TECHNOLOGY FOR SPACE STATION EVOLUTION –

THE DATA MANAGEMENT SYSTEM

JANUARY 16, 1990
DALLAS, TEXAS

N93-27705

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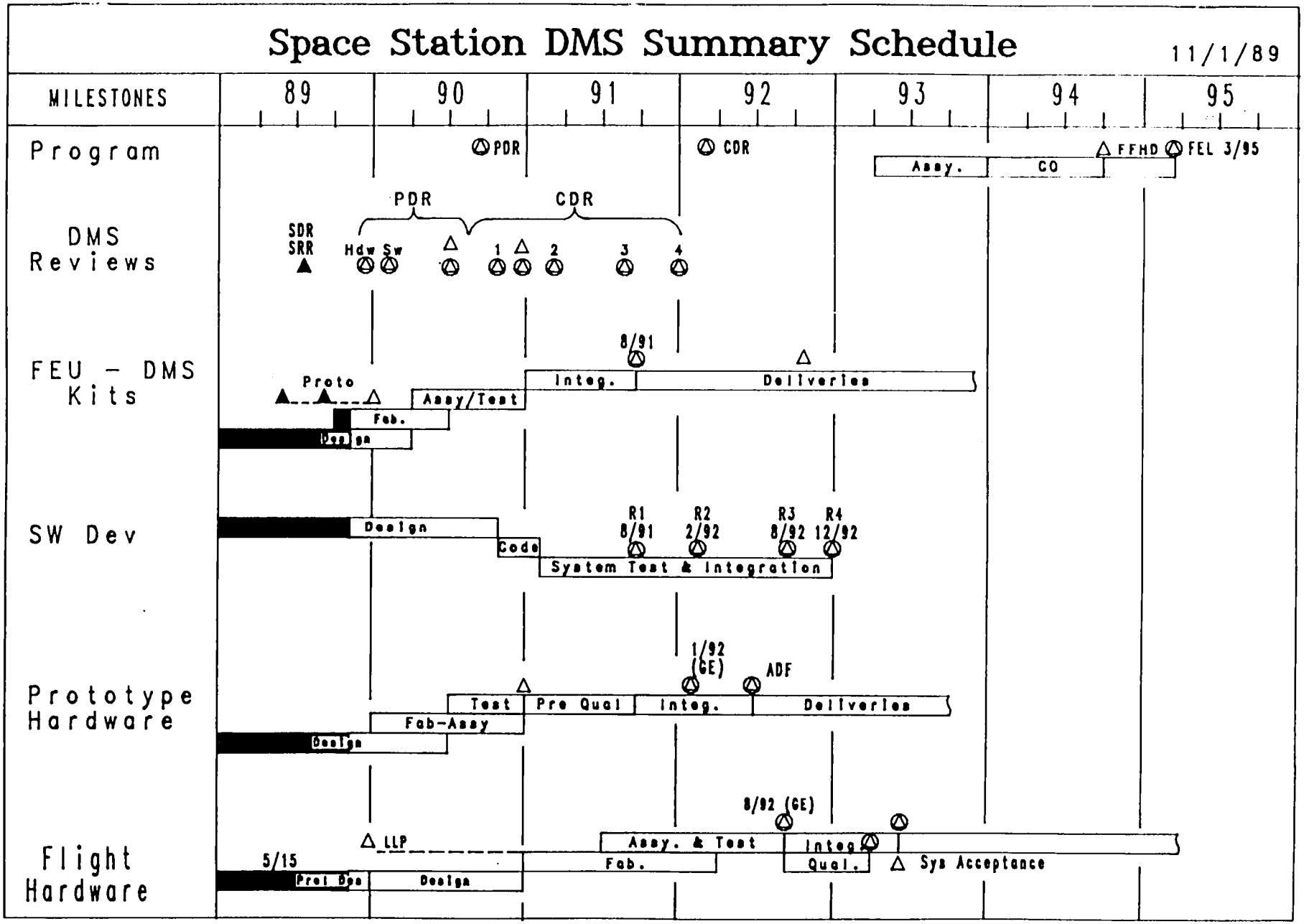
Space Station DMS Summary Schedule
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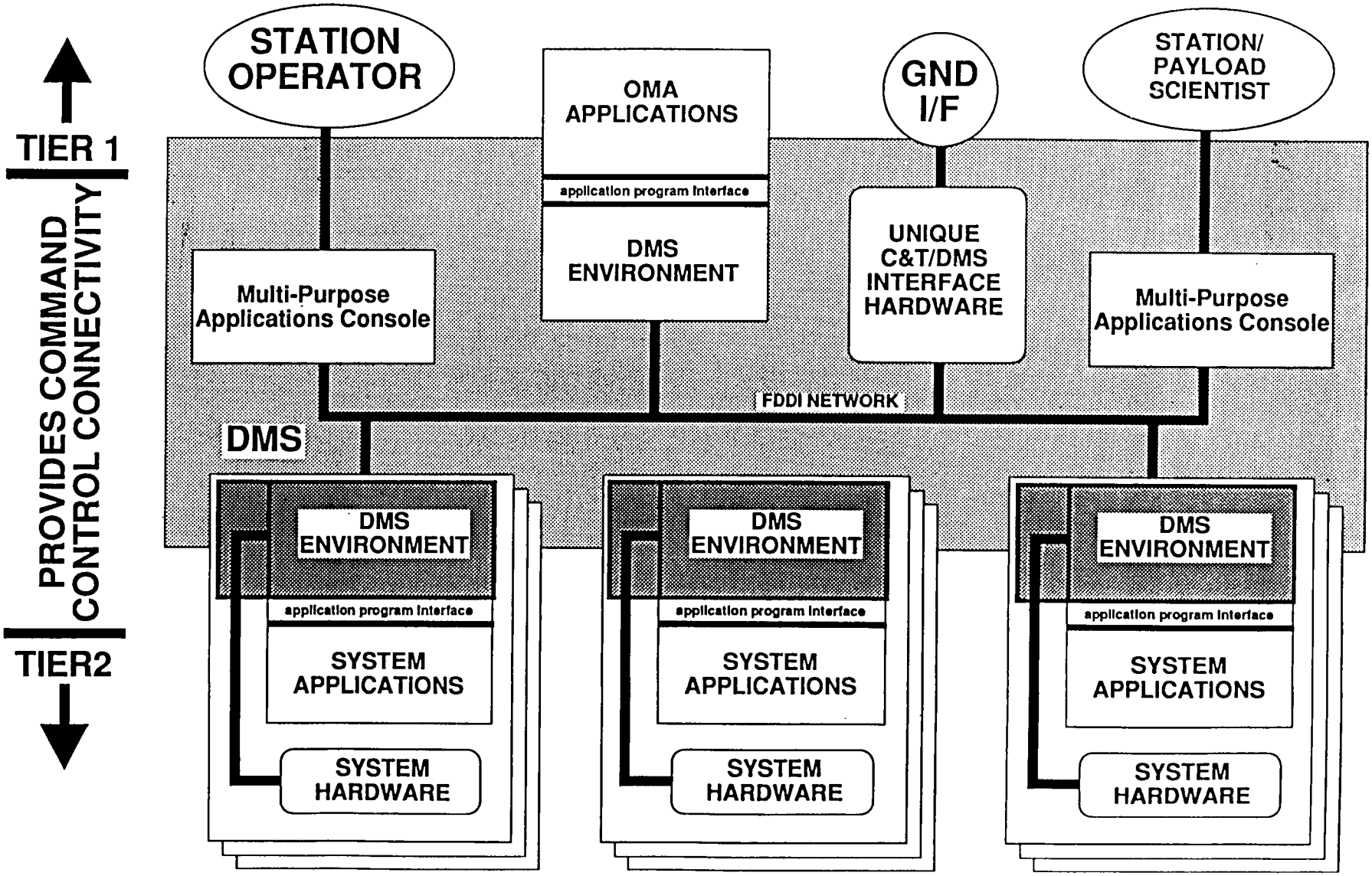
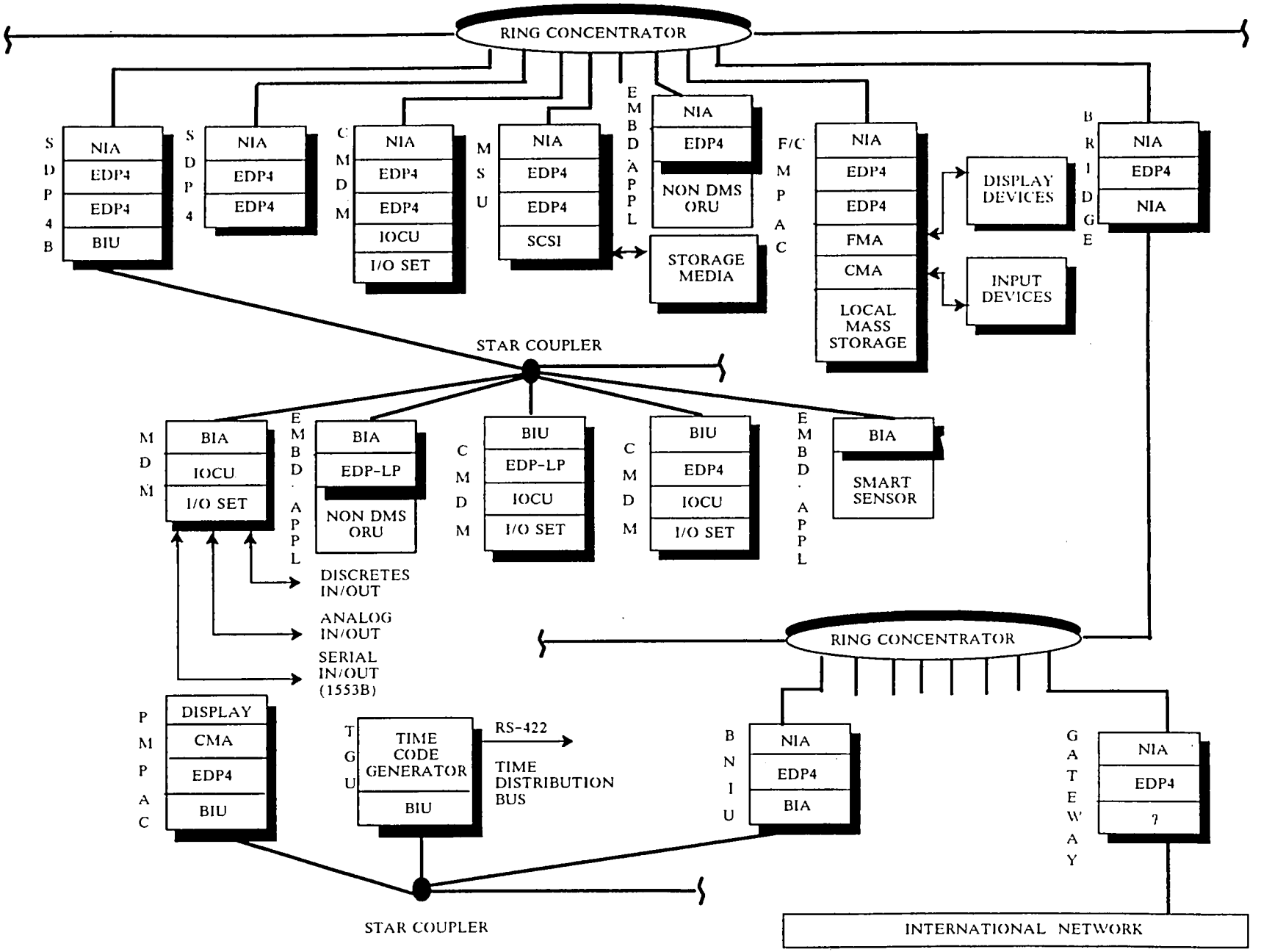
DMS ARCHITECTURE AND IMPLEMENTATION APPROACH

