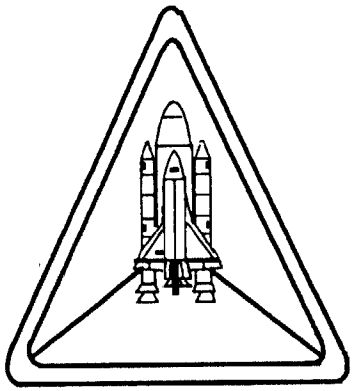
MISSION OPERATIONS DIRECTORATE
SPACE STATION GROUND SYSTEMS DIVISION



SHUTTLE

SPACE STATION CONTROL CENTER ARCHITECTURE

JUNE 18, 1991

DJ22/B. KAREN SCHMALZ

AGENDA

INTRODUCTION

ARCHITECTURE DRIVERS

PHASING OF SSCC CAPABILITIES

ARCHITECTURE EVOLUTION

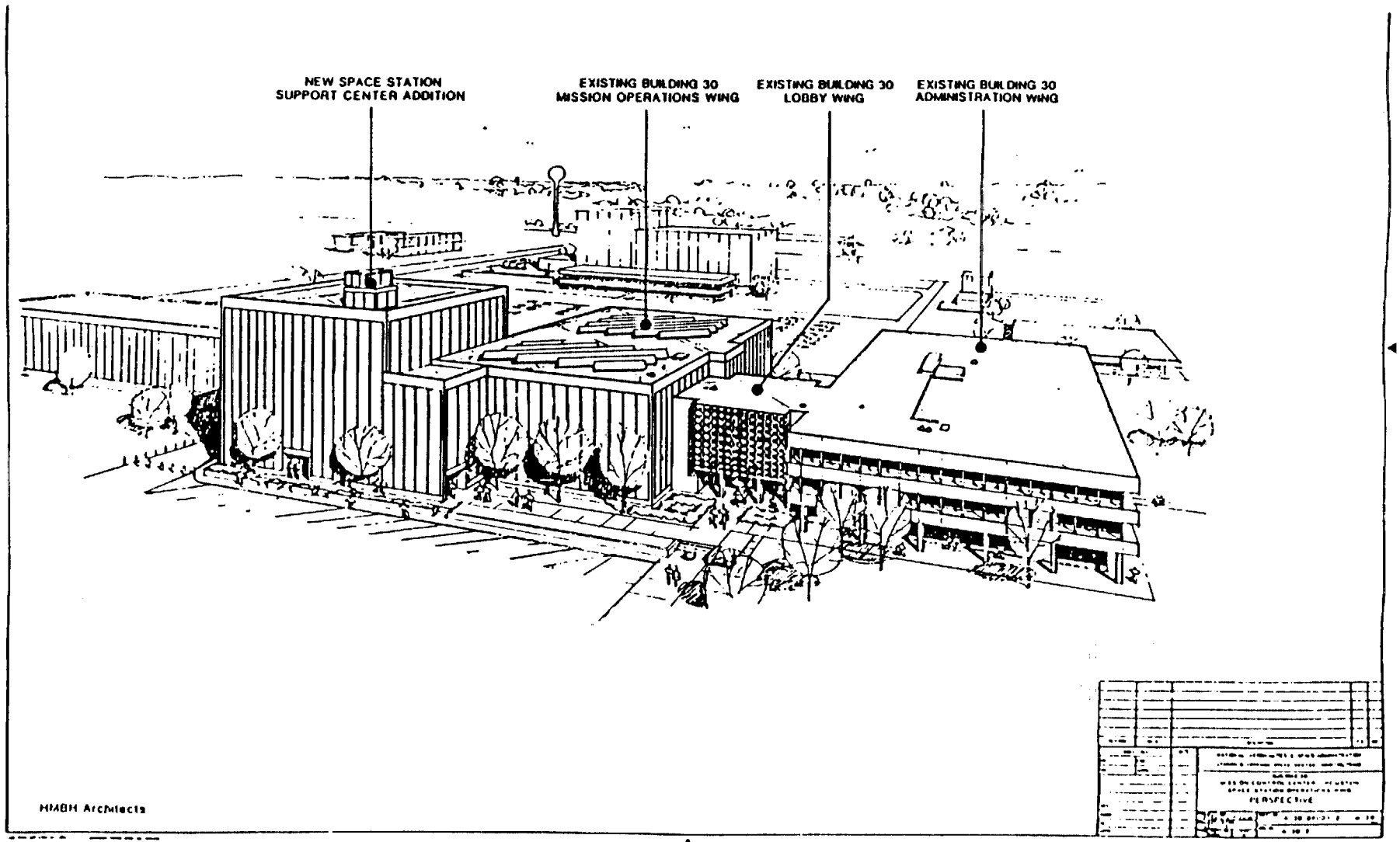
SUMMARY

INTRODUCTION RESPONSIBILITIES

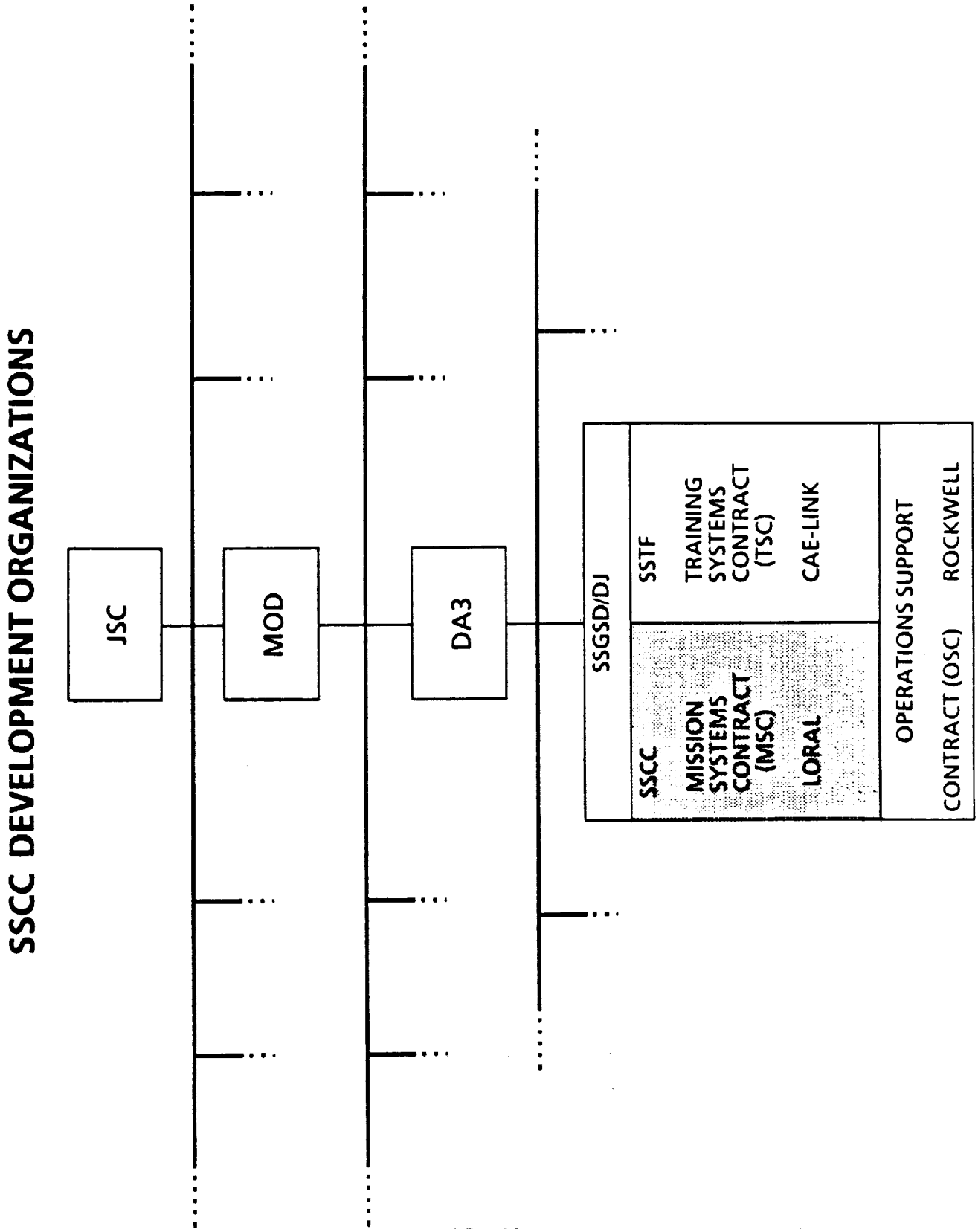
- THE SPACE STATION CONTROL CENTER (SSCC) IS UNDER THE COGNIZANCE OF THE JOHNSON SPACE CENTER AND WILL BE LOCATED ADJACENT TO THE SHUTTLE'S MISSION CONTROL CENTER

