TIMED

Thermosphere • Ionosphere • Mesosphere • Energetics and Dynamics

Mission Software Engineering

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Topics of Discussion (1 of 2)

- *Science Data Flow*
  - Mission Objectives
  - Science Team Interface
  - TIMED System Science Data Flow
  - Subsystems With Major Software Components
  - Subsystem Science Data Flow
- *Software Management*
  - TIMED Software Management Structure
  - Subsystems With Major Software Components
  - Software Development Plans
  - Ground System Software Development Process
  - Spacecraft Software Development Process
  - Configuration Management

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Topics of Discussion (2 of 2)

- **Verification and Validation**
- **Software Reuse**

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Mission Objectives

* *To determine the MLTI Basic Structure:*

  To determine the temperature, density, and wind structure in the Mesosphere, Lower thermosphere, and Ionosphere (MLTI) region (60-180 km), including the seasonal and latitudinal variations;

* *To understand the MLTI energy balance:*

  To determine the relative importance of the various radiactive, chemical, electrodynamical, and dynamical sources and sinks of energy for the thermal structure of MLTI region.

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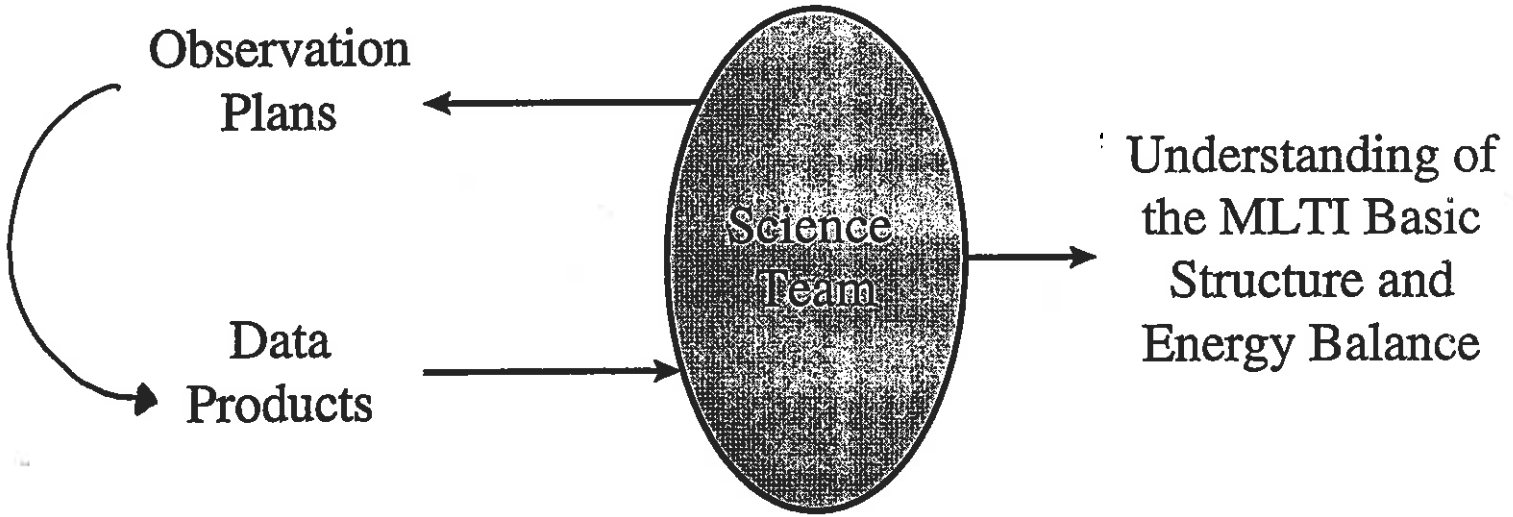
Science Team Interface