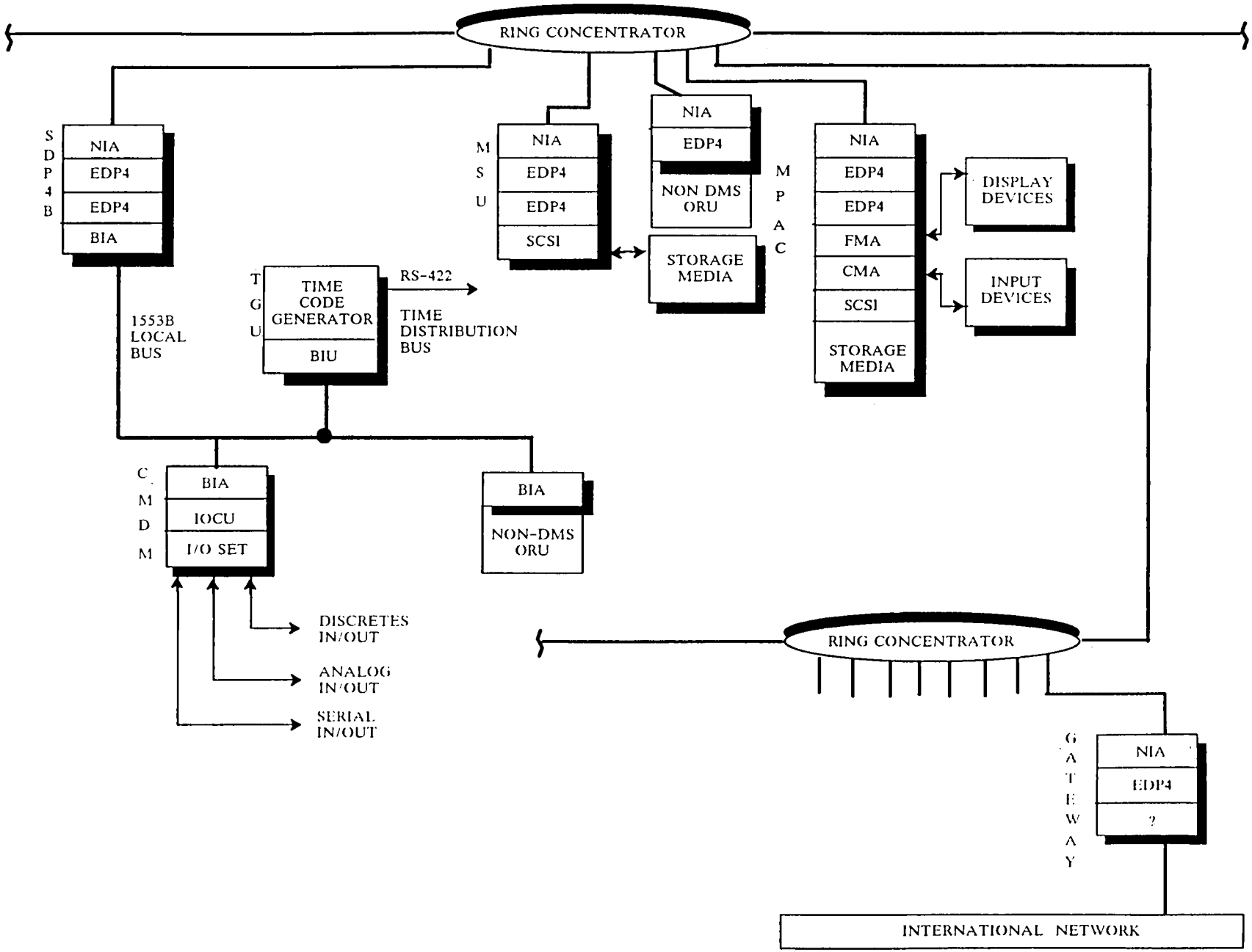
ON-ORBIT ARCHITECTURE



DMS GENERIC ARCHITECTURE (AC)



DMS GENERIC ARCHITECTURE (PMC)



DMS BUILDING BLOCKS

NOMENCLATURE / CHARACTERISTICS	DESCRIPTION
• EMBEDDED DATA PROCESSOR EDP4 (STANDARD) • 4 MEGABYTES MEMORY • 4 MIPS PROCESSING • 28 WATTS POWER CONSUMPTION	• SINGLE CARD GENERAL PURPOSE COMPUTER WHICH PROVIDES THE PROCESSING FUNCTION FOR ALL SPACE STATION FREEDOM HARDWARE CONFIGURATION ITEMS REQUIRING A PROCESSING CAPABILITY.
• EMBEDDED DATA PROCESSOR NIA (STANDARD) • 100 MBPS DATA RATE • 25 WATTS POWER CONSUMPTION	• SINGLE CARD WHICH PROVIDES THE FUNCTIONAL AND PHYSICAL CONNECTION TO THE DMS FDDI (FIBER DISTRIBUTED DATA INTERFACE) OPTICAL NETWORK AND TO THE TGDS (TIME GENERATION AND DISTRIBUTION SYSTEM)
• INPUT OUTPUT CONTROL UNIT IOCU • STANDARD CARD FOR MDM • POWER CONSUMPTION - 7 + WATTS	• STANDARD CARD FOR MDM WHICH PROVIDES PROCESSING CAPABILITY AND CONTROL FUNCTIONS FOR MDM I/O

DMS ARCHITECTURAL COMPONENTS

NOMENCLATURE / CHARACTERISTICS

- STANDARD DATA PROCESSOR

NIA
EDP4
EDP4

SDP 4

- PWR CONSUMPTION ~ 104W
- INTERFACE TO NETWORK
- 4 MEGABYTES MEMORY
- 4 MIPS PROCESSING SPEED
- SOFTWARE SUPPORTED
  - OS/RTE
  - NOS
  - USE
  - DCS
  - DMS SM
  - OMA
  - APPLICATIONS

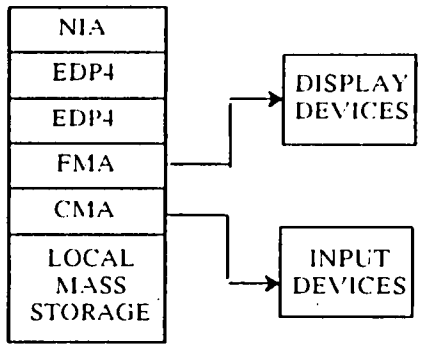
DESCRIPTION

- GENERAL PURPOSE COMPUTER WHICH PROVIDE DATA PROCESSING RESOURCES TO SUPPORT CONTROL AND MANAGEMENT OF INTEGRATED STATION FUNCTIONS AND COMMAND AND CONTROL FUNCTIONS REQUIRED BY SYSTEMS, ELEMENTS, AND PAYLOADS.
- PROVIDES INTERFACE TO DMS GLOBAL NETWORKS

DMS ARCHITECTURAL COMPONENTS

NOMENCLATURE / CHARACTERISTICS

- FIXED OR CUPOLA MULTIPURPOSE APPLICATION CONSOLE (MPAC)



FMPAC OR CMPAC

- FMPAC POWER CONSUMPTION 1638 WATTS
- CMPAC POWER CONSUMPTION 969 WATTS
- FMA (FIXED MPAC ADAPTOR) DRIVES DISPLAYS
- CMA (COMMON MPAC ADAPTOR) DRIVES INPUT DEVICES
- SUPPORTS LOCAL MASS STORAGE 30 MBYTES FIXED, 1.4 MBYTES REMOVABLE
- SOFTWARE SUPPORTED
  - SAME AS SDPR
  - PLUS?