- RESPONSIBILITY FOR DESIGN, DEVELOPMENT AND OPERATIONS OF THE CONTROL CENTER IS THE RESPONSIBILITY OF THE MISSION OPERATIONS DIRECTORATE AT JSC

- SPACE STATION GROUND SYSTEMS DIVISION IS RESPONSIBLE FOR DESIGN AND DEVELOPMENT OF THE CONTROL CENTER SYSTEMS WHICH IS CURRENTLY IN PROCESS UNDER THE MISSION SUPPORT CONTRACTOR TEAM LED BY LORAL SPACE INFORMATION SYSTEMS



JSC CONTROL CENTER COMPLEX


SSCC DEVELOPMENT ORGANIZATIONS
JSC
MOD
DA3
SSGSD/DJ
SSCC
MISSION SYSTEMS CONTRACT (MSC)
LORAL
SSTF
TRAINING SYSTEMS CONTRACT (TSC)
CAE-LINK
OPERATIONS SUPPORT CONTRACT (OSC)
ROCKWELL

U.S. Gov t

INTRODUCTION
SSCC PROGRAMMATIC ROLES

- PRIMARY GROUND CENTER FOR
  - MONITORING AND CONTROLLING THE SPACE STATION MANNED BASE CORE SYSTEMS
  - MANAGEMENT OF UPLINK FOR CORE AND PAYLOAD SYSTEMS
  - INSURING THE SAFETY OF THE CREW AND MANNED BASE

- FOCAL POINT OF OPERATIONS PLANNING FOR THE SPACE STATION AND ASSOCIATED GROUND SYSTEMS
  - RESOURCE PLANNING AND SCHEDULING FOR ALL OF THE MANNED BASE
  - COORDINATION OF THE CORE OPERATIONS WITH PAYLOAD OPERATIONS

- PRIMARY SOURCE OF ONBOARD CORE SYSTEMS DATA FOR OTHER SITES

ARCHITECTURE DRIVERS

PROGRAMMATIC DIRECTIVES (AIS LEVEL 3, ADA, ETC.)

- ONBOARD DESIGN
  - OBJECT ACCESS (AND OBJECT DATA BASE)
  - DATA FORMATS (CCSDS PACKETS, TOLS, ETC.)
  - USER INTERFACE LANGUAGE
- SPACE STATION FREEDOM PROGRAM RESTRUCTURE
- BUDGET/RISK/SCHEDULE
  - COTS MARKETPLACE
  - MISSION CONTROL CENTER USE AND DESIGN REUSE
- MCC EXPERIENCE AND LESSONS LEARNED
- CONTINUOUS/CONCURRENT OPERATIONS

ARCHITECTURE DRIVERS

- PERFORMANCE REQUIREMENTS
  - DISPLAY OF CORE DATA WITHIN 5 SECONDS OF RECEIPT
  - COMMAND UPLINK TRANSMISSION DELAY 1 SECOND MAXIMUM
  - DATA RETRIEVAL 5 MINUTES FOR LESS THAN 1 DAY OLD DATA
    30 MINUTES FOR LESS THAN A YEAR OLD
    24 HOUR FOR MORE THAN A YEAR OLD
  - 30 MINUTE RECONFIGURATION