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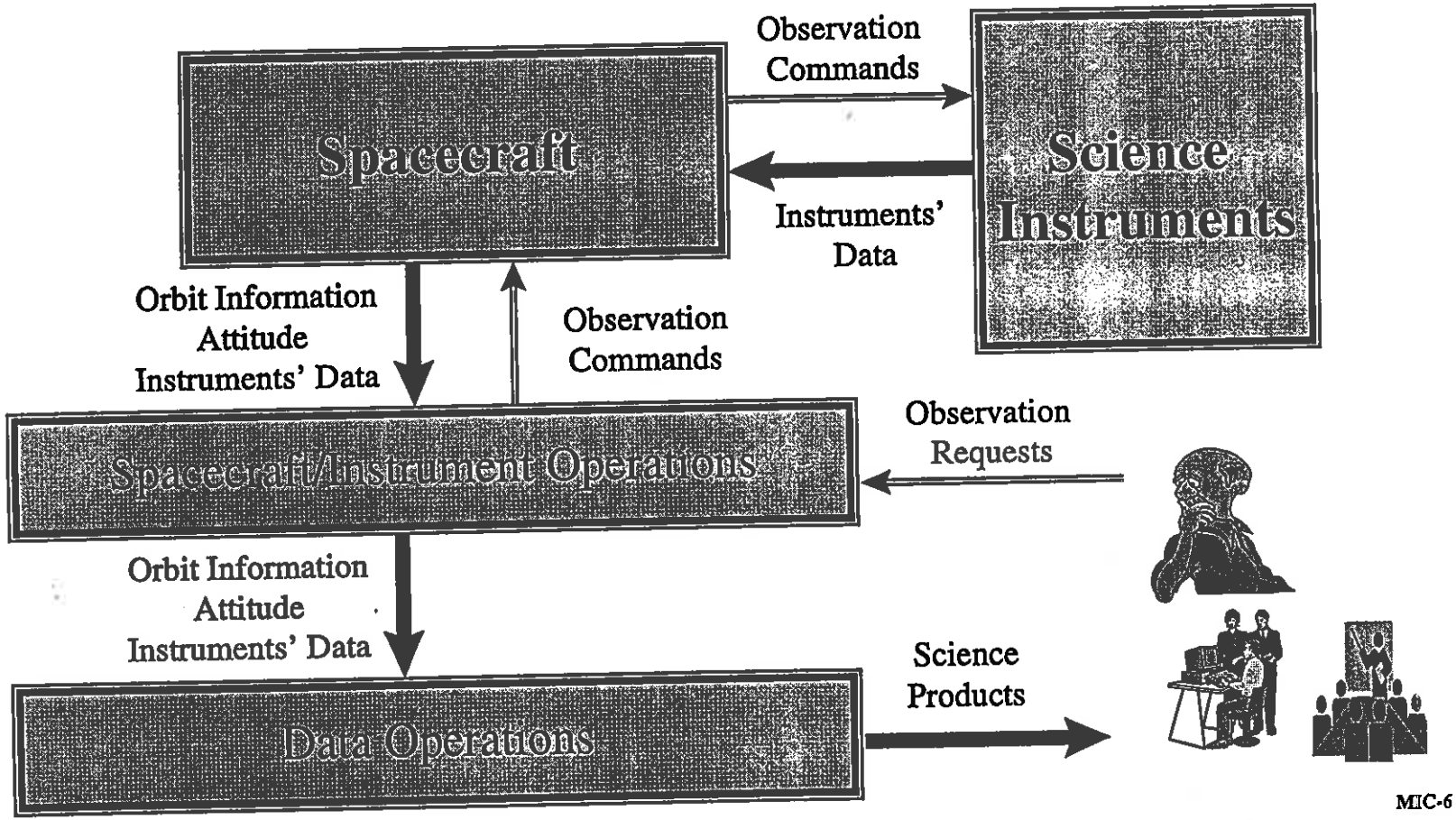
TIMED System Science Data Flow



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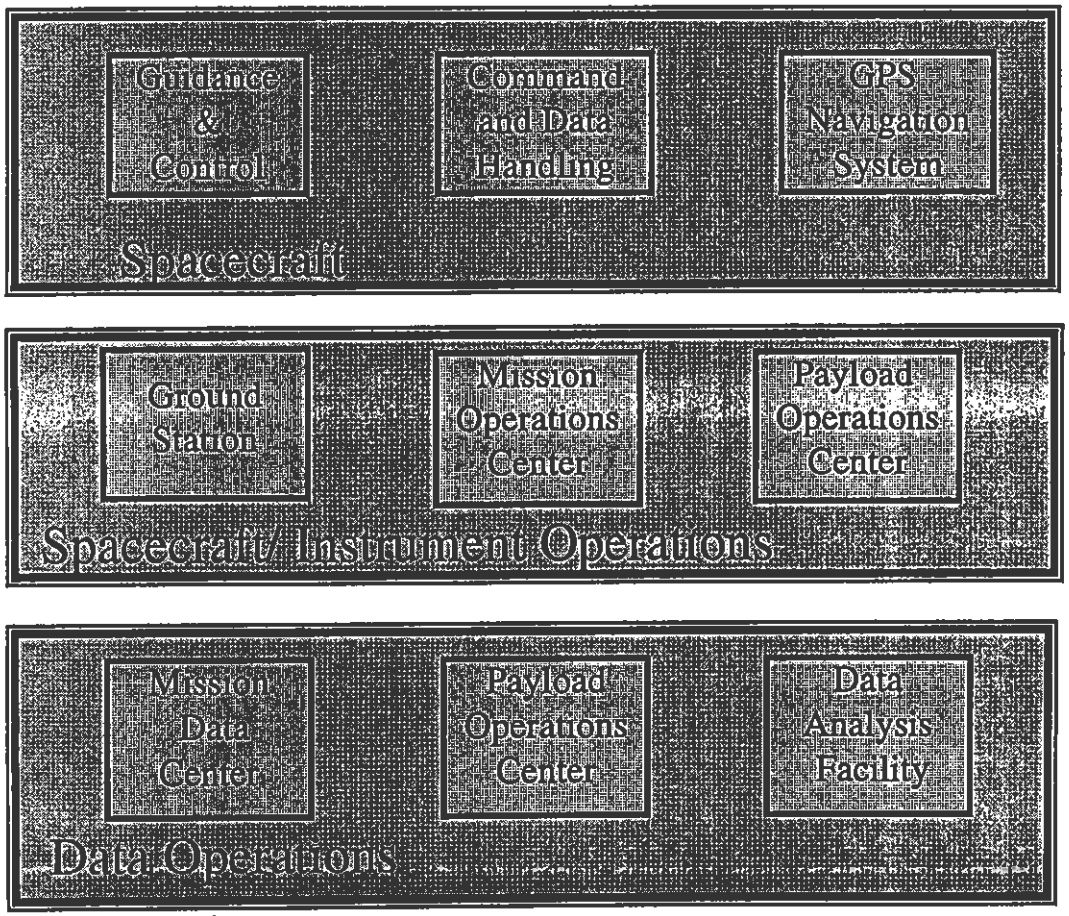
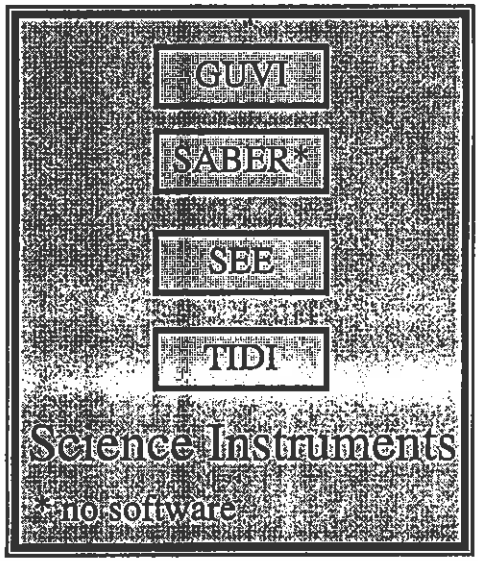
Subsystems With Major Software Components