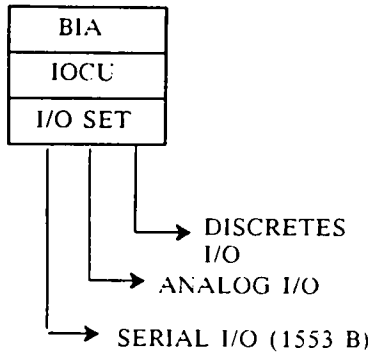
DESCRIPTION

- PROVIDES ELECTRONIC INTERFACE BETWEEN APPLICATION PROGRAMS AND ONBOARD OPERATORS. USED FOR OPERATIONAL CONTROL AND MONITORING, TRAINING, TESTING, CAUTION & WARNING ANNUNCIATION AND CREW SERVICES.
- SUPPORTS VISUAL AND LOGICAL ASPECTS OF HUMAN COMPUTER INTERFACE USING USE SOFTWARE.

DMS ARCHITECTURAL COMPONENTS

NOMENCLATURE / CHARACTERISTICS

- MULTIPLEXER/DEMULTLIPLEXER (MDM)



MDM

- PROVIDES CHASSIS WITH STANDARD BACKPLANE INTO WHICH I/O SETS CAN BE PLUGGED TO PERFORM REQUIRED TASKS
- 10 STANDARD CARDS ARE CURRENTLY DEFINED.
- POWER CONSUMPTION:
  - IOCU CARD - 7 WATTS
  - TEMP/PRESS/ANALOG - 4 WATTS
  - ANALOG INPUTS (32) - 2 WATTS
  - ANALOG OUTPUTS (4) - 2 WATTS
  - ANALOG OUTPUTS (16) - 4 WATTS
  - 5V DISCRETE INPUTS - 1 WATT
  - 5V DISCRETE OUTPUTS - 3 WATTS
  - SOLENOID DRIVER - TBD
  - SERIAL I/O - TBD
  - MIL STD 1553B BCU - TBD
- CAN ALSO ACCEPT USER CARDS THAT SATISFY STANDARD BACKPLANE INTERFACE
- SOFTWARE SUPPORTED – NONE

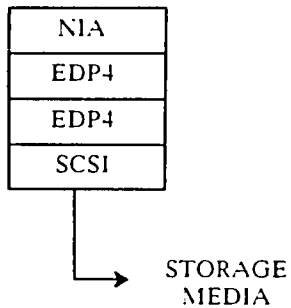
DESCRIPTION

- PROVIDES INTERFACE TO SENSOR AND EFFECTORS.
- COLLECTS, REFORMATS TO DIGITAL WORDS, MULTIPLEXES AND TRANSMITS SENSOR DATA.
- RECEIVES COMMAND WORDS, DEMULTIPLEXES. ISSUES COMMANDS

DMS ARCHITECTURAL COMPONENTS

NOMENCLATURE / CHARACTERISTICS

- MASS STORAGE UNIT (MSU)



- PROVIDES INTERFACE TO MAIN DMS NETWORK VIA NIA AND EDP4
- LOCAL PROCESSING CAPABILITY IN EDP4
- ALSO PROVIDES SCSI (SMALL COMPUTER SYSTEMS INTERFACE) TO STORAGE MEDIA WITH MODULAR DESIGN TO ALLOW EASY UPGRADE
- CURRENT STORAGE MEDIA IS 250 MBYTES HARD DISK
- POWER CONSUMPTION IS ~ 104 WATTS FOR MSU PLUS - TBD WATTS FOR STORAGE MEDIA
- SOFTWARE SUPPORTED
  - -OS/RTE
  - -NOS
  - -DCS
  - -APPLICATIONS

DESCRIPTION

- PROVIDES MASS STORAGE FOR CORE AND PAYLOAD USES
- UTILIZES DIRECT ACCESS, NONVOLATILE MAGNETIC DISK MEMORY
- PROVIDES THE PROCESSING, INSTRUCTIONS, MEMORY AND I/O CAPABILITIES TO RECEIVE INPUT INFORMATION, MANIPULATE THE INFORMATION UNDER INTERNAL STORED PROGRAMS AND PROCESS THE DATA FOR STORAGE

DMS ARCHITECTURAL COMPONENTS

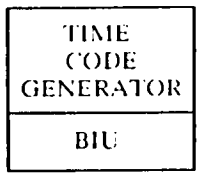
NOMENCLATURE / CHARACTERISTICS		DESCRIPTION
• EMBEDDED APPLICATIONS		
NIA EDP4 NON DMS ORU	• PROVIDES CONNECTIVITY TO 100 MBPS NETWORK • DMS PART OF POWER CONSUMPTION = 53 WATTS • SOFTWARE -SUBSET OF NOS	• PROVIDES STANDARD FUNCTIONAL AND PHYSICAL INTERFACE BETWEEN THE DMS 100 MBPS OPTICAL NETWORK AND A NON DMS PROCESSOR.
BIA SMART SENSOR	• PROVIDES CONNECTIVITY TO 10 MBPS LOCAL BUS – LAYERS 1 AND 2 ONLY • DMS PART OF POWER CONSUMPTION - 4 WATTS • SOFTWARE – NONE	• PROVIDES PHYSICAL LAYER (LAYER 1) AND MEDIUM ACCESS CONTROL SUBLAYER (PARTIAL LAYER 2) PROTOCOLS BETWEEN DMS 10 MBPS LOCAL BUS AND AN INTELLEGENT HARDWARE APPLICATION.
• GATEWAY (GW)		
NIA EDP4 ?	• CONNECTS 100 MBPS OPTICAL NETWORK WITH NON DMS NETWORK. • U.S. PORTION OF POWER CONSUMPTION - 80 WATTS • RECEIVES & DISTRIBUTES TIME INFORMATION TO NON DMS NETWORK	• THE GATEWAY PROVIDES CONNECTIVITY BETWEEN A DMS OPTICAL NETWORK AND A NON DMS NETWORK. GW TERMINATES U.S. PROTOCOLS AT ISO/OSI LAYER 2 AND PROVIDES A STANDARD LAYER 3 INTERFACE. NON-U.S. DMS CARDS MUST INTERFACE AT LAYER 3. • IT MAY BE POSSIBLE TO UTILIZE THE DMS BNIU TO PROVIDE THIS FUNCTION IF SUFFICIENT AGREEMENTS CAN BE REACHED WITH THE INTERNATIONAL PARTNERS

DMS ARCHITECTURAL COMPONENTS

NOMENCLATURE / CHARACTERISTICS

DESCRIPTION

- TIME GENERATION UNIT (TGU)



- CCCSDS SEGMENTED CODE
- ACCURATE TO + 10 MICROS
- POWER CONSUMPTION - 30 WATTS

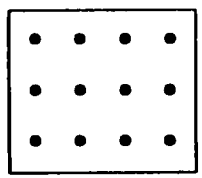
- THE TIME GENERATION UNIT IS THE PRECISION TIME AND FREQUENCY SOURCE FOR ALL SPACE STATION FREEDOM SYSTEMS AND PAYLOADS. CONVERSION TO A CONTINUOUS UNSEGMENTED CODE PROVIDED BY DMS AT DESIGNATED PROCESSORS. TWO TGU'S AND THE TDB CONSTITUTE TGDS.

- RING CONCENTRATOR

- EIGHT ATTACHMENT PORTS
- OPTICAL SIGNAL REGENERATION
- POWER CONSUMPTION - 7 WATTS

- THE RING CONCENTRATOR PROVIDES THE CONNECTIVITY FOR ALL NIU'S INTERFACING TO THE DMS OPTICAL NETWORKS. THE RC PROVIDES SWITCHING MECHANISM TO CONNECT OR BYPASS AN ORU.

- PATCH PANEL



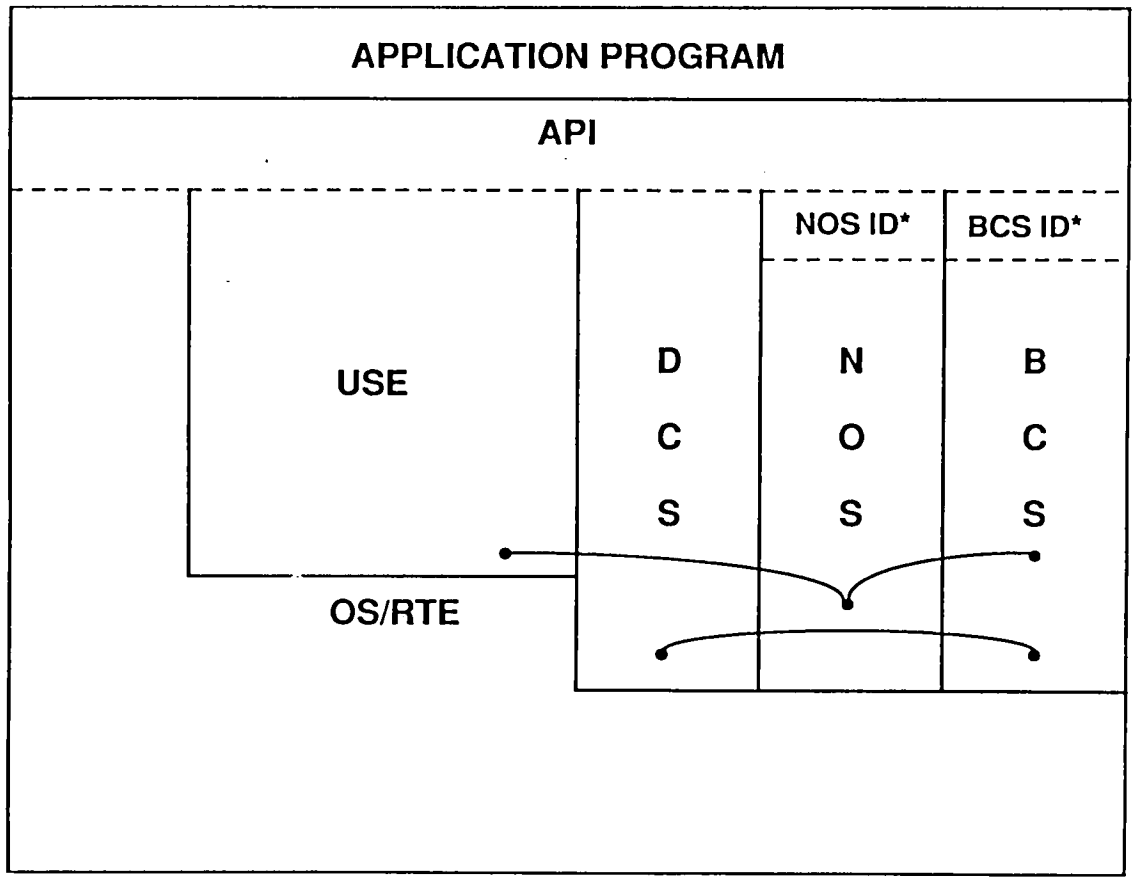
- PASSIVE DEVICE
- MANUAL OPERATION
- PROVIDES 192 PORTS
  - -32 OF WHICH PROVIDE DATA AND CONTROL FLOW TO THE C & T SIGNAL PROCESSOR (SP) (8 PORTS EACH SP, SPARE DUPLEXED FOR REDUNDANCY

