Space Mission Operations Overview

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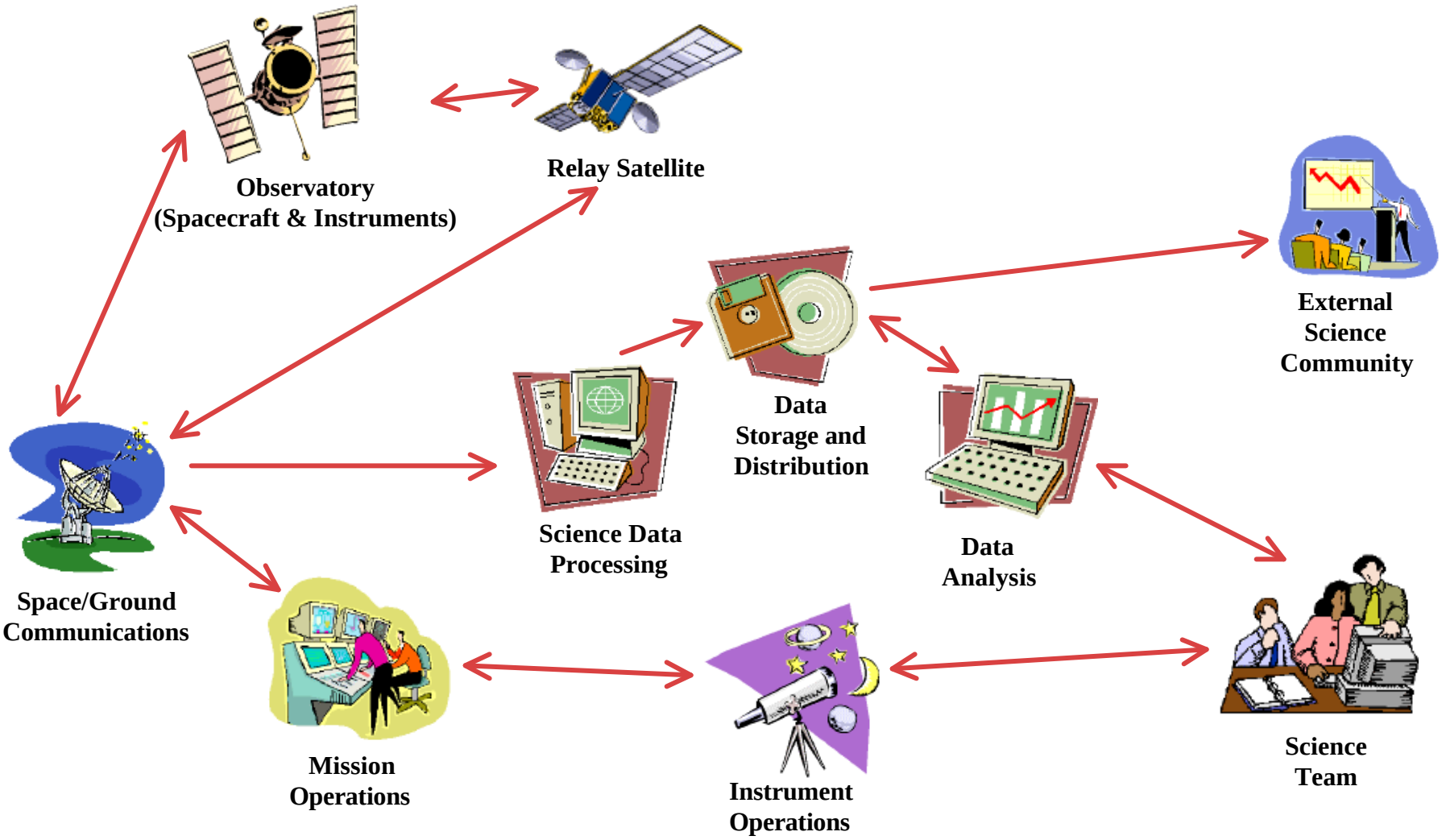
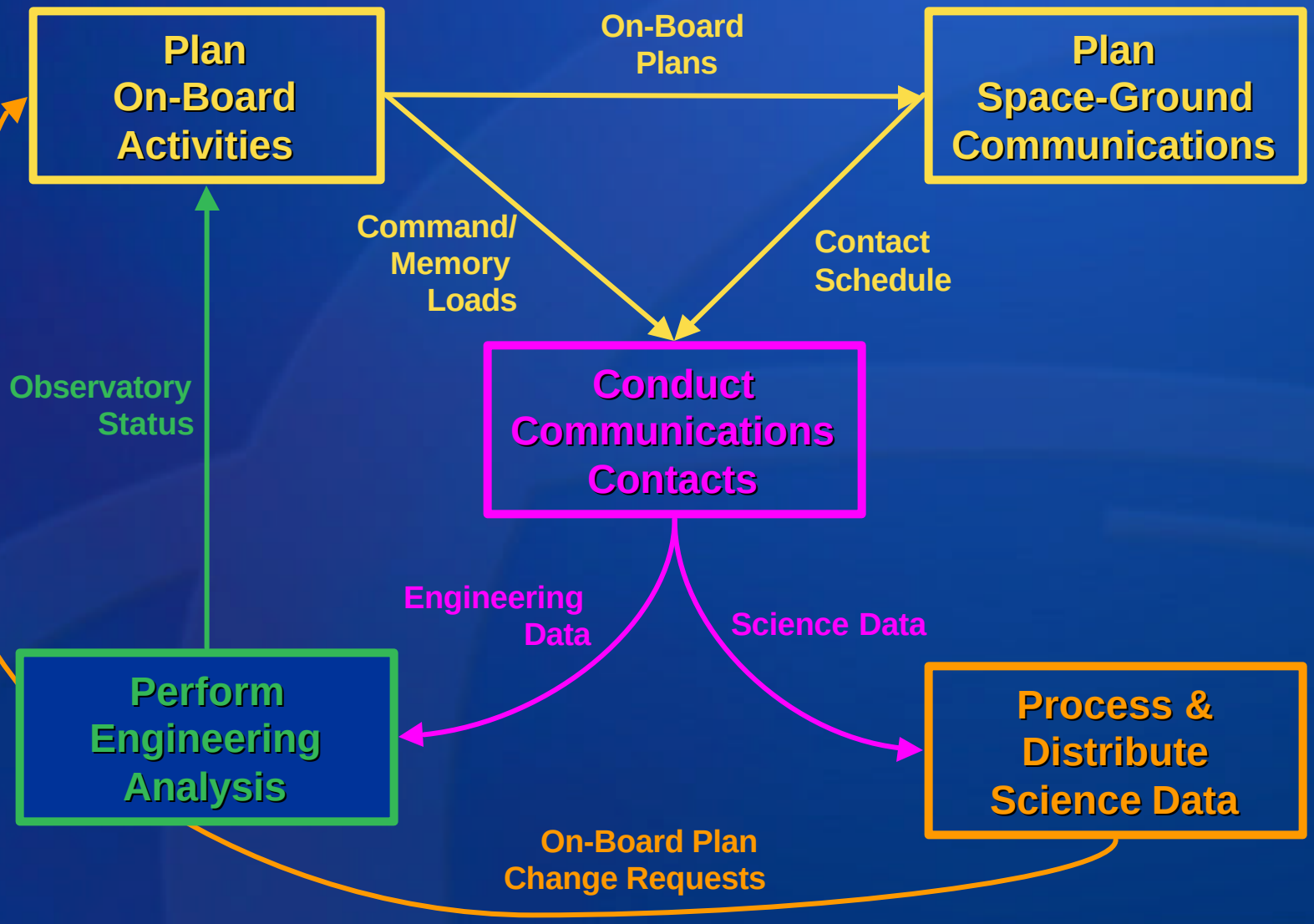
Mission Operations