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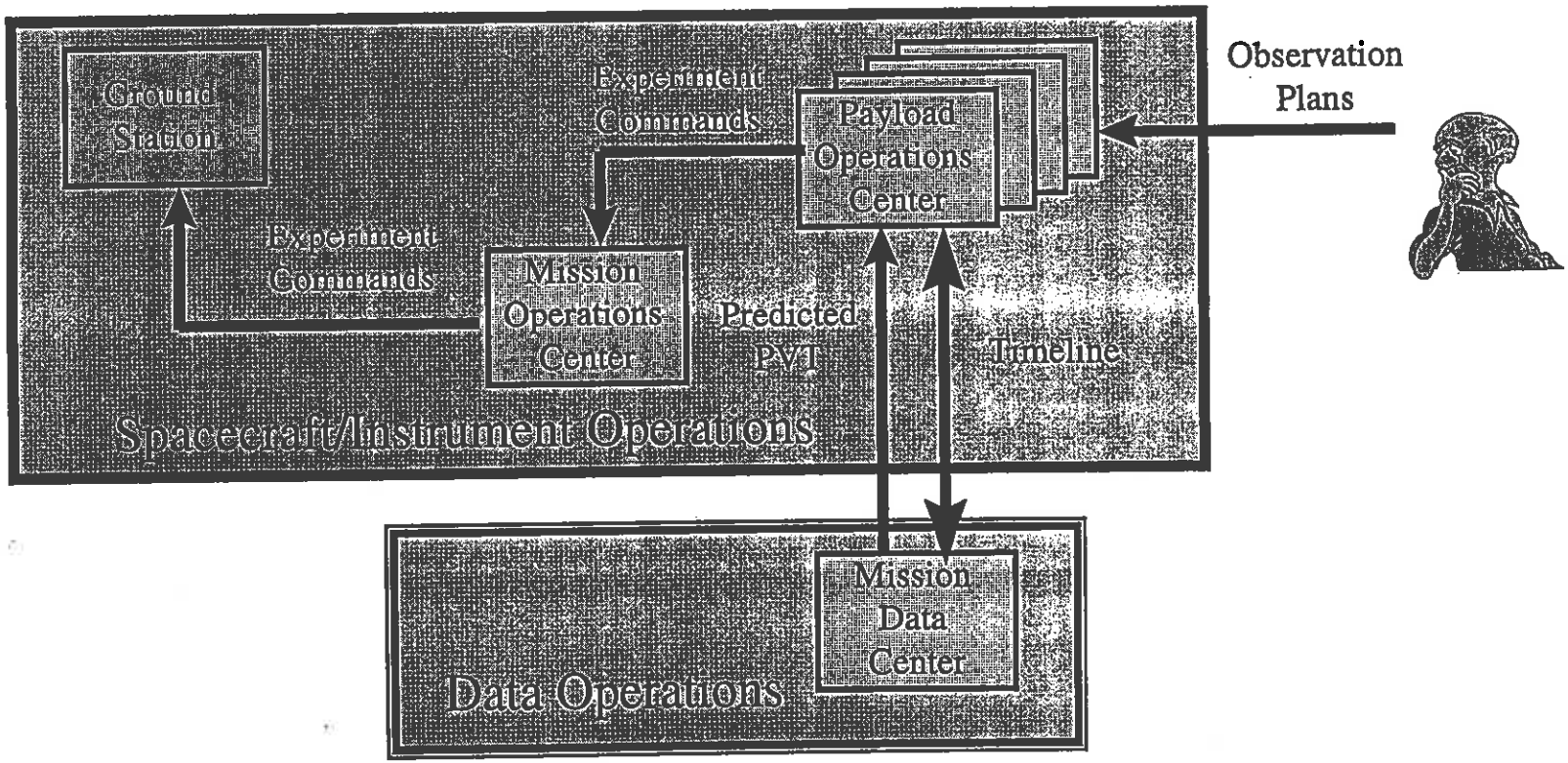
Subsystem Science Data Flow (1 of 4) (Mission Commanding)



