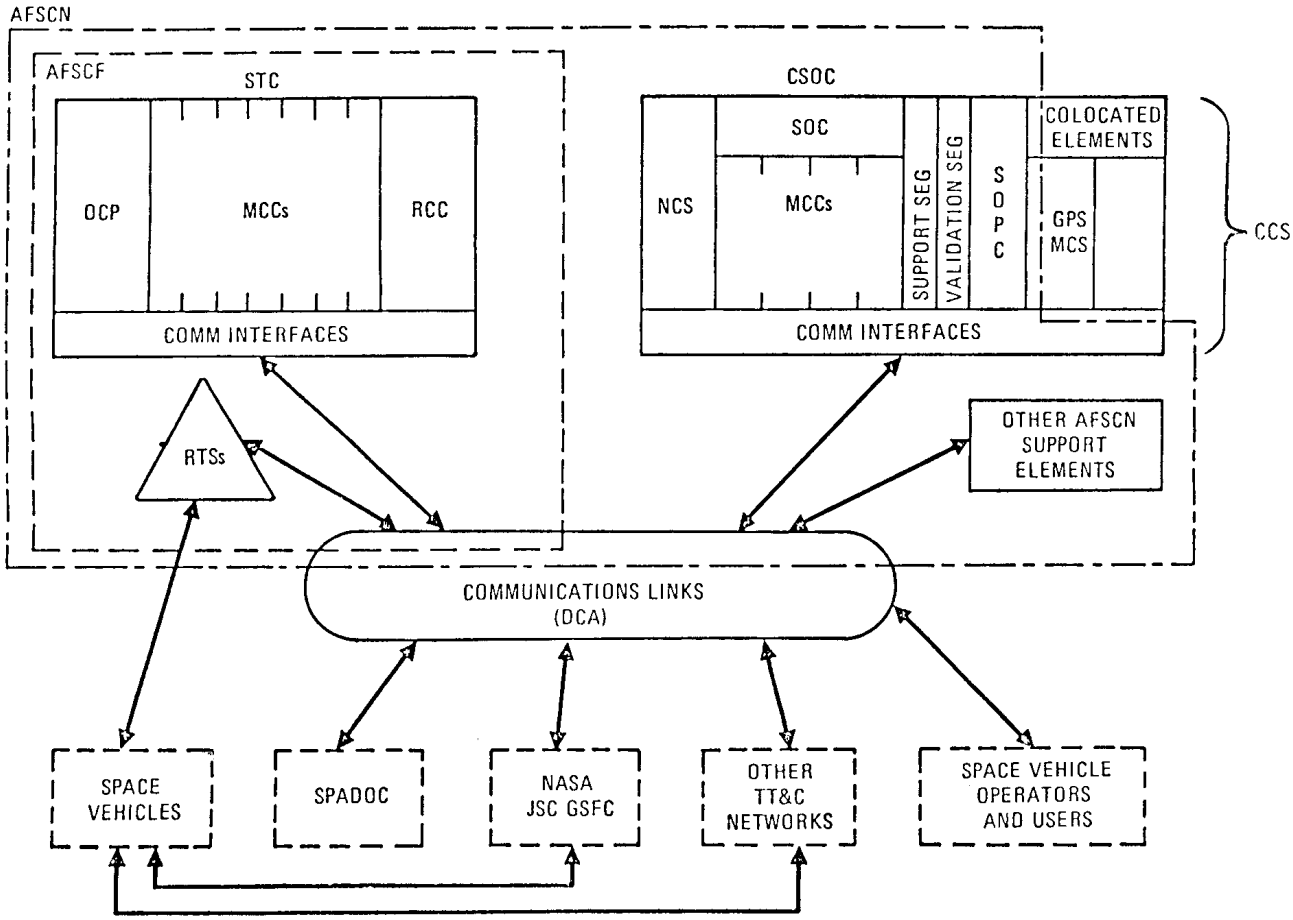
SUMMARY

The CCS Telemetry software provides the AF operators and users with the capability to support many programs and types of satellites, in multiple Fission Control Centers, with the same package of software. Software O&M costs will be reduced, cross training facilitated, and the support of new programs coming onto the AFSCN will be eased.