- THE PATCH PANEL PROVIDES CAPABILITY FOR MANUAL SELECTION OF CONNECTIVITY FOR THE HIGH RATE FIBER OPTIC LINKS. THE PANEL IS TRANSPARENT TO BOTH THE DIRECTION AND THE FORMAT OF THE DATA.

DMS SUMMARY

BASELINE CONTENT	REBASELINE	
	PMC	AC
Distributed Architecture	More Centralized Architecture	More Distributed Architecture
Distributed Processing at Local Bus Level	Limited Processing at Local Bus Level	Increased Processing Capability at Local Bus Level
Two Types of Local Bus Capability	One Local Bus Type	Add High Performance Local Bus
Separate Payload and Core Networks	Payload & Core Networks Shared	Separate Payload and Core Bus
New Tech Displays	Use Existing Display Technology	Upgrade Displays
8 High Rate P/L Link (0 – 100 MBPS)	3 High Rate Links (0 – 100 MBPS) ZOE Recording for Core Data	8 (0 – 100 MBPS)
HARDWARE QTY:	HARDWARE QTY:	HARDWARE QTY:
SDP – 29	SDP – 16	SDP – 28
EDP – 216	EDP – 0	EDP – 0
MDM – C – 12	MDM – C – 59	MDM – C – 87
MDM – 117	MDM – 0	MDM – 81
Bridge – 3	Bridge – 0	Bridge – 3
RC – 42	RC – 18	RC – 44

DMS SOFTWARE SERVICES ARCHITECTURE



API	(Application Program Interface)
OS/RTE	(Operating System/Ada Runtime Environment)
NOS	(Network Operating System)
BCS	(BUS Control System)
DCS	(Data and Command Services)
USE	(User Support Environment)

***Interface Exposed to Embedded NIU or BIU in Non DMS Processor**

DMS SOFTWARE SERVICES

NOMENCLATURE / CHARACTERISTICS

- OPERATING SYSTEM/ADA RUNTIME ENVIRONMENT

OS/RTE

- TWO PERFORMANCE CATEGORIES
  - PROCESS CONTROL
  - INFORMATION PROCESSING
- FUNCTIONS
  - INITIALIZATION
  - PROCESS MANAGEMENT
  - MEMORY MANAGEMENT
  - PROCESS COMMUNICATION
  - TIME SERVICE
  - INPUT/OUTPUT MANAGEMENT
  - FILE MANAGEMENT
  - ADA RUNTIME ENVIRONMENT EXTENSIONS
  - PRIVACY AND SECURITY
  - MONITOR SERVICES
  - FDIR AND RM FOR PROCESSORS AND I/O

DESCRIPTION

- PROVIDES MANAGEMENT, ALLOCATION, AND DEALLOCATION OF THE CPU, MEMORY, SYSTEM CLOCK, AND I/O DEVICE PROCESSING RESOURCES AND PROVIDES NETWORK TRANSPARENT INTERFACES FOR APPLICATION TO APPLICATION COMMUNICATIONS.

DMS SOFTWARE SERVICES (CONT)

NOMENCLATURE / CHARACTERISTICS

- NETWORK OPERATING SYSTEM

NOS

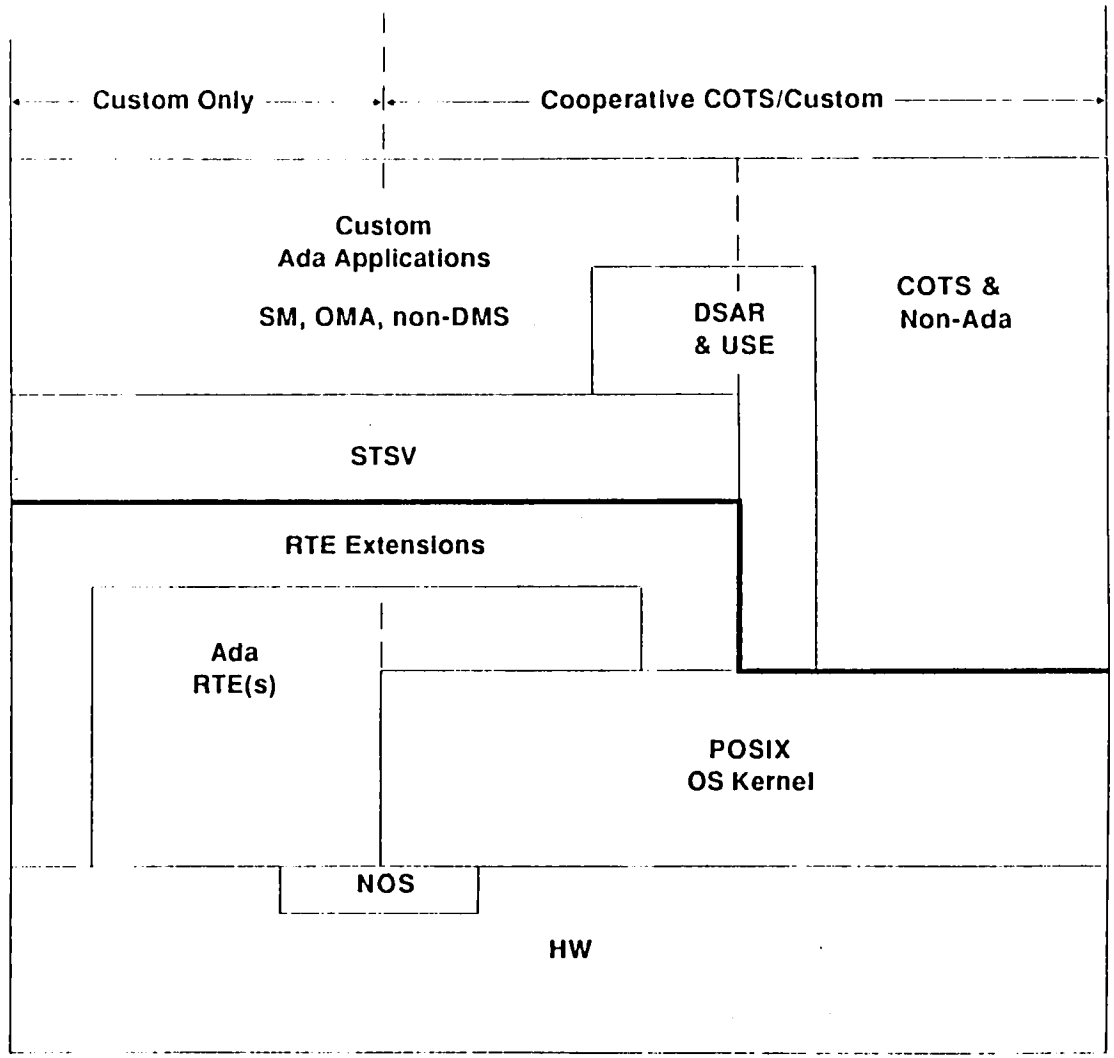
- MESSAGING SERVICES
  - CONNECTION ORIENTED
  - CONNECTIONLESS
  - BROADCAST
  - MULTICAST
  - POINT TO POINT
- SUPPORTS
  - PRIORITIZATION
  - TIME TAGGING
  - GRADE OF SERVICE
  - SECURITY & PRIVACY
  - NETWORK MANAGEMENT
  - FDIR

DESCRIPTION

- PROVIDES NETWORK COMMUNICATION FUNCTIONS FOR SYSTEMS, ELEMENTS, AND PAYLOADS PERFORMING ALL OF THE FUNCTIONS REQUIRED FOR TRANSPARENT TRANSMISSION OF USER DATA ACCROSS THE DMS NETWORK. SERVICES PROVIDED ARE LISTED IN TABLE 3.4.1.1.2.-1 OF SSP 30261, PART 3, REV D DRAFT.