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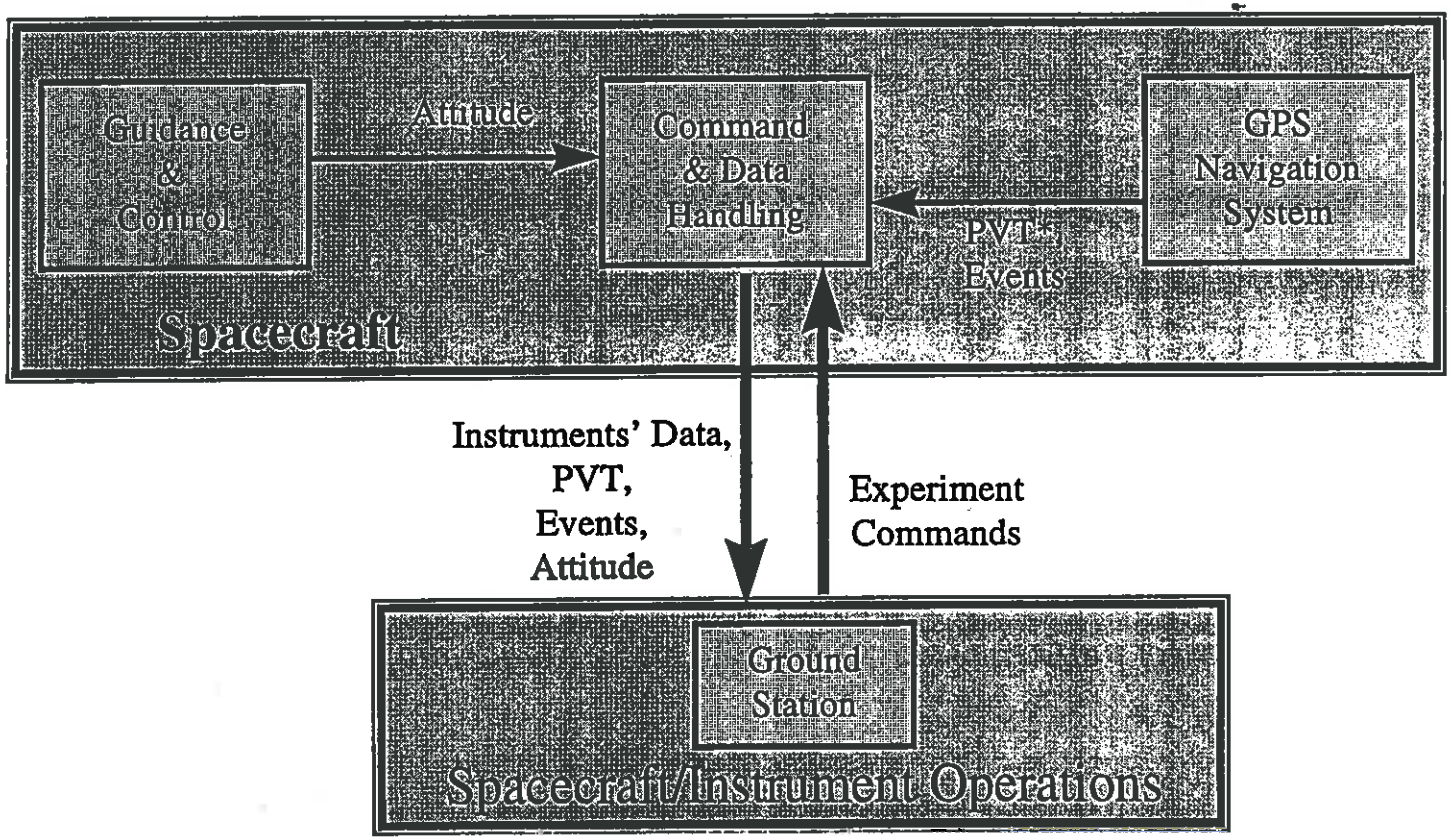
Subsystem Science Data Flow (2 of 4) (Spacecraft)