- AVAILABILITY REQUIREMENTS
  - MANDATORY FUNCTIONS .995
  - DISRUPTIONS NOT TO EXCEED 45 MINUTES IN 150 HOURS

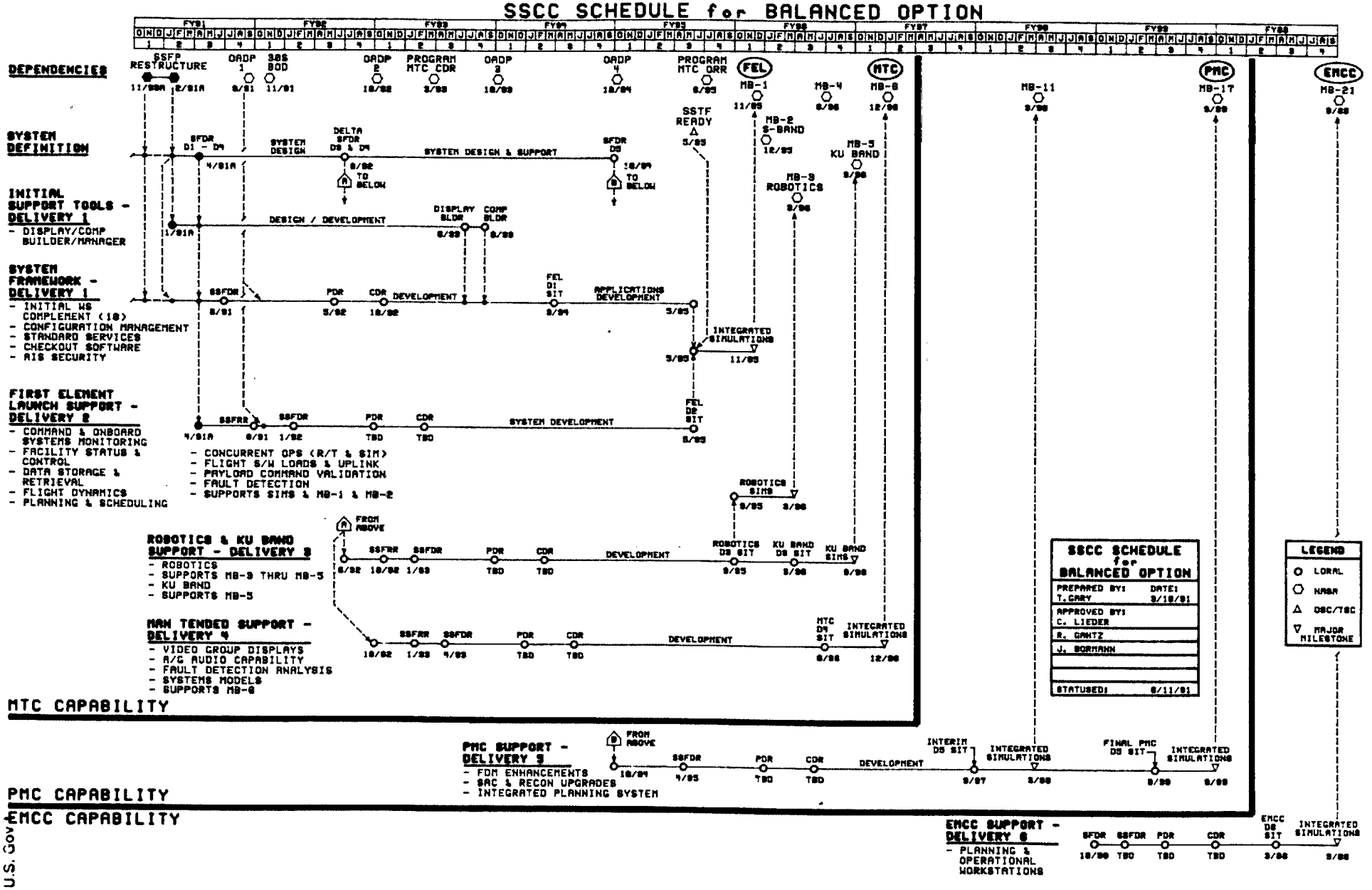
- REAL-TIME AND NON-REAL-TIME DATA SEPARATION