DMS SOFTWARE SERVICES (CONT)

NOMENCLATURE / CHARACTERISTICS		DESCRIPTION
• NOMENCLATURE/FUNCTION		
DCS	• SENSOR DATA PROCESSING • DATA AND COMMAND DISTRIBUTION • DATA DICTIONARY • ARCHIVE MANAGEMENT • CHECKPOINT MANAGEMENT • STRUCTURED FILE SERVICE • PRIVACY AND SECURITY • DATA REDUNDANCY SERVICES • INSTRUMENTATION SERVICES • LOCAL PROCESS CONTROL	• PROVIDES DATA HANDLING SERVICES WHICH ARE COMMON ACROSS MULTIPLE SYSTEMS AND ELEMENTS
USE	• SOFTWARE SUPPORT FOR MPAC I/O DEVICE • STATIC & DYNAMIC DISPLAYS • WINDOWED VIDEO IMAGES DISPLAYS • WINDOWED C&W DISPLAYS • PROCEDURAL, ENGLISH-LIKE USER INTERFACE LANGUAGE (UIL) • REMOTE TERMINAL SERVICE • ACCESS AUTHORIZATION	• THE DMS USE PROVIDES THE ONBOARD RUNTIME ENVIRONMENT SERVICES WHICH ARE A SUBSET OF THE DEVELOPMENT TOOLS AND RUNTIME ENVIRONMENT DEFINED FOR THE SSIS HCI (HUMAN COMPUTER INTERFACE) SERVICES FOR GROUND AND ONBOARD.



DMS Software Layering

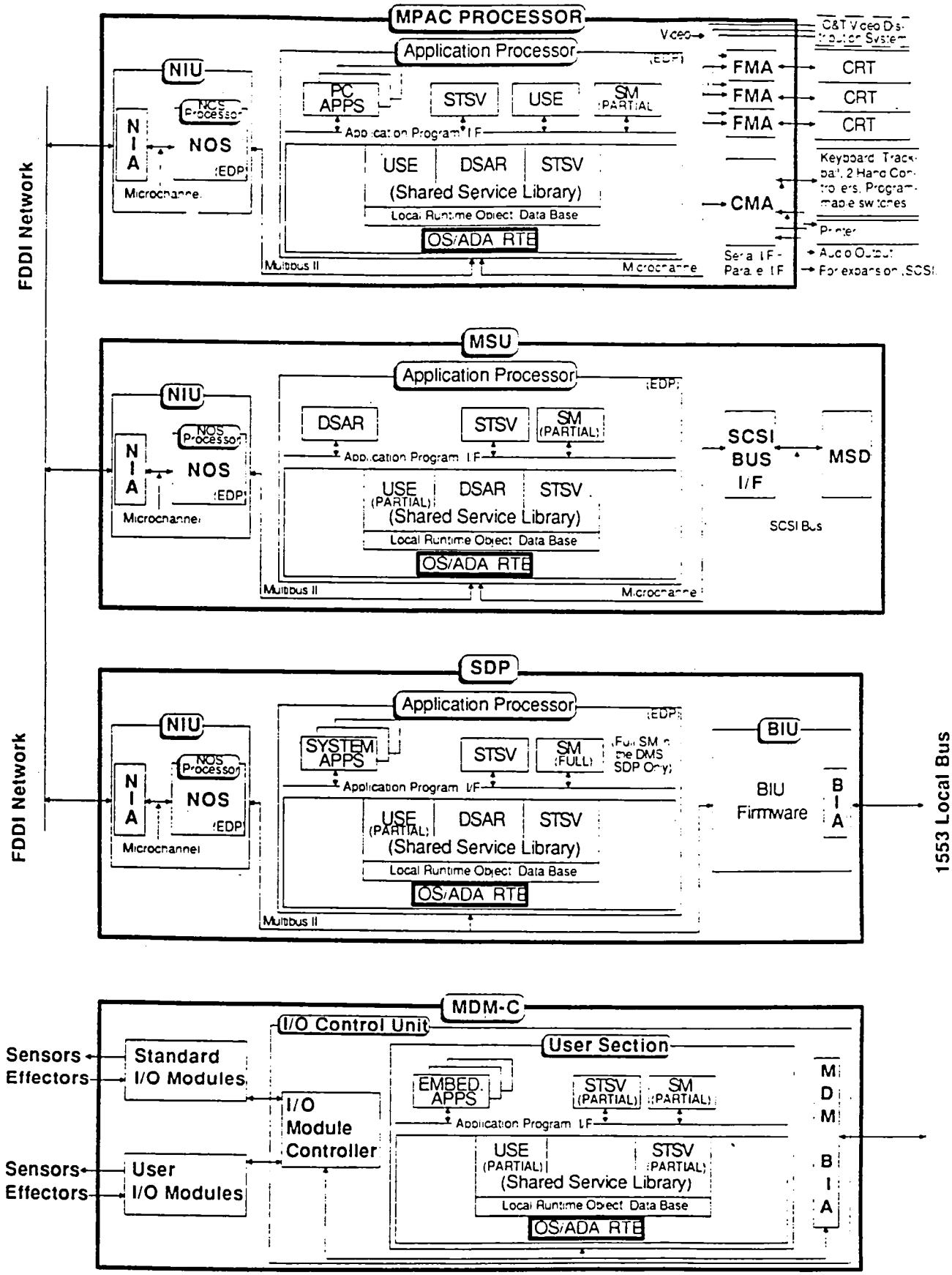
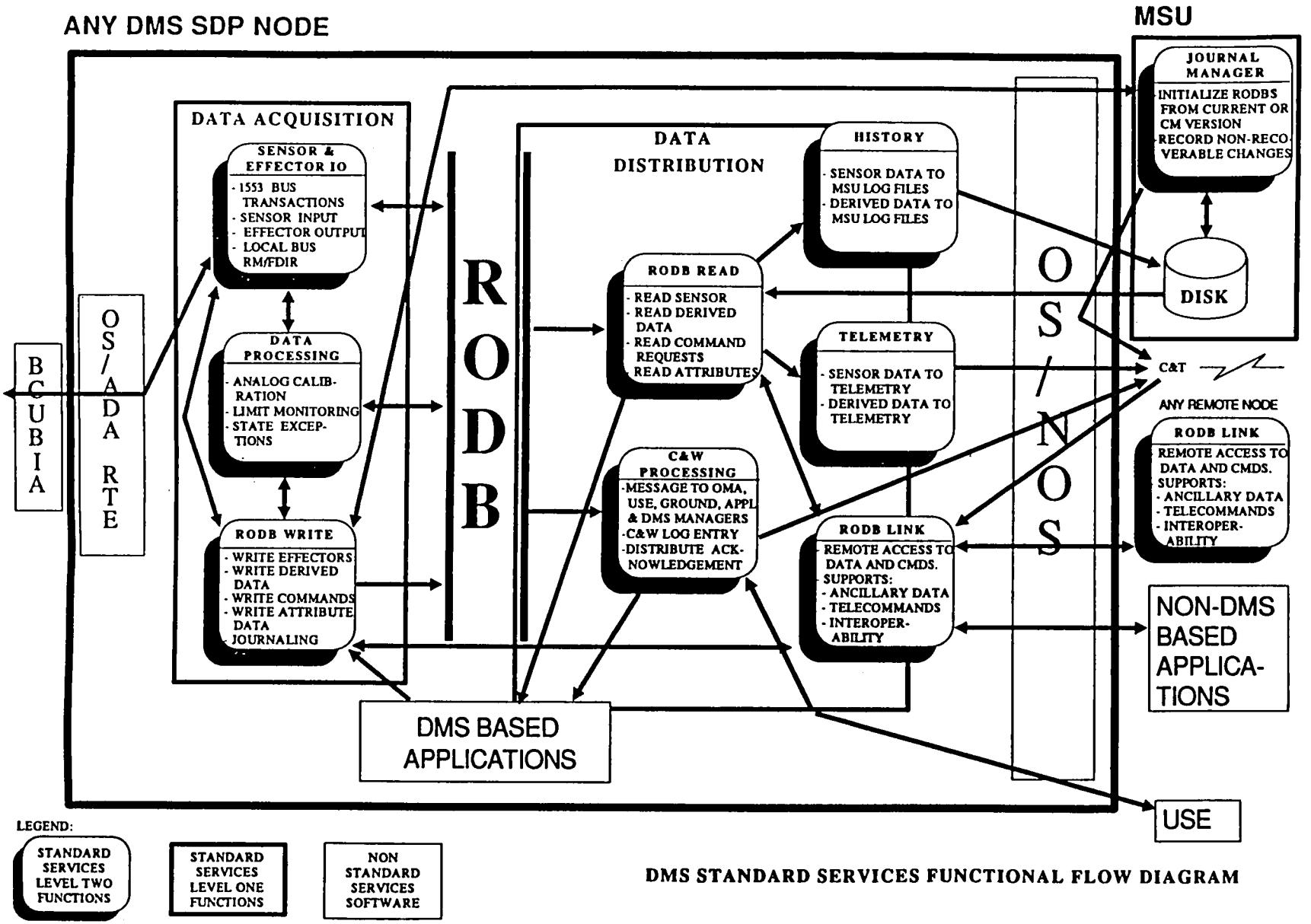
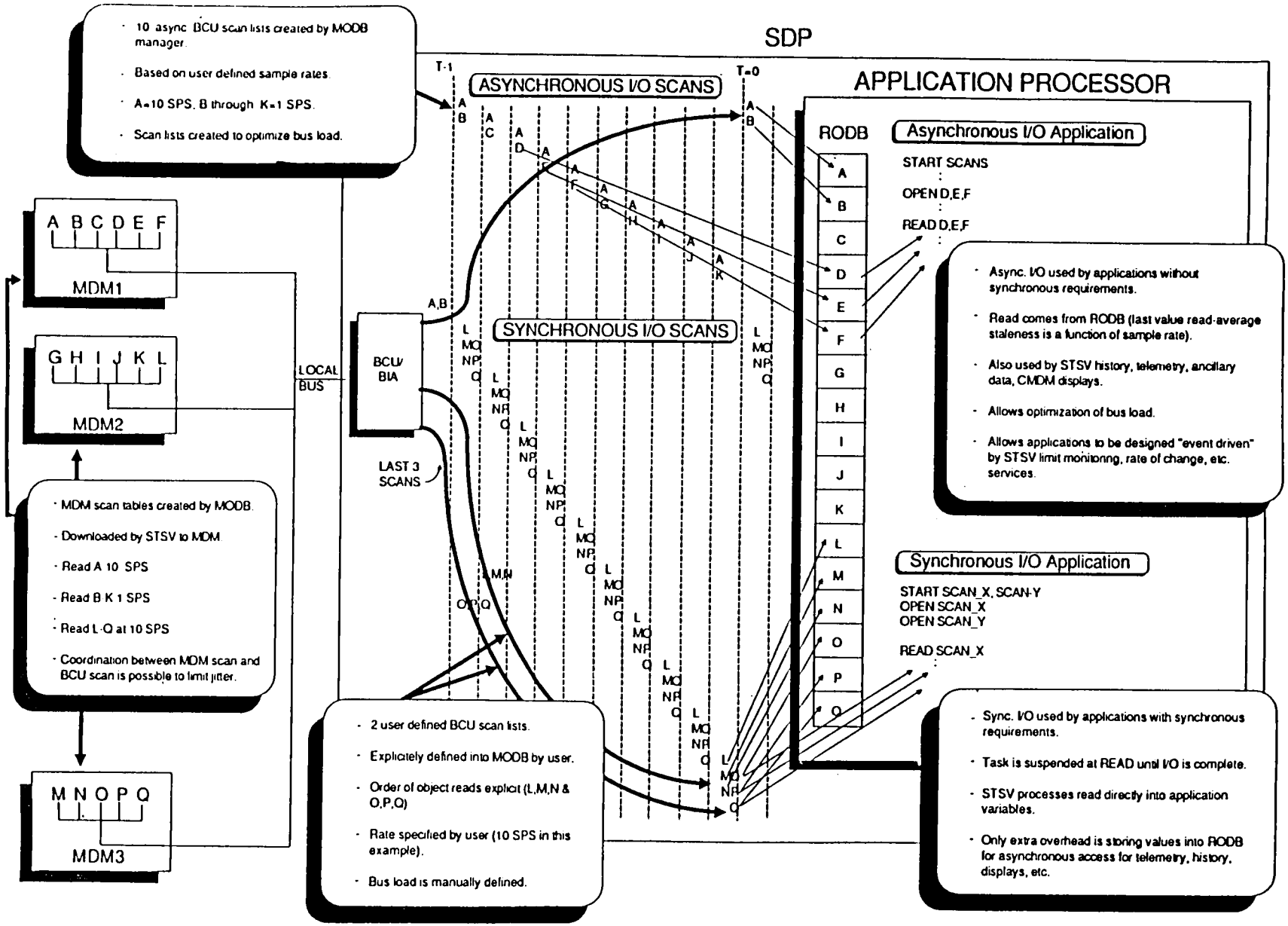