(See Figure 6).

1988 AFSCN CONFIGURATION

FIGURE 1



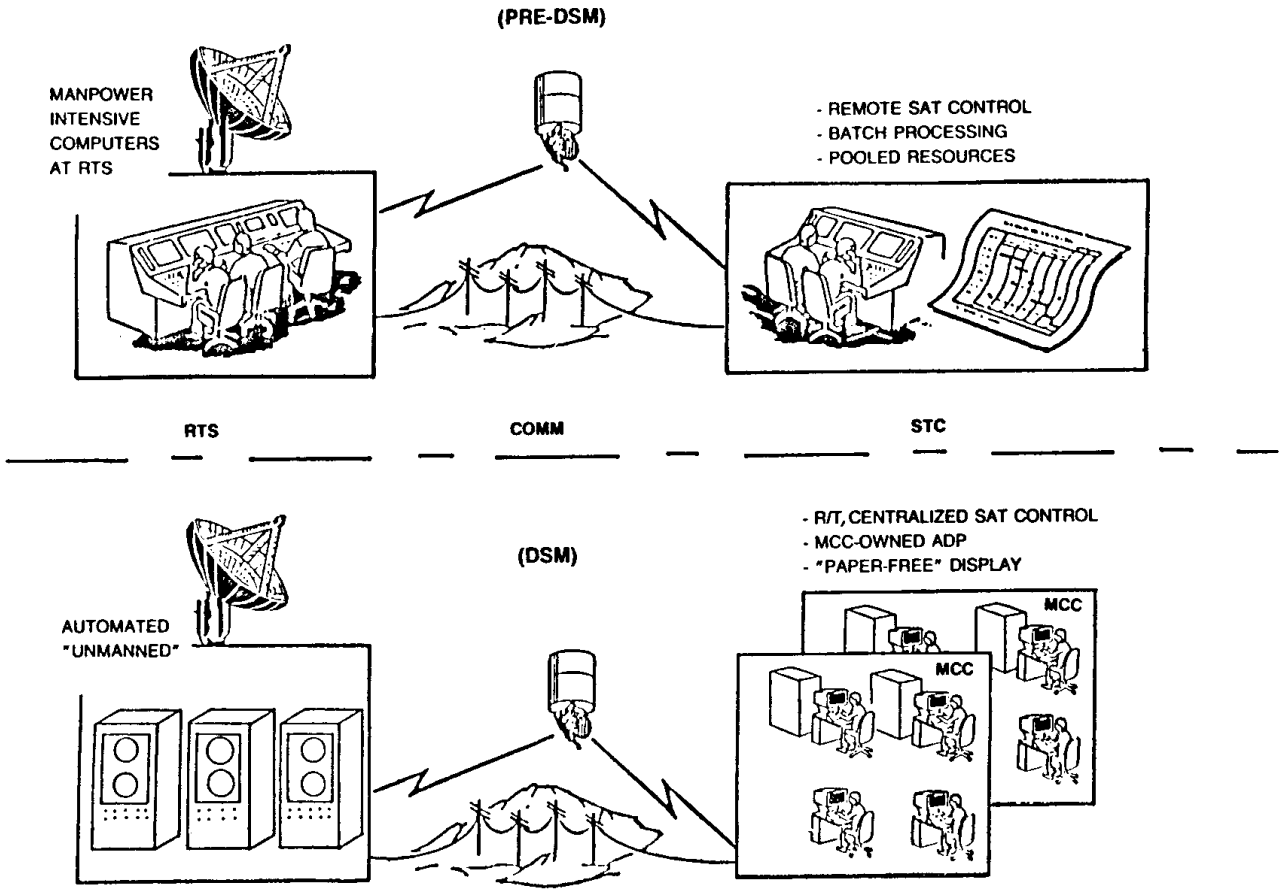