- FLEXIBLE CONNECTIVITY

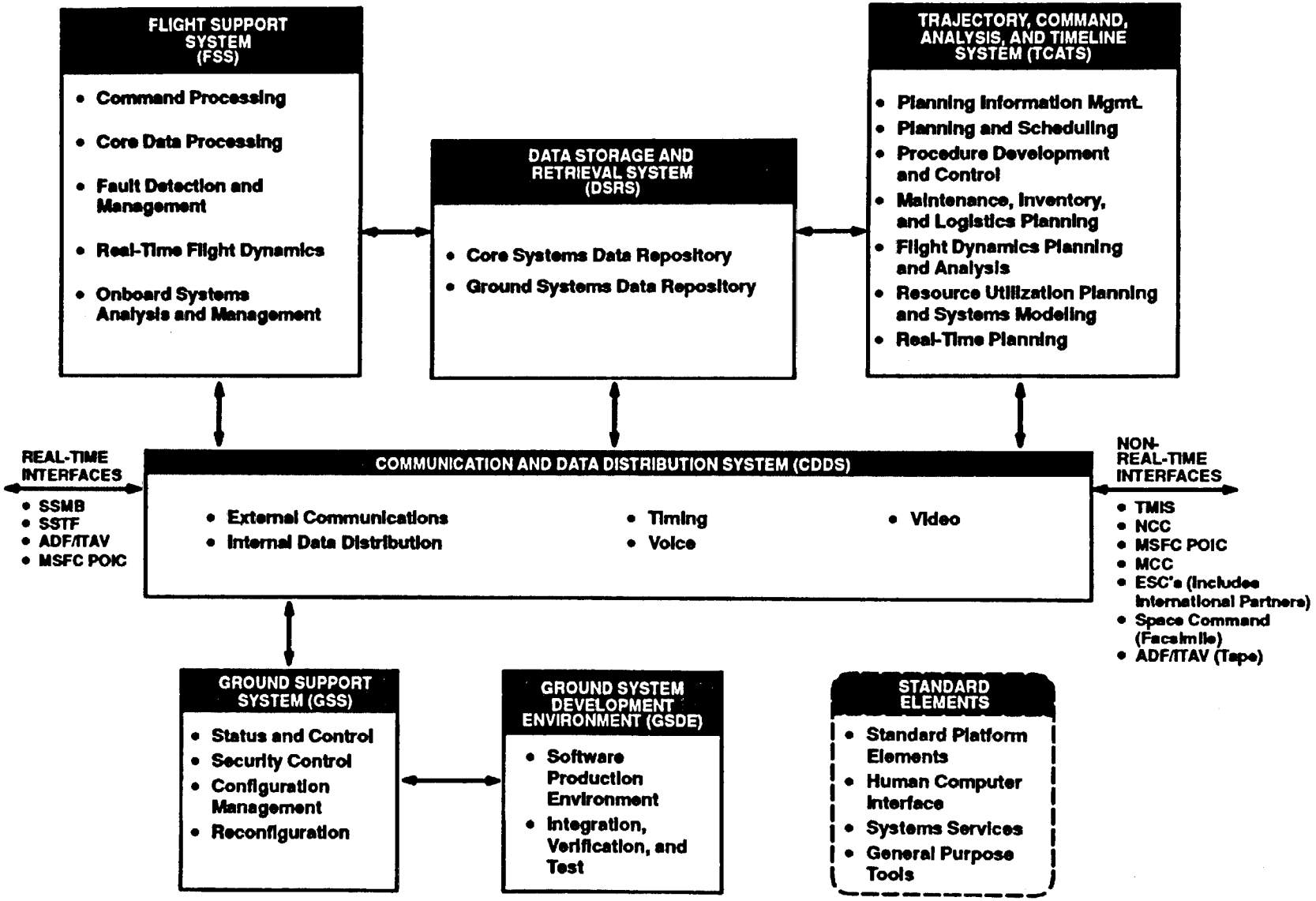
PHASING OF SSCC CAPABILITIES

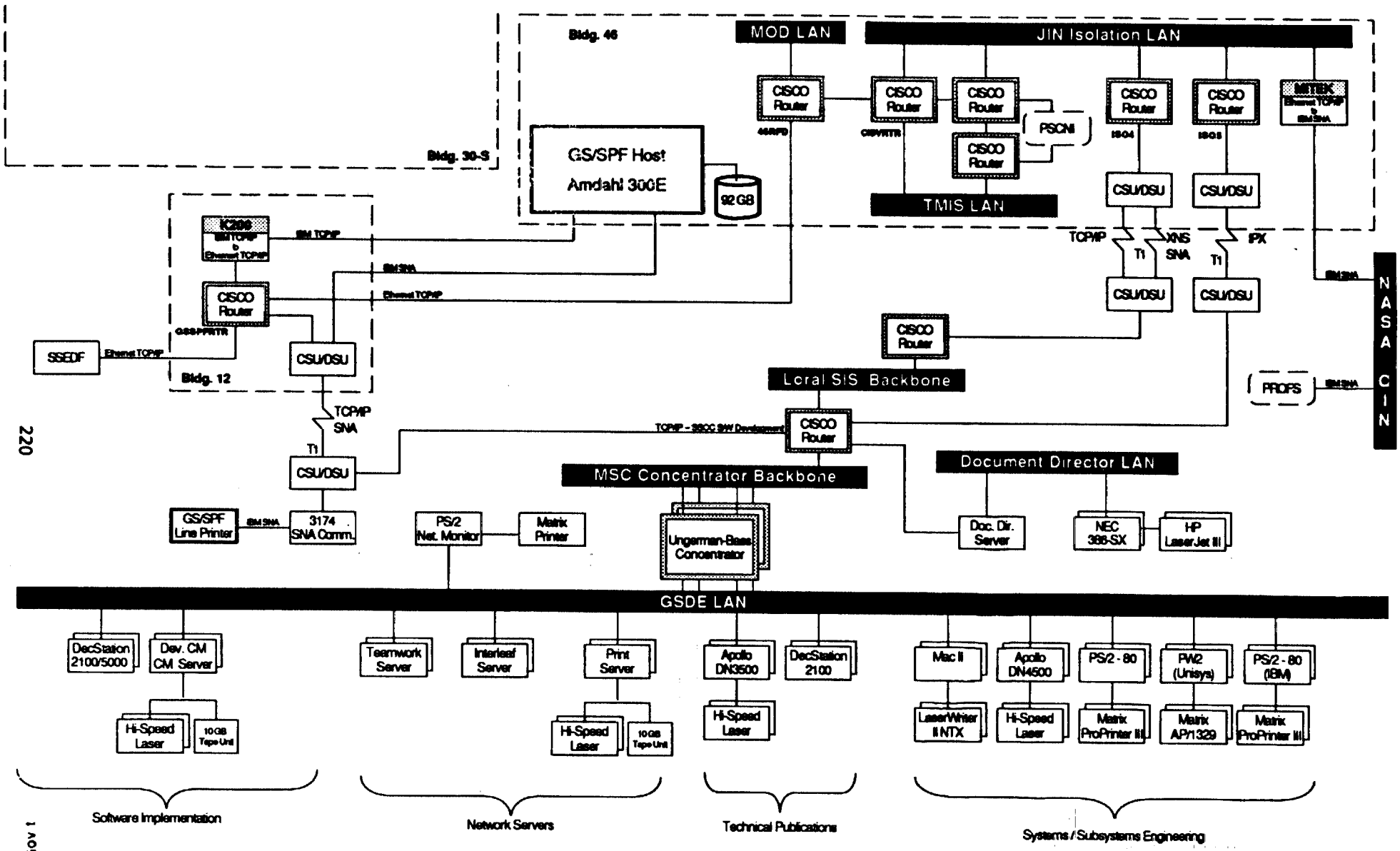
- SOFTWARE PRODUCTION ENVIRONMENT
- DELIVERY 1, INITIAL SUPPORT TOOLS AND SYSTEM FRAMEWORK
  - FOR BUILDING OF CONTROLLER DISPLAYS AND COMPUTATIONS
- DELIVERY 2, FIRST ELEMENT LAUNCH SUPPORT
  - SUPPORT OF SIMULATIONS FOR TRAINING
  - SUPPORT SPACE STATION ASSEMBLY FLIGHTS 1 AND 2
- DELIVERY 3, ROBOTICS AND KU-BAND
  - SUPPORT OF ASSEMBLY FLIGHTS 3 THRU 5 & CANADIANS
- DELIVERY 4, MAN TENDED SUPPORT
  - SUPPORT OF ASSEMBLY FLIGHTS & MTC UTILIZATION & RESUPPLY FLIGHTS
- DELIVERY 5, PERMANENTLY MANNED CAPABILITY
- DELIVERY 6, EIGHT MAN CREW CAPABILITY