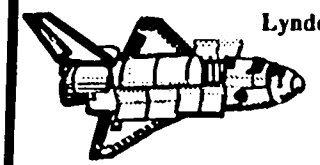
FIGURE 4.0-2. DMS Architecture Model



DMS STANDARD SERVICES FUNCTIONAL FLOW DIAGRAM



SYNCHRONOUS AND ASYNCHRONOUS I/O STANDARD SERVICES SCENARIO



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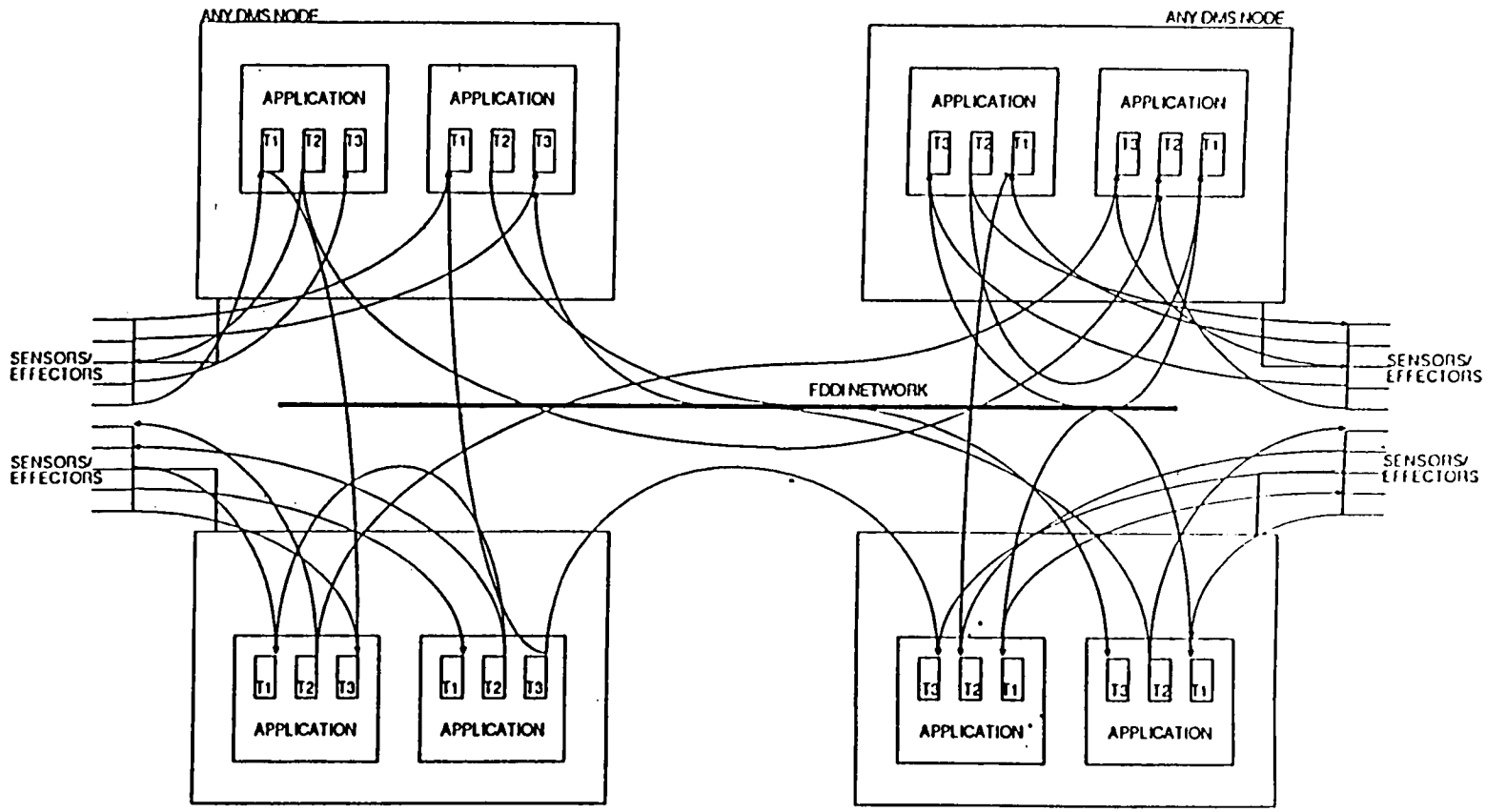
SPACECRAFT
SOFTWARE
DIVISION

OVERVIEW OF THE RUNTIME OBJECT DATABASE

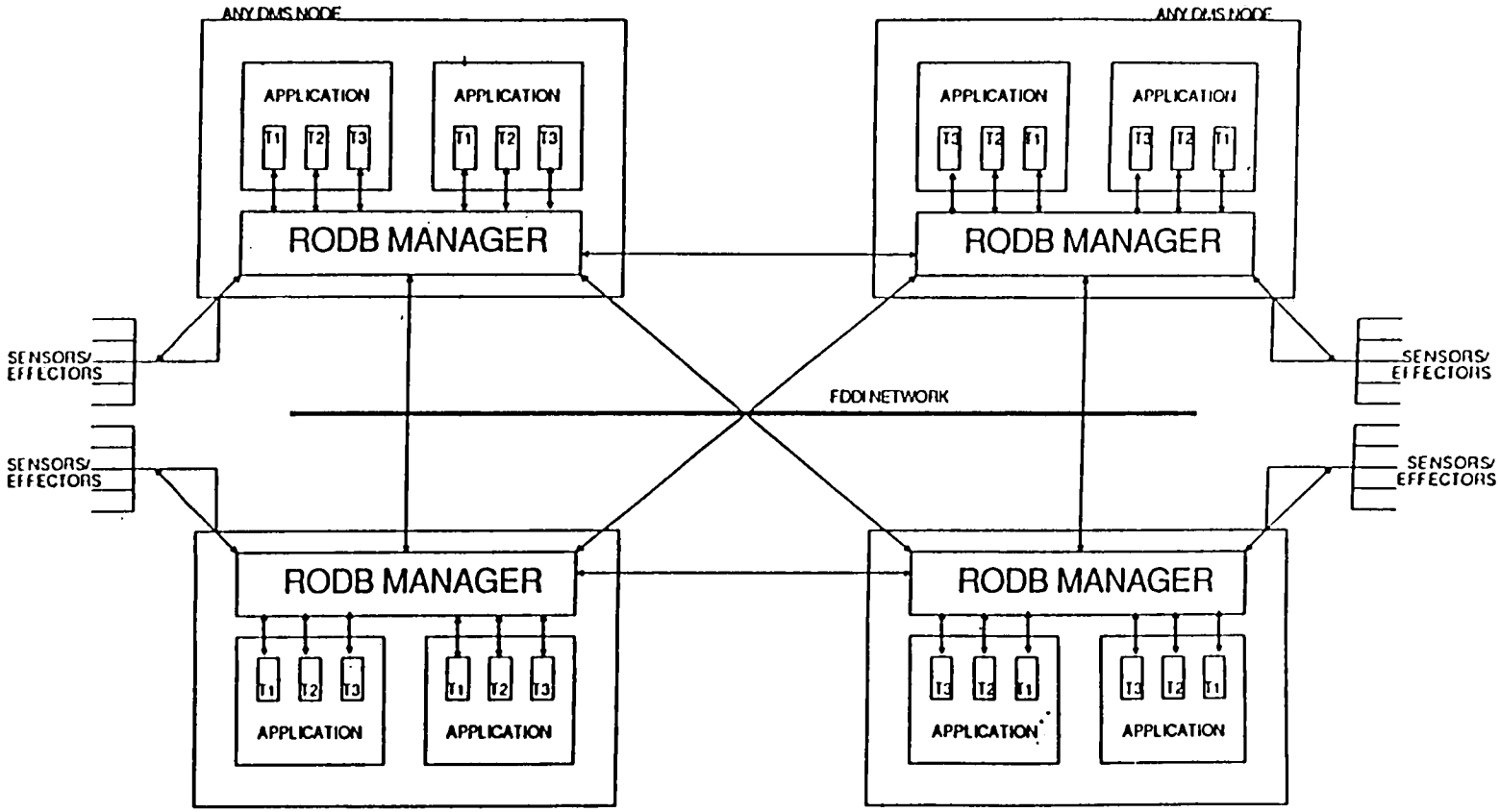
GENERAL COMMAND AND CONTROL DATA FLOW MODE - CHAOS