Fig. 2 Pre-DSM and DSM CCS

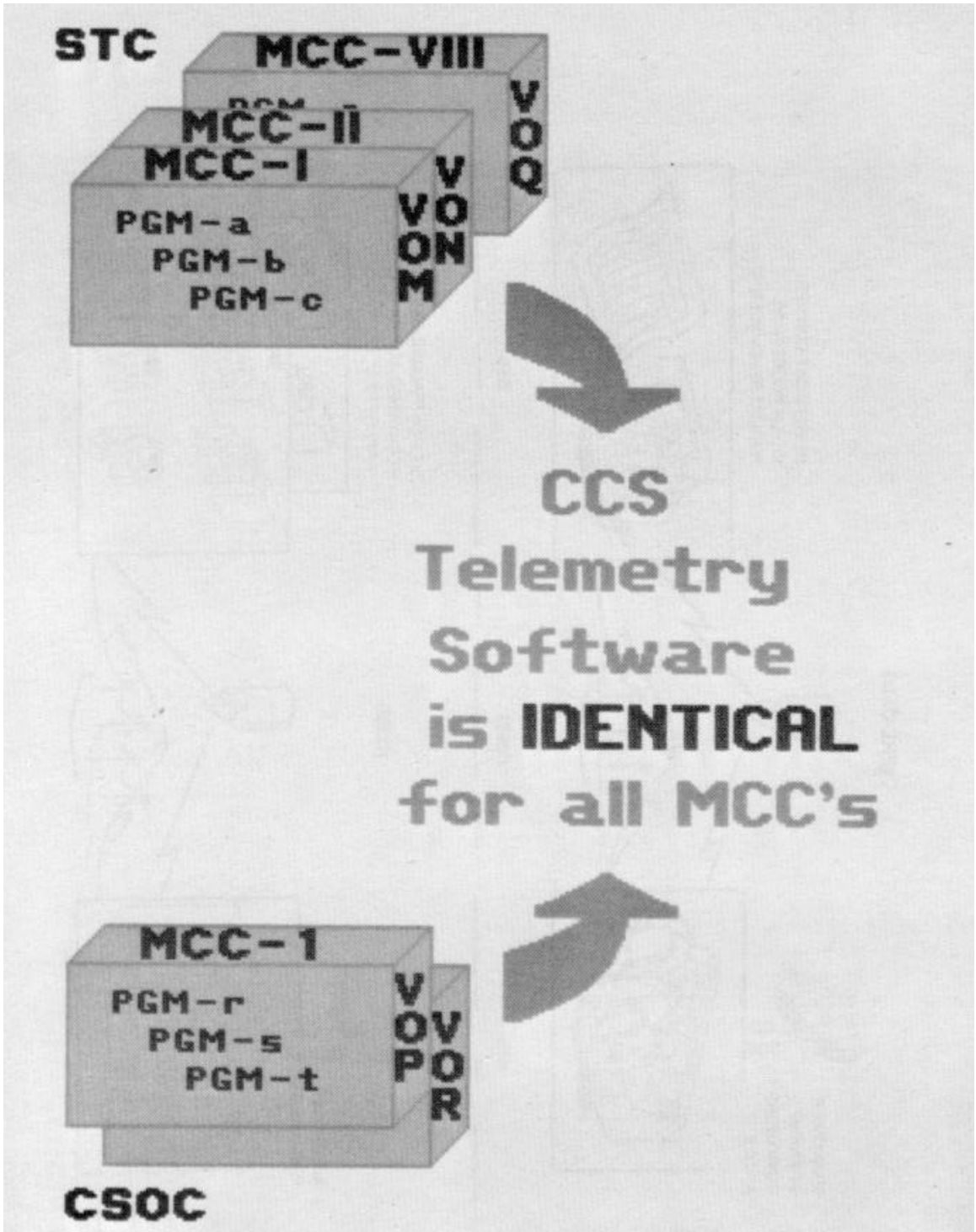
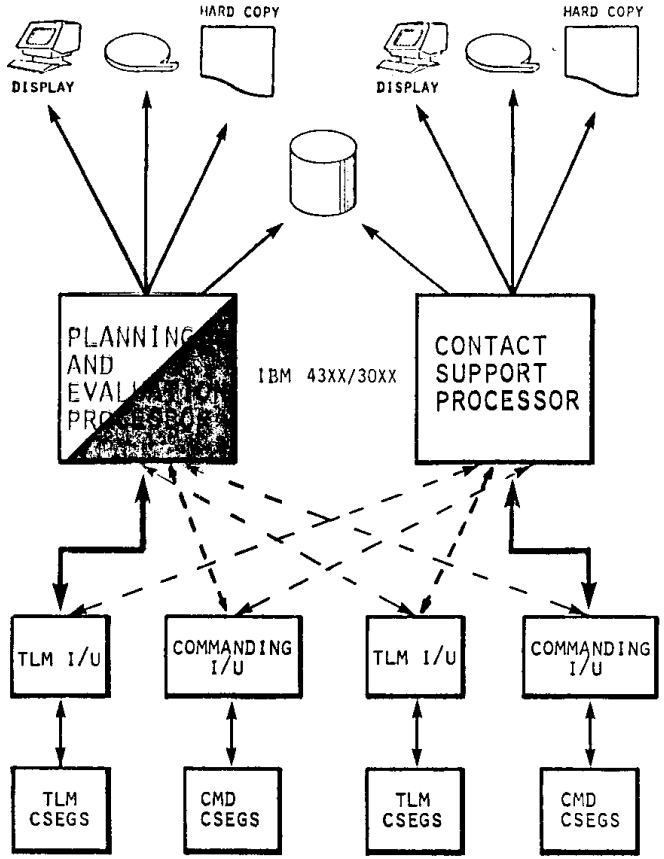