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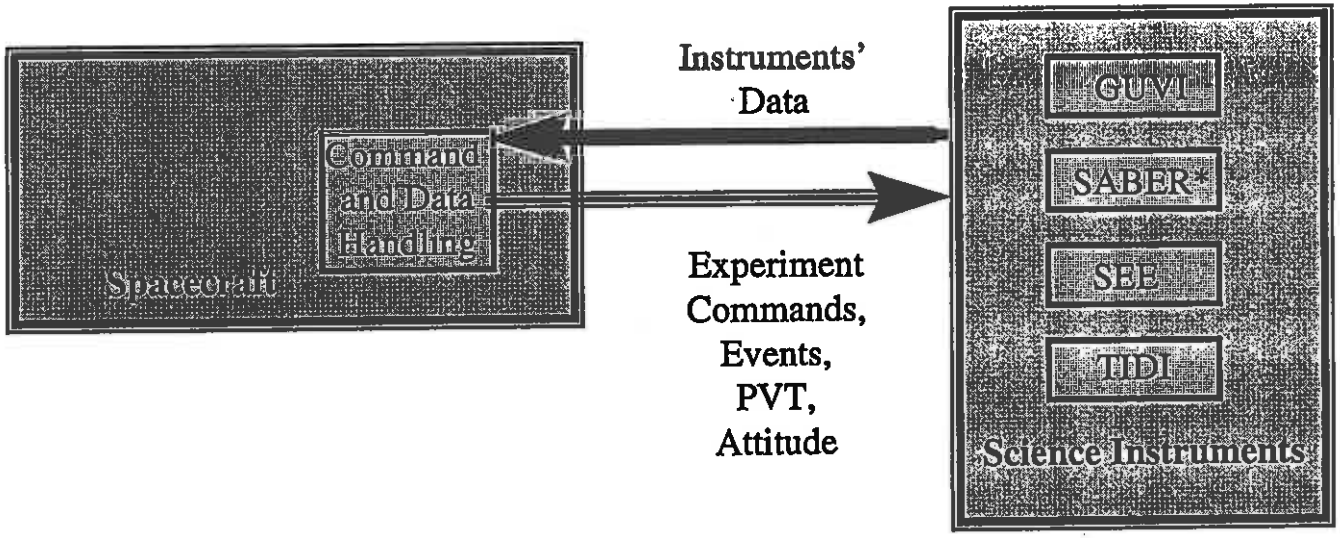
* PVT=Position, Velocity, and Time

Subsystem Science Data Flow (3 of 4) (Science Instruments)



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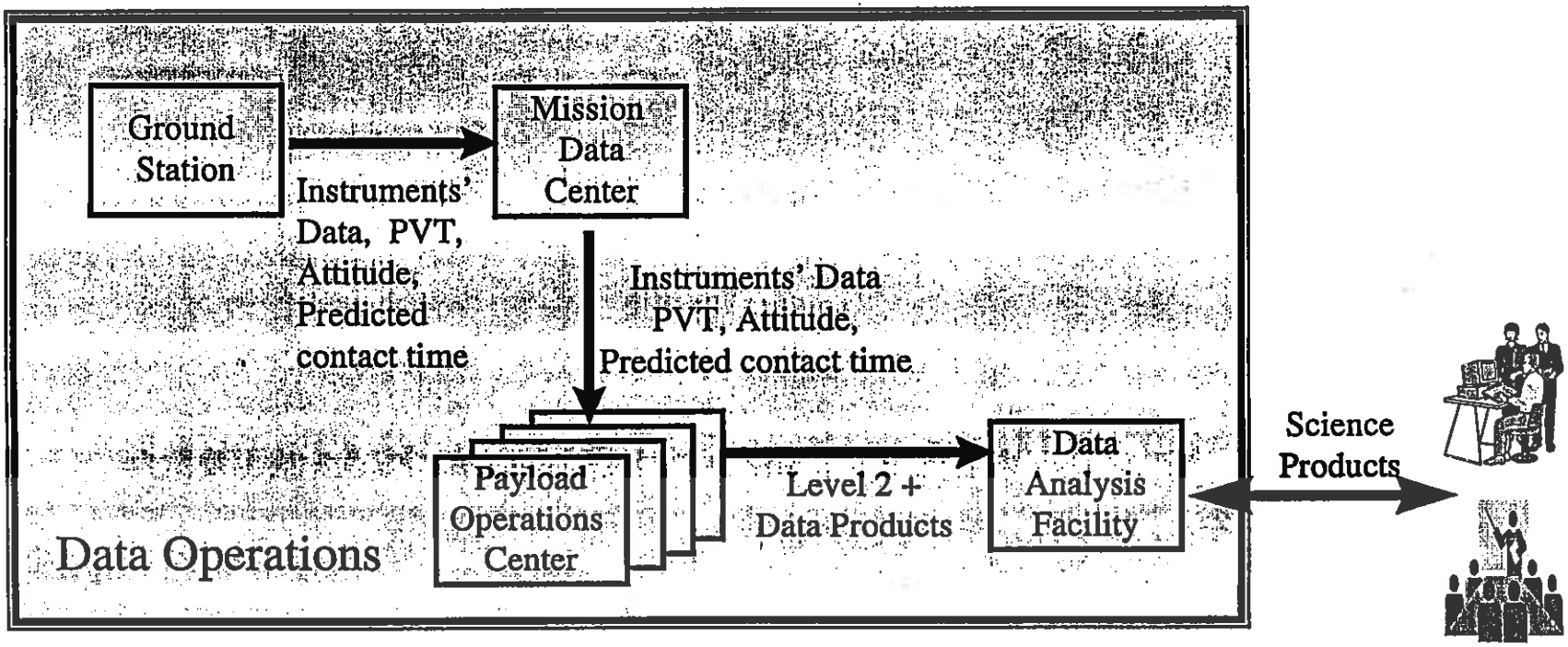
Subsystem Science Data Flow (4 of 4) (Data Operations)