COMMAND AND CONTROL WITHOUT RODB/MODB CONCEPT WOULD MEAN:

- IPC MECHANISM FOR TASK TO TASK COMMUNICATION (PRIVATE ICDs FOR ABOVE LINES)
- NO COMMON, SYSTEM-WIDE APPROACH TO COMMAND AND CONTROL FROM OMA, DISPLAYS, GROUND
- NO COMMON, SYSTEM-WIDE APPROACH TO COMPLEXITIES OF COMMUNICATIONS
- MANUAL OVERRIDE (FROM MPAC OR GROUND) IS A NIGHTMARE OF ICD RESOLUTIONS
- IT&V WOULD BE A NIGHTMARE OF PRIVATE IPC VERIFICATION
- NO DRIVING FORCE BEHIND COMMON DATA REPRESENTATION

RODB COMMAND AND CONTROL DATA FLOW MODEL - ORDER



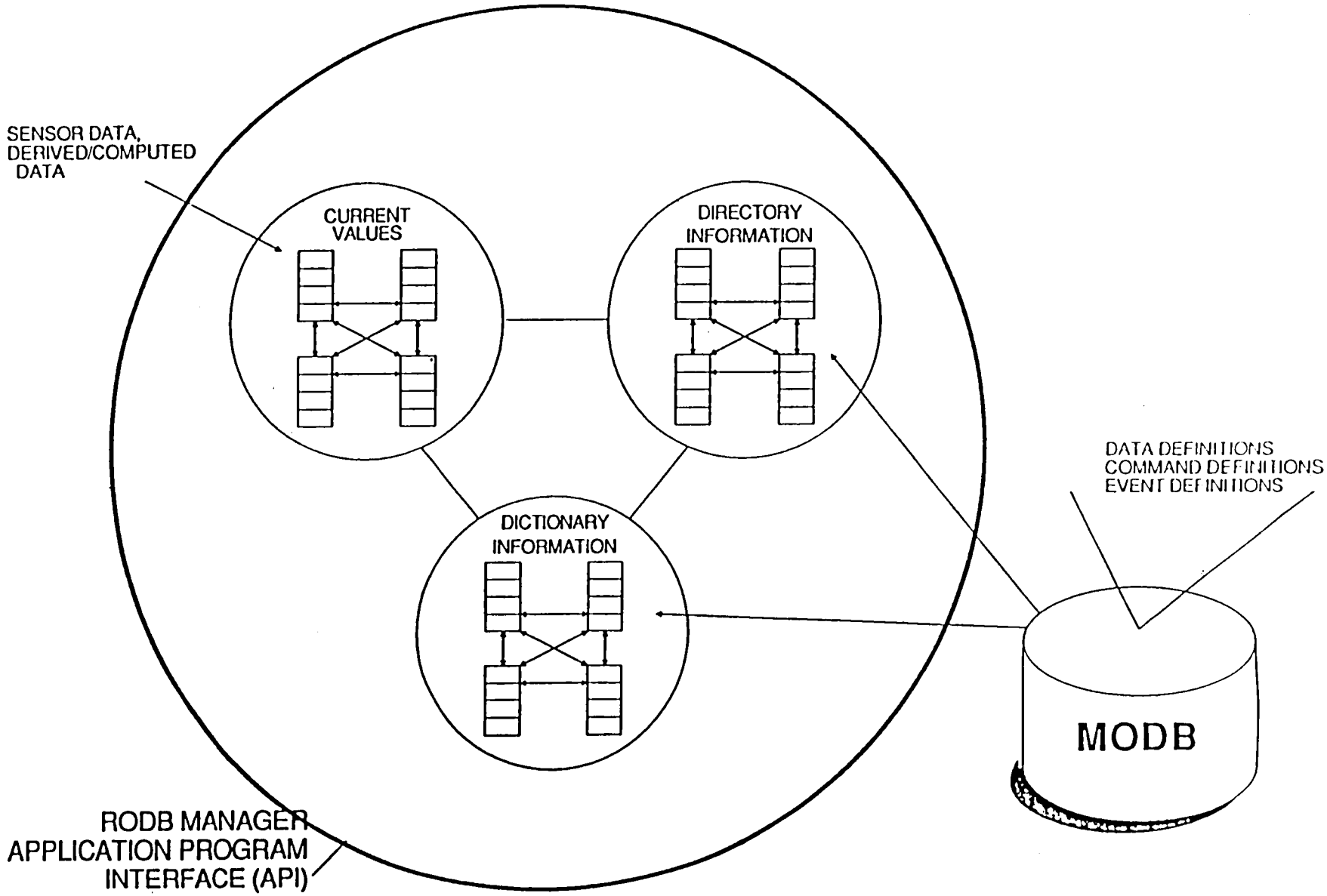
COMMAND AND CONTROL WITH RODB/MODB CONCEPT WOULD MEAN:

- ONE DMS ENGINEERED, SYSTEM-WIDE APPROACH TO COMMAND AND CONTROL
- EFFECTIVE, CONSISTENT USE OF COMMUNICATION SERVICES BY ALL APPLICATIONS
- MODB/RODB IS LIKE AN AUTOMATED ICD FOR THE WHOLE SYSTEM
- EFFECTIVE ENVIRONMENT FOR CREW COMMAND AND CONTROL DISPLAYS FOR NORMAL OPERATIONS AS WELL AS TROUBLE SHOOTING & MANUAL OVERRIDE
- EFFECTIVE ENVIRONMENT FOR IT&V OF FLIGHT HARDWARE AND SOFTWARE
- COMMON DATA REPRESENTATIONS ACROSS ALL APPLICATIONS

Definitions

- RODB
  - Isolates applications from the effects of data request changes resulting from:
    - Crew user interface
    - Space/ground telemetry/command
  - Provides standard services to applications for sensor/effector related processing
  - Requires applications to make data global for visibility
  - Runtime online data base
  - Contains directory, dictionary, and current values of objects
  - Contains a subset of the data in the MODB

THE RODB AS THREE KINDS OF INFORMATION



Object Definition Model

- Three parts:

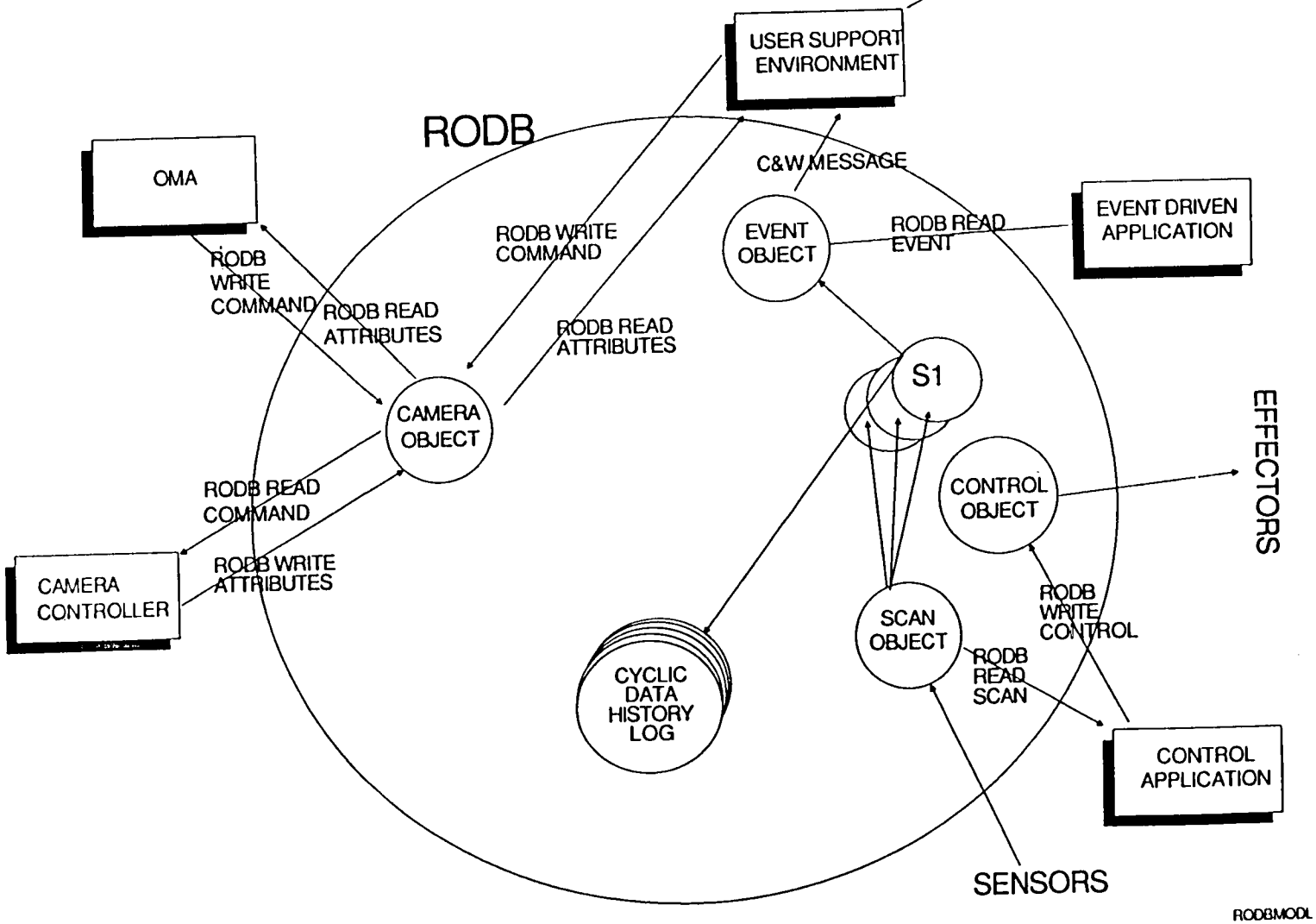
  1. Description of the object (at a position in the hiererchy)