SSCC SCHEDULE for BALANCED OPTION



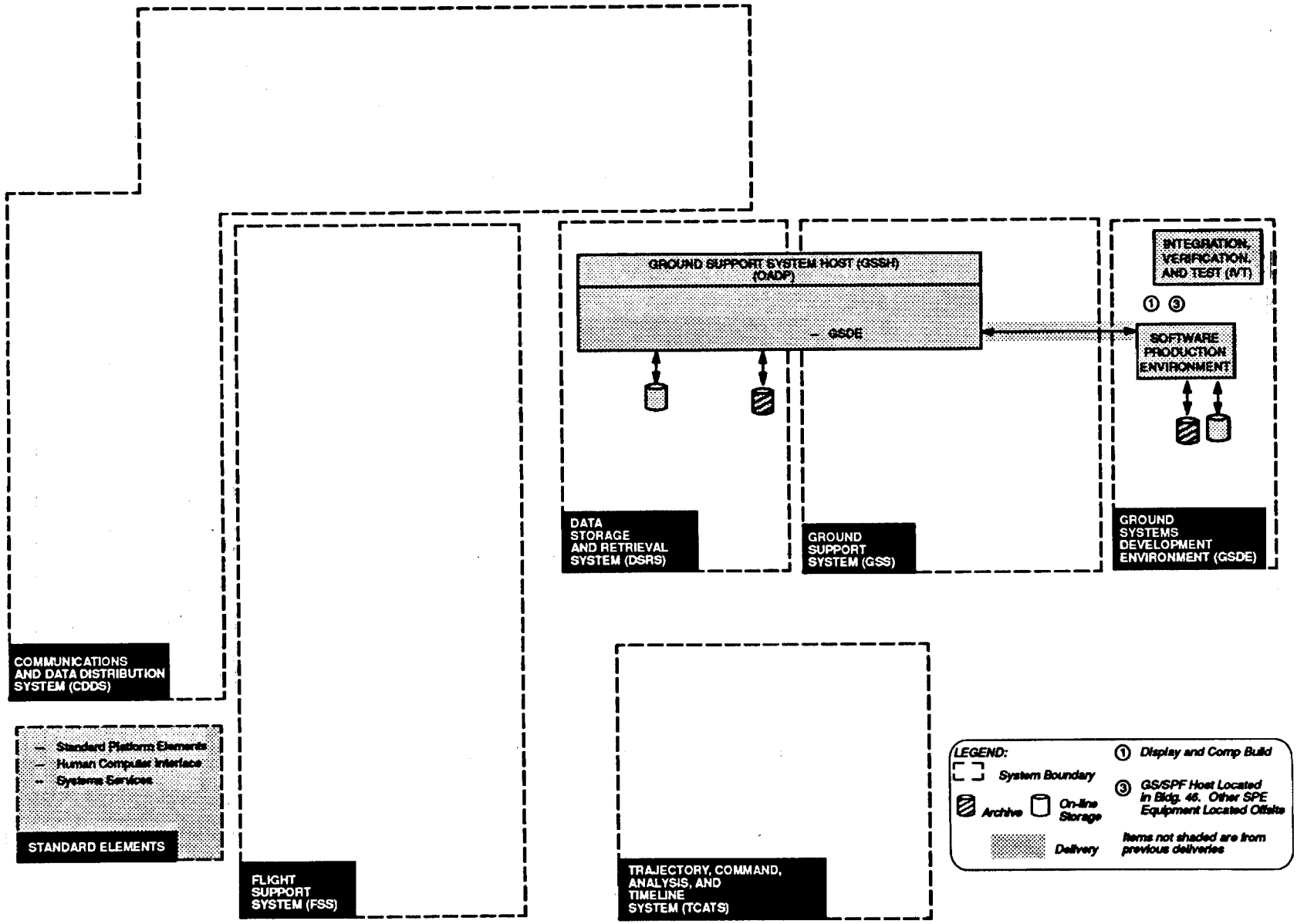
SSCC ARCHITECTURE LAYER ZERO





Ground System Development Environment - Existing Capability

SSCC ARCHITECTURE – DELIVERY 1

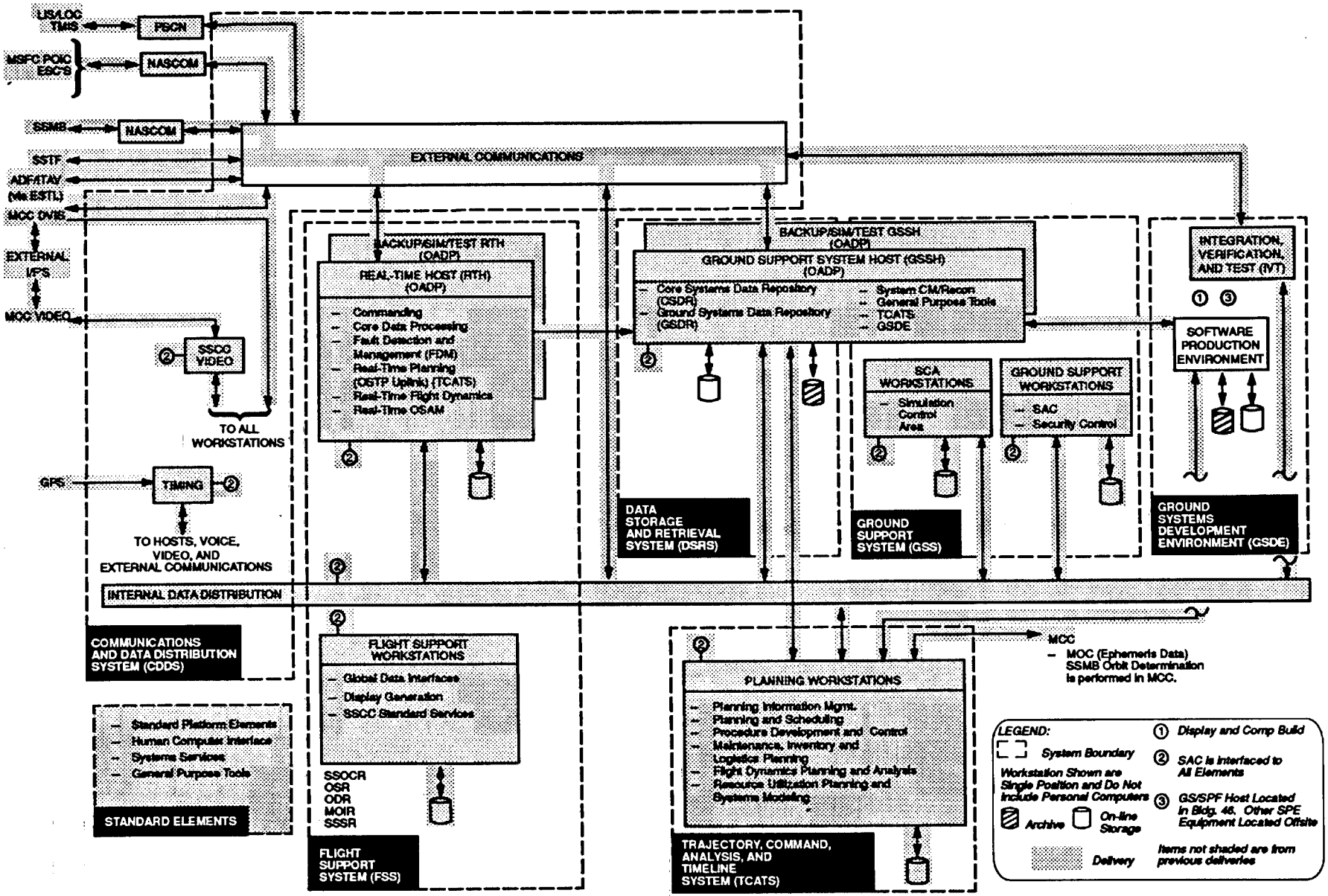


DELIVERY 1 CAPABILITY

INITIAL SUPPORT TOOLS AND SYSTEM FRAMEWORK

- STANDARD ELEMENTS
  - GROUND SUPPORT SYSTEM HOST (GSSH) 1 CLASS B
  - COMMUNICATION BETWEEN GSSH AND SPE GS/SPF HOST
  - OBJECT ACCESS
  - DISPLAY BUILDER/MANAGER
  - COMP BUILDER/MANAGER
  - INITIALIZATION
  - INITIAL LOG/DELOG
  - RELATIONAL DATA BASE MANAGER (RDBMS)
- GROUND SYSTEMS DEVELOPMENT ENVIRONMENT
  - SOFTWARE PRODUCTION ENVIRONMENT
    - -- DEVELOPMENT WORKSTATIONS
    - -- BUILD DISPLAYS AND COMPS
    - -- SECURITY SERVICES FOR ACCESS CONTROL
    - -- SOFTWARE DEVELOPMENT AND TEST
    - -- DEVELOPMENT CONFIGURATION MANAGEMENT
  - INTEGRATION, VERIFICATION AND TEST
    - -- INITIAL OBJECT TEST DATA BASE
    - -- INITIAL CHECKOUT SOFTWARE

SSCC ARCHITECTURE – DELIVERY 2



DELIVERY 2 CAPABILITY
FIRST ELEMENT LAUNCH SUPPORT

- **STANDARD ELEMENTS**
  - REAL-TIME HOST (RTH) 1 CLASS B, UPGRADE RTH 1 TO CLASS C
  - RTH 2 CLASS C
  - UPGRADE GSSH 1 TO CLASS D
  - GSSH 2 CLASS D
  - CONSOLE HOUSINGS
  - WORKSTATIONS, TOOLS, AND PERIPHERALS
  - GENERAL PURPOSE TOOL CONTROLLER, SPREADSHEET AND WORDPROCESSOR
  - RTH DATA REPLAY
  - ALARM MANAGEMENT
  - INITIALIZATION UPGRADE
  - RECOVERY SERVICES
  - TIMING SERVICES
  - USER INTERFACE LANGUAGE