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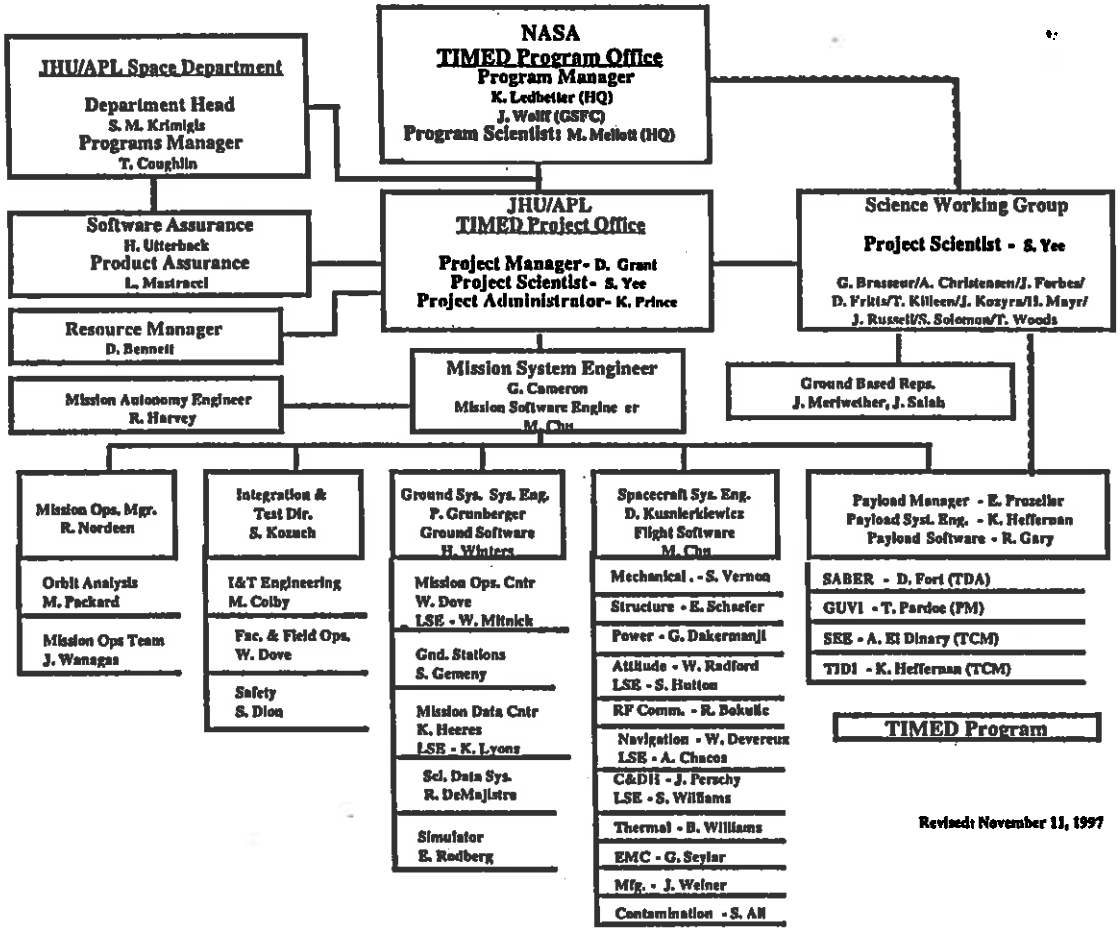
TIMED Software Management Structure