  2. Attributes of the object:
     - → Descriptions
     - → Names
     - → Constraints
     - → RODB and MODB information

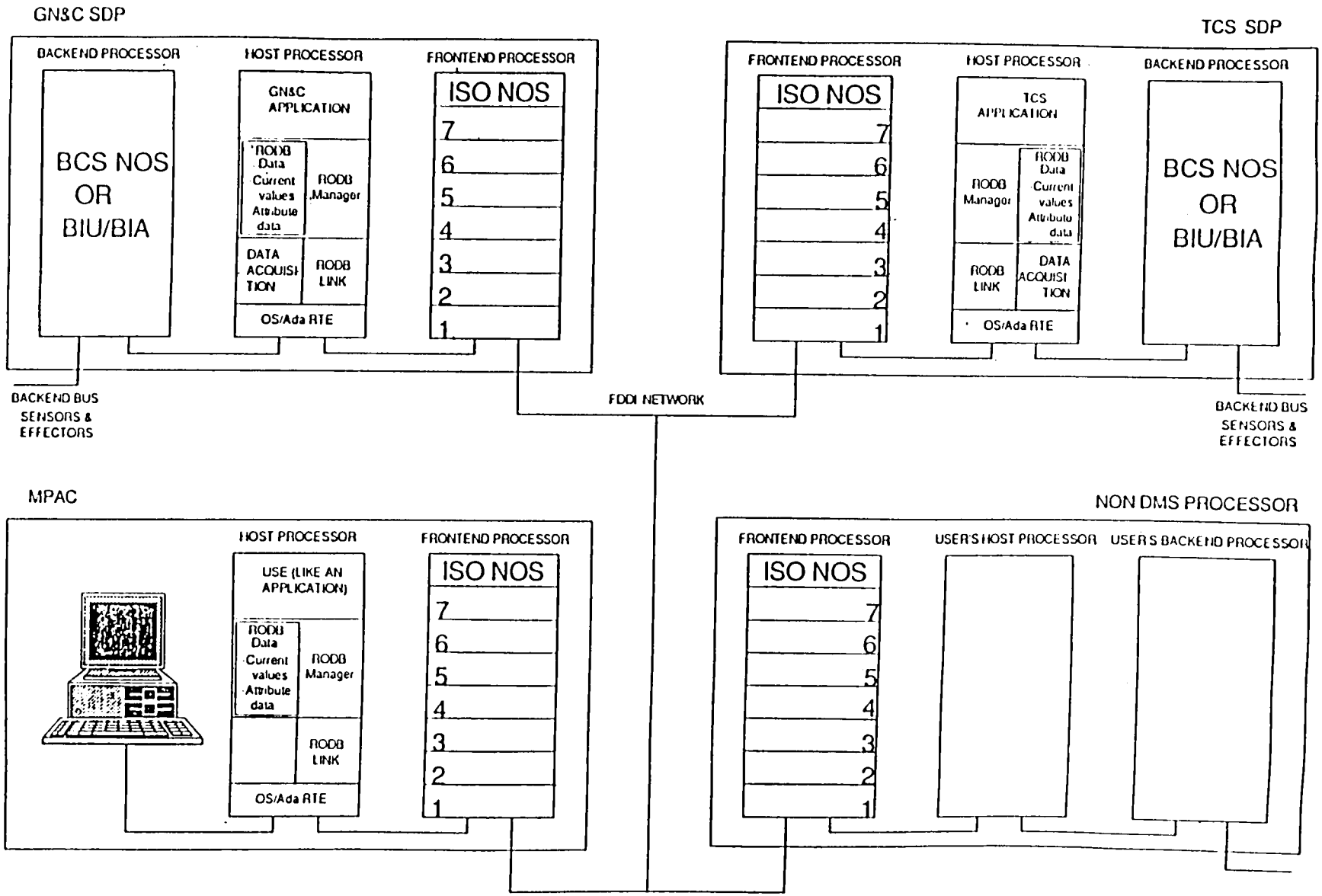
  3. Actions on the object:
     - → Descriptions
     - → Names
     - → Parameters
     - → Completion codes
     - → Timeouts

General RODB Model

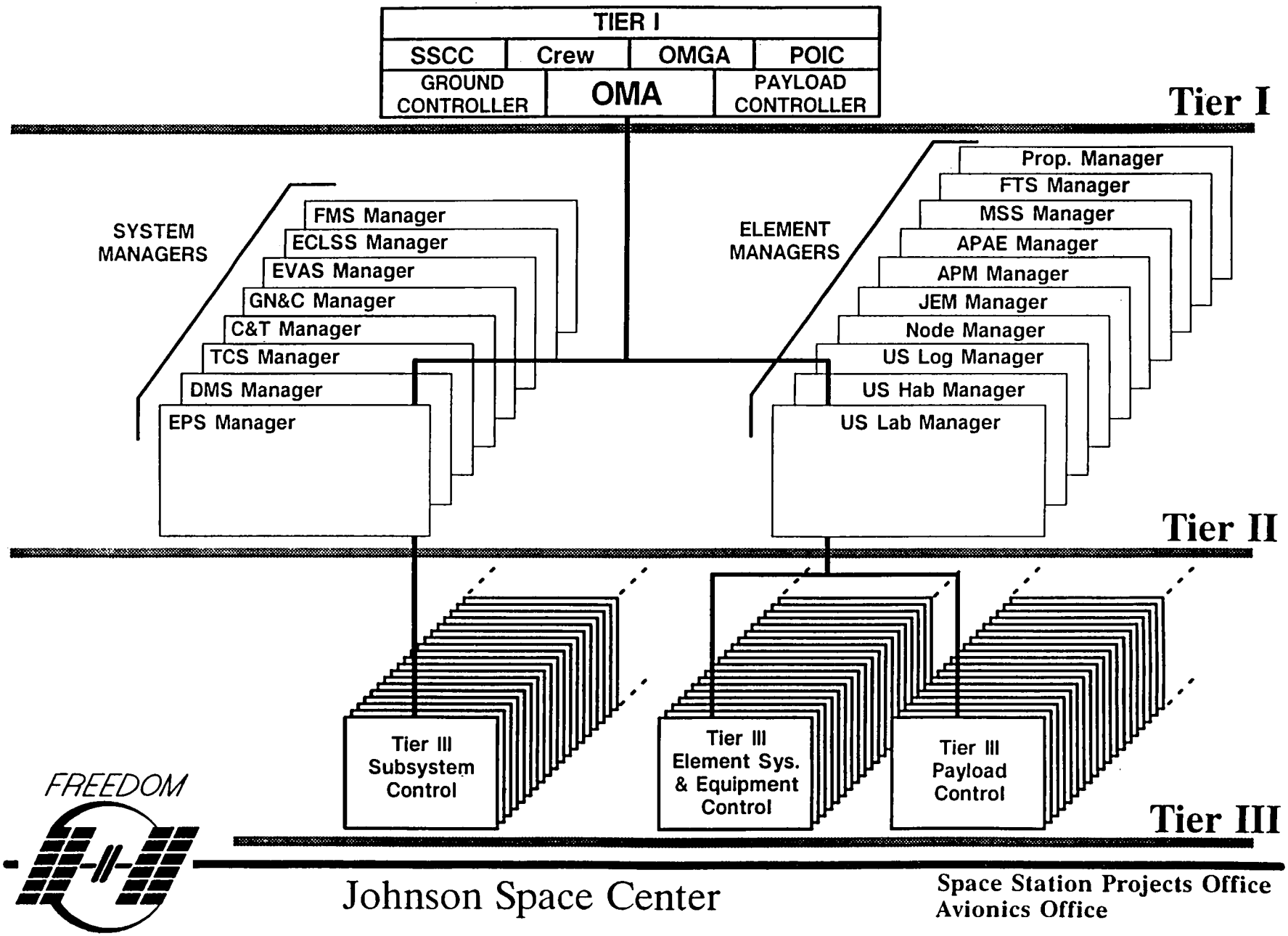
DMS



RODB NODE MODEL



COMMAND & CONTROL HIERACHY



FREEDOM

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