DELIVERY 2 CAPABILITY (CONT'D)
FIRST ELEMENT LAUNCH SUPPORT

- COMMUNICATIONS AND DATA DISTRIBUTION SYSTEM
  - TWO STRING EXTERNAL COMMUNICATIONS CAPABILITY
  - DATA RECORDING AND TEST
  - VOICE CAPABILITY WITH SSMB, GROUND FACILITIES AND SSCC INTERNAL INCLUDING VOICE RECORDERS
  - VIDEO GROUND DISTRIBUTION INCLUDING SSCC TV MONITORS
  - TIMING TO HOSTS, EXTERNAL COMMUNICATIONS, VOICE, VIDEO
  - INTERNAL DATA DISTRIBUTION LAN'S (OPERATIONS AND TCATS)
  - EXTERNAL INTERFACES (SSMB, SSTF, ADF/ITAV, MCC, LIS/LOC, NCC, POIC)
- DATA STORAGE AND RETRIEVAL SYSTEM
  - STORE, ARCHIVE AND RETRIEVE CORE SYSTEMS DATA DOWNLINKED FROM SSMB
  - STORE, ARCHIVE AND RETRIEVE RESULTS OF COMPUTATIONS ON TELEMETRY DATA (FROM CORE DATA PROCESSING)
  - PERMANENTLY ARCHIVE SELECTED FLIGHT DATA
  - ALLOW FOR CONCURRENT MULTIUSER ACCESS TO STORED DATA
  - PROVIDE LOCATION-TRANSPARENT RETRIEVAL OF STORED TELEMETRY DATA
  - PERFORM CALIBRATION, LIMIT SENSING, AND ENGINEERING UNIT CONVERSION ON RETRIEVED TELEMETRY DATA
  - PERFORM ACCESS CONTROL
  - MANAGE STORAGE AND RETRIEVAL RESOURCES

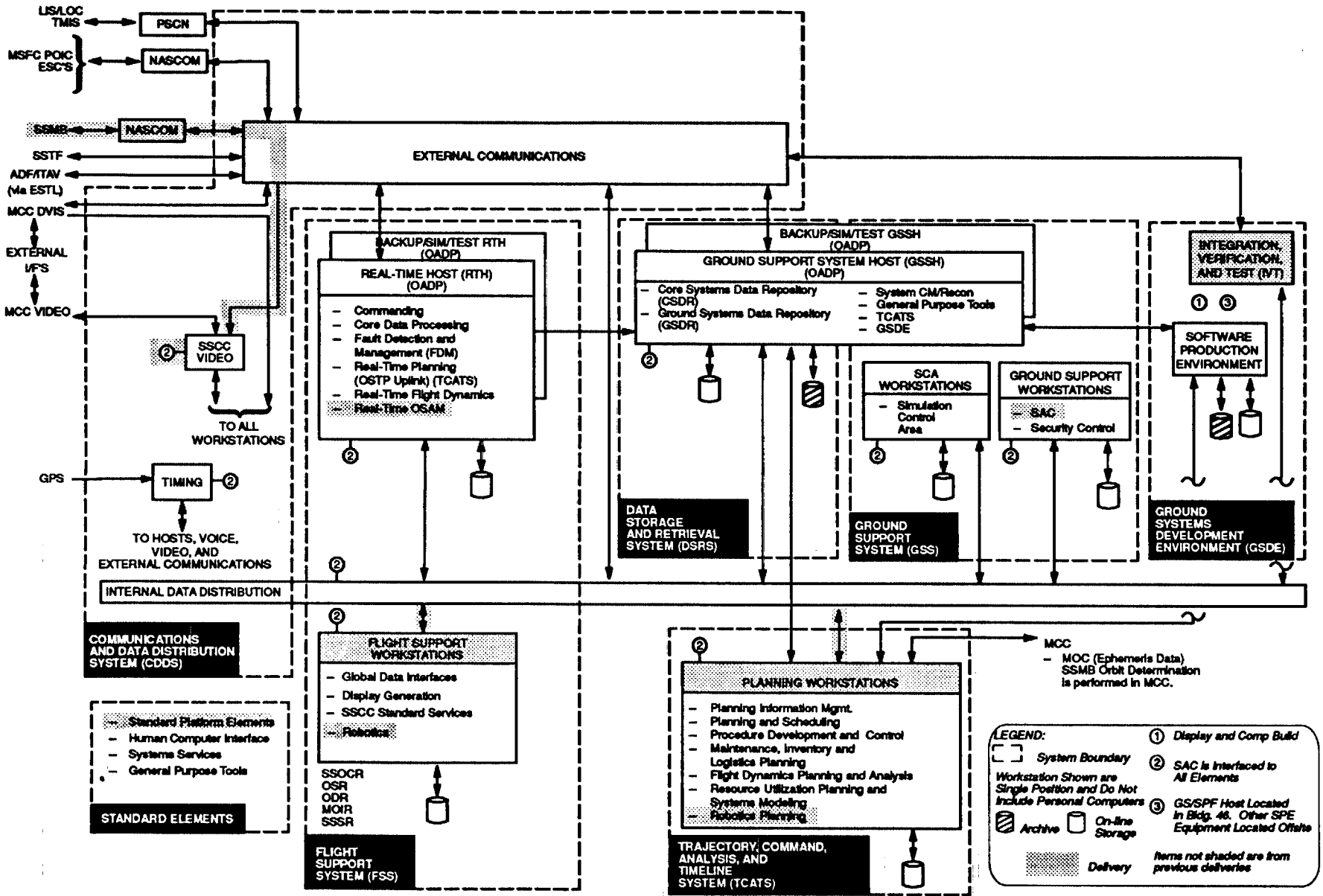
DELIVERY 2 CAPABILITY (CONT'D)
FIRST ELEMENT LAUNCH SUPPORT

- FLIGHT SUPPORT SYSTEM
  - CORE COMMAND BUILD, SAFING, UPLINK, LOGGING AND MANAGEMENT
  - PAYLOAD COMMAND MERGE AND UPLINK
  - CORE DATA PROCESSING (CALIBRATIONS, COMPUTATIONS, ENGINEERING UNIT CONVERSIONS, LIMIT SENSING)
  - REAL-TIME CORE SYSTEM MODELS
  - REAL-TIME FLIGHT DYNAMICS CALCULATIONS AND STORAGE/RETRIEVAL
  - FAULT DETECTION AND MANAGEMENT (CAUTION AND WARNING TRANSLATIONS, FAULT ANNUNCIATION, FAULT MESSAGE LOGGING)
- TRAJECTORY, COMMAND, ANALYSIS, AND TIMELINE SYSTEM
  - PLANNING INFORMATION MANAGEMENT
  - PLANNING AND SCHEDULING
  - REAL-TIME PLANNING
  - RESOURCE UTILIZATION PLANNING AND SYSTEMS MODELING (EARLY UTILIZATION TOOLS)
  - FLIGHT DYNAMICS PLANNING AND ANALYSIS
  - PROCEDURE DEVELOPMENT AND CONTROL
  - MAINTENANCE INVENTORY AND LOGISTICS PLANNING
  - SYSTEM SERVICES (DATA LIBRARY AND OBJECT ACCESS DATA SERVER)