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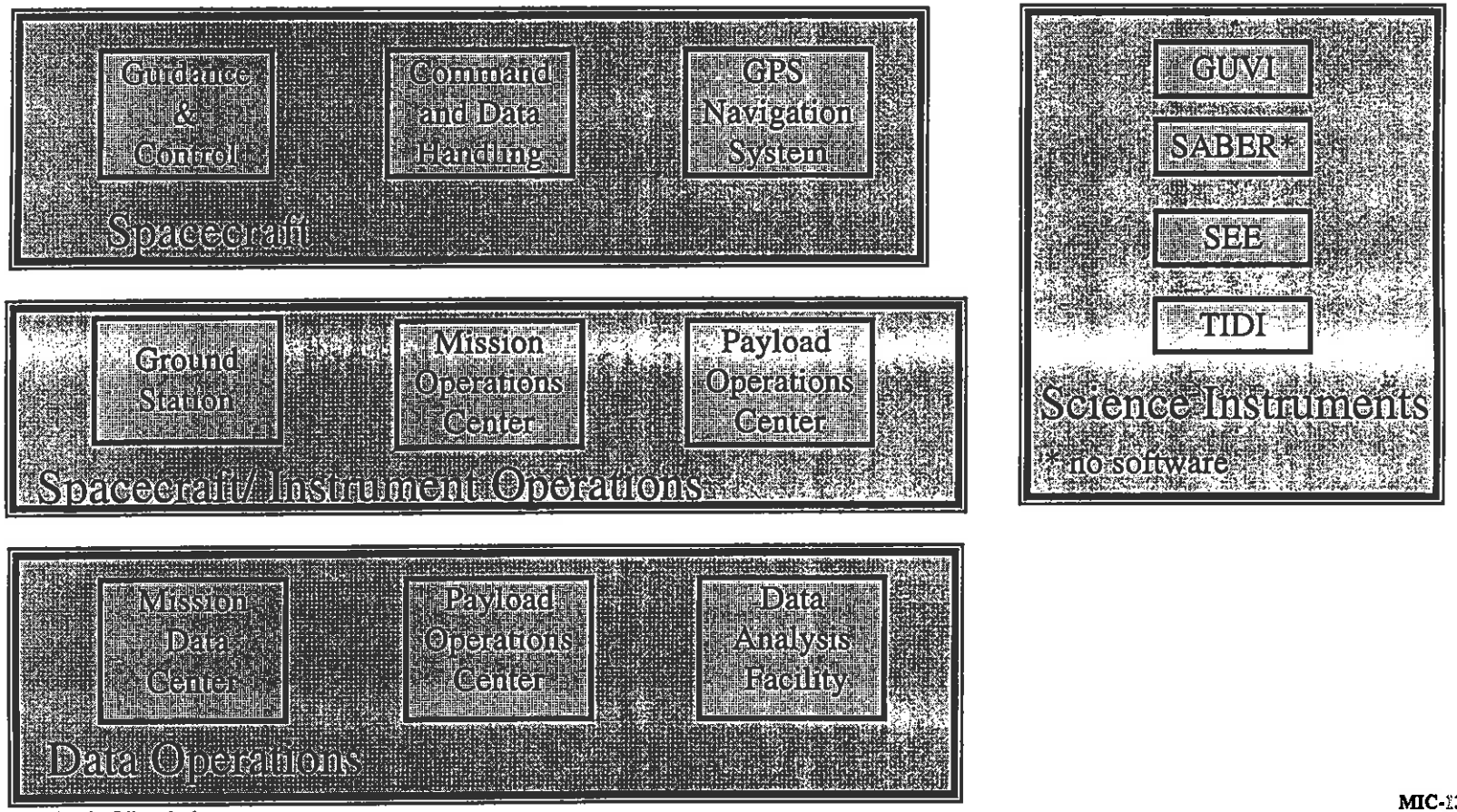
Subsystems With Major Software Components



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Software Development Plan

- **Developed by each software team**
- **Defines the software development process:**
  - **Specifies components**
  - **Categorizes software (criticality, usage, technical risk, and development risk)**
  - **Specifies documentation, testing, reviews, and configuration management**
  - **Signed by software leads, segment software engineers, and the Software Quality Assurance Engineer**