STC
MCC-VIII
MCC-II
MCC-I
PGM-a
PGM-b
PGM-c
VOQ
VOM
CCS
Telemetry
Software
is IDENTICAL
for all MCC's
MCC-1
PGM-r
PGM-s
PGM-t
VOP
VOR
CSOC

FIGURE 3

FIGURE 4



SYSTEM KERNEL ARCHITECTURE

- COMMON ADPE/CPCI NUCLEUS FOR EACH OF 10 MCC/RCC/SDTL COMPLEXES
- DUAL PROCESSORS WITH SHARED DISKS
- DISPLAYS, DISKS, TAPES AND PRINTERS ADDED AS REQUIRED FOR MISSION SPECIFIC NEEDS
- UPGRADE VERTICALLY WITH FASTER HARDWARE; HORIZONTALLY WITH MODULAR HARDWARE AND SOFTWARE
- AVERAGE 5,500 MEGABYTES OF DISK STORAGE PER MCC AND RCC
- EITHER PROCESSOR CAPABLE OF EXECUTING CONTACT SUPPORT FUNCTION
- RAPID SWITCHOVER VIA HOT BACKUP FOR 0.9994 CONTACT SUPPORT MISSION RELIABILITY

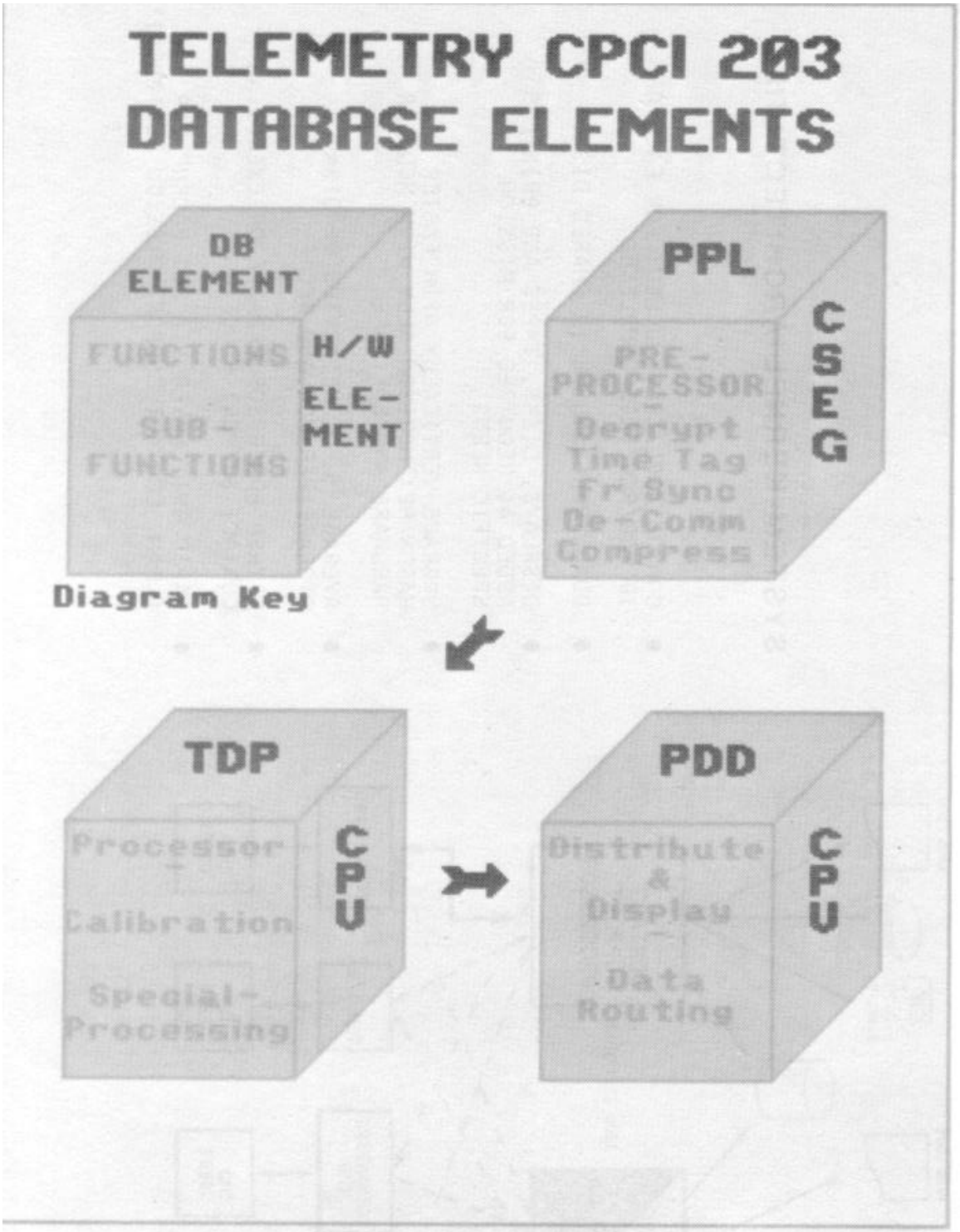

TELEMETRY CPCI 203
DATABASE ELEMENTS
DB
ELEMENT
FUNCTIONS
SUB-
FUNCTIONS
H/W
ELE-
MENT
Diagram Key
PPL
PRE-
PROCESSOR
Decrypt
Time Tag
Fr Sync
De-Comm
Compress
CSEG
TDP
Processor
Calibration
Special-
Processing
CPU
PDD
Distribute
&
Display
Data
Routing
CPU

FIGURE 5

Telemetry Processing

* **TLM Processed to User Defined Needs**
  - Uses TLM High Order Language (THOL)
  - Generates new, & midifies existing functions
  - User friendly (for non-programmers)

* **THOL Helps Define Telemetry Processing**
  - Preprocessing Parameter Loads (PPL)
    (Decommutation & compression operations)
  - Telemetry Data Processing Requests (TDP)
    (Engineering unit conversion, calibration, etc.)
  - Processed Data Distribution (PDD)
    (To displays, other applications, external users, etc)

* **Facilities to Load Manufacturer's Telemetry Descriptions**
  - Wavetrain catalog
  - Measurand catalog

* **TLM Can Be Input From External Source**

* **TLM Can Be Sent to External Users**

* **Supports Alarms Within One Second Of Receipt Of Data**

FIGURE 6