DELIVERY 2 CAPABILITY (CONT'D)
FIRST ELEMENT LAUNCH SUPPORT

- GROUND SUPPORT SYSTEM
  - STATUS AND CONTROL
  - CONFIGURATION MANAGEMENT
  - RECONFIGURATION
  - SECURITY CONTROL
  - SIMULATION CONTROL AREA SUPPORT
- GROUND SYSTEMS DEVELOPMENT ENVIRONMENT
  - DEVELOPMENT OF SSCC SOFTWARE AND DATA PRODUCTS
  - CONFIGURATION MANAGEMENT OF SOFTWARE PRODUCTS
  - DELIVERY OF SOFTWARE PRODUCTS TO THE GSSH
  - CHECKOUT SOFTWARE UPGRADE/ADDITIONS
  - INTEGRATION, VERIFICATION, AND TEST (IVT) TEST DATA BASE

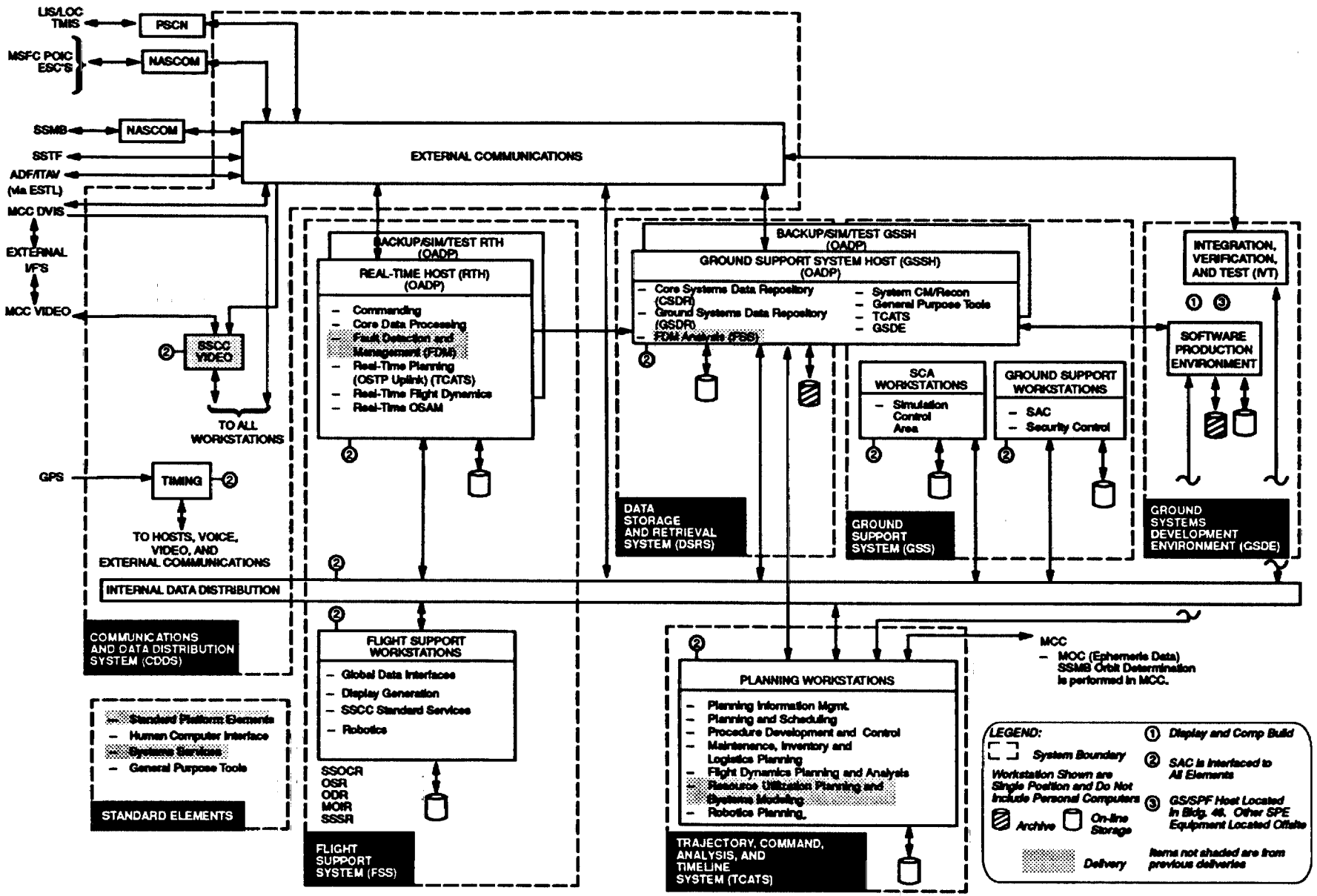
SSCC ARCHITECTURE – DELIVERY 3



DELIVERY 3 CAPABILITY
ROBOTICS AND KU-BAND SUPPORT

- STANDARD ELEMENTS
  - ADDITIONAL CONSOLE HOUSINGS
  - ADDITIONAL WORKSTATIONS AND PERIPHERALS
  - INTEGRATION, VERIFICATION AND TEST HOST CLASS D FOR DEVELOPMENT SUPPORT
  - ROBOTICS WORKSTATIONS
- COMMUNICATIONS AND DATA DISTRIBUTION SYSTEM
  - SSMB KU-BAND DOWNLINK VIDEO
- FLIGHT SUPPORT SYSTEM
  - REAL-TIME OSAM (ROBOTICS DAP MODEL)
  - REAL-TIME ROBOTICS OPERATIONS SUPPORT
- TRAJECTORY, COMMAND, ANALYSIS, AND TIMELINE SYSTEM
  - ROBOTICS MODELS AND PLANNING
- GROUND SUPPORT SYSTEM
  - SAC FOR SSMB VIDEO