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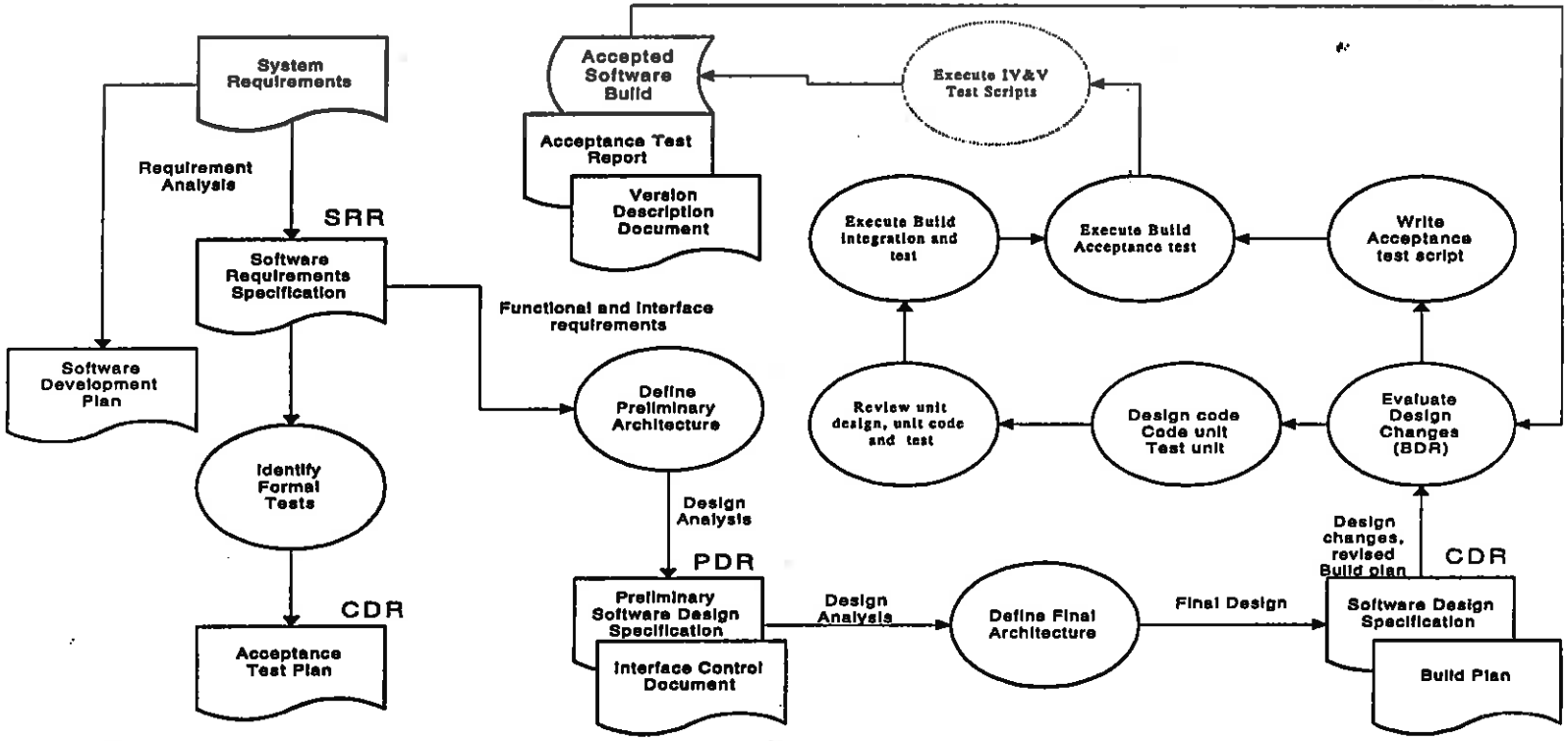
TIMED General Software Development Process



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Configuration Management (1 of 3)

- Configuration Elements
  - Documentation configuration
    - » Software Development Plan
    - » Requirements Specification
    - » Interface Control Document
    - » Acceptance Test Plan
  - Software configuration
    - » Subsystem software
    - » Commercial Off the Shelf software versions
    - » Software for testing and analysis
    - » Regression tests

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Configuration Management (2 of 3)

- **Documentation will be controlled by sign-off Sheet**
- **Software will be controlled as follows:**
  - **Before I&T**
    - » **Software controlled by Subsystem Lead**
    - » **Documented in the Software Development Plan or Software CM Plan**
  - **During I&T, pre-launch, and post launch**
    - » **Software controlled by Configuration Control Board**
    - » **Documented in the TIMED Configuration Management Plan**
    - » **Use common software Configuration Management tool**
    - » **Use Software Problem Report for *ALL* changes and has to be approved by CCB**

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Configuration Management (3 of 3)

- **Configuration Control Board Organization**
  - **Software Quality Assurance Officer (Chair)**
  - **Mission System Engineer**
  - **Mission Software Engineer**
  - **Segment System Engineer**
  - **Segment Software Engineer**
  - **Software Subsystem Lead**
  - **I&T and/or Mission Operations Lead**

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Verification and Validation

- Reviews (SRR, PDR, CDR)
- Code walkthroughs
- Unit testing
- Module integration testing
- Independent testing at subsystem level
- Independent Validation & Verification
  - Established for C&DH, GNS and G&C
- Integration & Test
- Mission simulations

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Software Reuse

- **Three different levels reuse**
  - **Requirements reuse**
  - **Design reuse**
  - **Code reuse**
    - » **Shared among the TIMED subsystems**
    - » **Reuse from the previous Projects**

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TIMED Mission Software Reuse (1 of 4)

Software Reuse Among the Subsystems

- **Software shared between I&T and Mission Operations**
- **Mini-MOC Build is a scaled down version of MOC and MDC**
- **Mongoose V Boot Program shared among C&DH, G&C and GNS**
  - **Requirements**
  - **Design**
  - **Code**
- **Tools to manage on board memory shared among C&DH, G&C, GNS, and MOC**

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TIMED Mission Software Reuse (2 of 4)

C&DH Software

- 1553 bus major and minor frame structure identical to that of NEAR
- Processing of CCSDS telecommands similar to that of ACE and NEAR
- Autonomy rule design derived from NEAR
- Time-tagged rule design derived from ACE and NEAR

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TIMED Mission Software Reuse (3 of 4)

Mission Data Center and Mission Operations Center

Code Shared

- Telemetry Router
  - » Developed by MDC, shared by MOC
- Orbit Propagator
  - » Developed by GNS, used by MDC
- Orbit Element Generator
  - » Developed by GNS, used by MDC
- Data Distribution System
  - » Developed by GSFC, reused by MDC

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Software Reuse (4 of 4)

Mission Operations Center

- **Epoch 2000 COTS product used for both NEAR Mission and TIMED Ground Station and MOC**

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