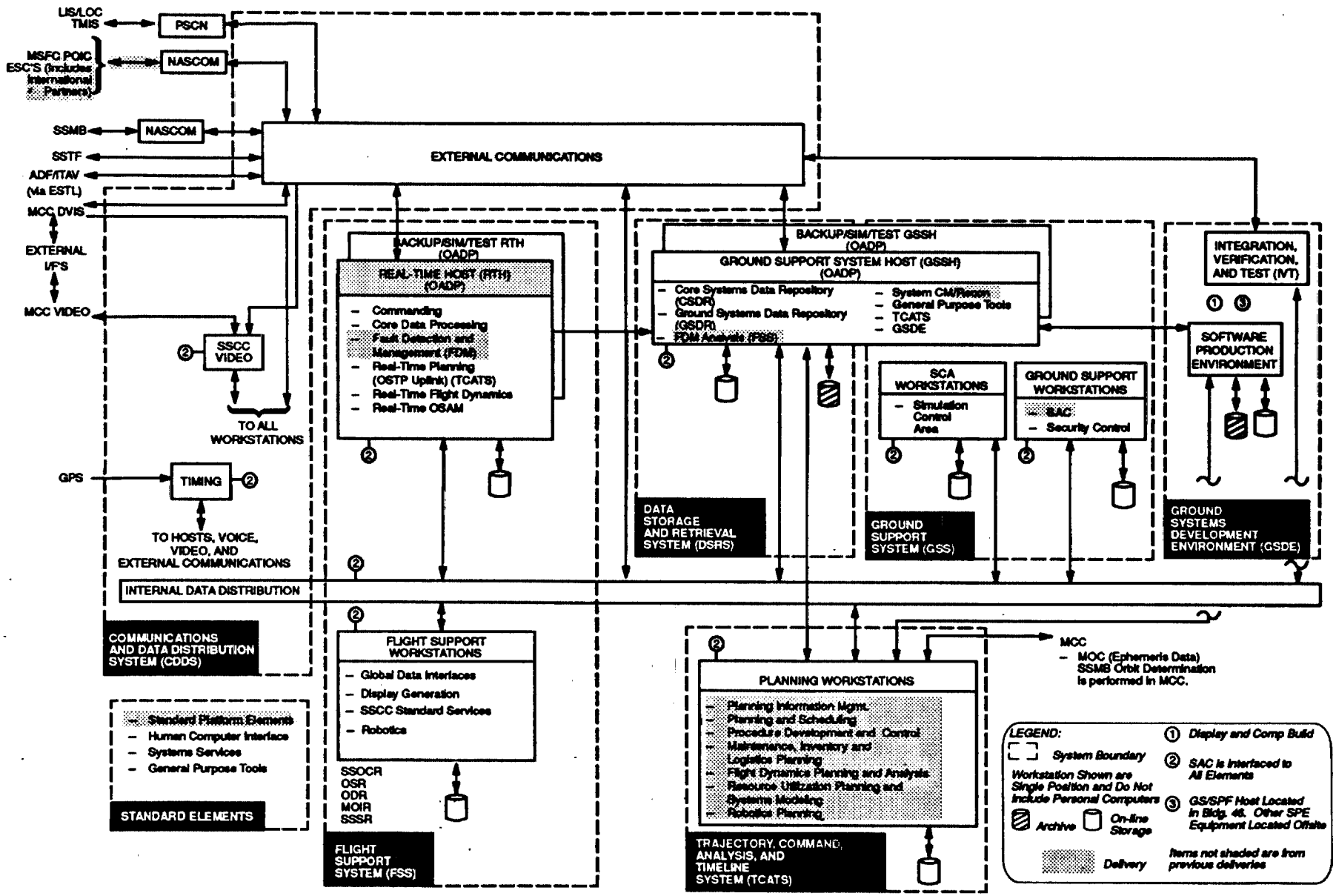
SSCC ARCHITECTURE – DELIVERY 4



DELIVERY 4 CAPABILITY
MAN TENDED SUPPORT

- STANDARD ELEMENTS
  - ADDITIONAL WORKSTATIONS
  - DELOG ENHANCEMENTS
- COMMUNICATIONS AND DATA DISTRIBUTION SYSTEM
  - VIDEO TV WINDOWS, GROUP DISPLAY, VISUALS
- FLIGHT SUPPORT SYSTEM
  - FAULT DETECTION AND MANAGEMENT ANALYSIS (TIC, IMPASS AND COMP INTERFACE)
  - FAULT DETECTION AND MANAGEMENT (ISE EVENT MESSAGE PROCESSING AND SSMB C&W SYNTHESIS)
- TRAJECTORY, COMMAND, ANALYSIS, AND TIMELINE SYSTEM
  - RESOURCE UTILIZATION PLANNING AND SYSTEMS MODELING (TCS, EPS, C&T, PROP MODELS)
  - CONFIGURATION MANAGEMENT EXTENSIONS

SSCC ARCHITECTURE – DELIVERY 5 & 6



DELIVERY 5 CAPABILITY – PMC SUPPORT

- STANDARD ELEMENTS
  - UPGRADE RTH 1 TO CLASS D
  - ADDITIONAL WORKSTATIONS
- FLIGHT SUPPORT SYSTEM,
  - FAULT DETECTION AND MANAGEMENT ENHANCEMENTS
- GROUND SUPPORT SYSTEM
  - STATUS AND CONTROL
  - RECONFIGURATION
- TRAJECTORY, COMMAND, ANALYSIS, AND TIMELINE SYSTEM
  - INTEGRATED PLANNING SYSTEM

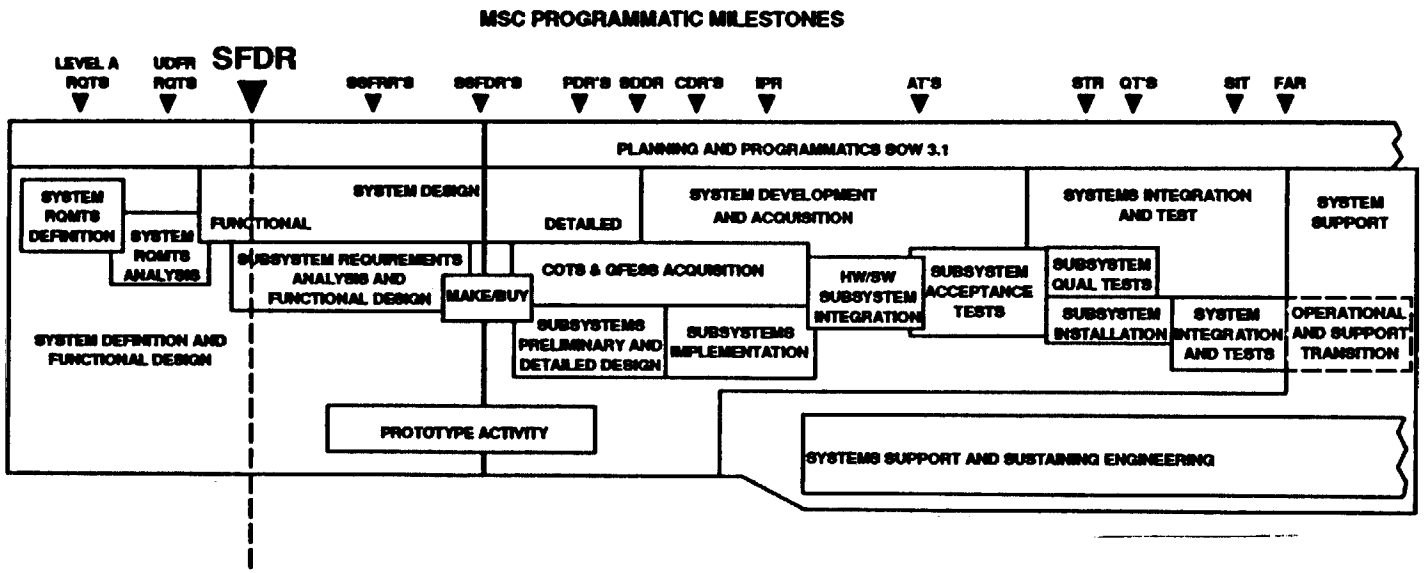
DELIVERY 6 CAPABILITY – EMCC SUPPORT

- STANDARD ELEMENTS
  - ADDITIONAL WORKSTATIONS

SUMMARY

- EARLY IN THE LIFE-CYCLE IF THE SSCC PROJECT
- SYSTEM FUNCTIONAL DESIGN REVIEW COMPLETED
- SUBSYSTEM REQUIREMENTS ARE NOW BEING DEVELOPED AND REVIEWED
- NEW FACILITY WILL BE AVAILABLE THIS FALL FOR DEVELOPMENT ACTIVITIES

SSCC SYSTEM LIFE CYCLE



APRIL 15-18