- **Mission operations involves:**
  - Planning for the activities to be performed on the observatory and
  - Taking the actions needed to ensure those activities are performed as planned
  - Maintaining health & safety of spacecraft & instruments
- **These on-board activities include:**
  - Taking instrument measurements, images, etc.
  - Configuring for ground communications
  - Managing data recording/playback
  - Performing orbit and attitude (pointing) maneuvers
  - Managing memory (data tables, software patches)
  - Managing the power system (solar panels vs. batteries)
  - Managing the thermal system

Mission Architecture



Mission Functions and Data Flow



Operations Activities

- **Plan on-board activities**
  - Instruments and spacecraft
  - Factor in science team requests and operational needs
- **Plan space-to-ground communications**
  - Identify communications opportunities
    - Ground stations
    - Relay satellites (e.g., TDRS)
  - Factor in communications needs
- **Conduct communications contacts**
  - Real-time commands
  - Stored command loads
  - Memory loads (data tables and software patches)
  - On-board recorder dumps

Operations Activities

- **Perform Engineering analysis**
  - On-board data recorder management
  - Short and long term performance trending
  - Statistical performance analysis
  - Anomaly analysis/investigation
- **Process and distribute science data**
  - Raw (as received from spacecraft) data processing
  - Data product generation (Level 0)
    - Quick-look products (speed over completeness)
    - Production data products (completeness over speed)
  - Science processing (Level 1-3)
    - Data calibration and conversion - Level 1
    - Mapping to earth coordinates (geophysically located parameters) – Level 2
    - Correlation to other data (e.g., other instruments, in-situ measurements) – Level 3

Mission Operations Phases

- Pre-Launch Planning and Testing
  - Begins approximately launch – 2 years
  - Generation and validation of operations products (e.g., command procedures)
  - Observatory/ground system interface testing
  - Operations simulations/rehearsals
- Launch and Early Orbit
  - Typically lasts 30-90 days
  - Get observatory in proper orbit
  - Check out spacecraft susbsystems and instruments
  - Perform instrument calibrations
- Normal Operations
- Contingency Operations

Automation Successes

- Automating conduct of communications contacts
  - Traditional approach – 24x7 staffing and monitoring of spacecraft
  - "Lights-out" becoming common for offshift contacts
    - System automatically monitors data, performs data dumps, etc.
    - Pages operators when needed
  - Automated contacts tend to be relatively simple
- Generation of engineering data products
  - Control centers typically automatically receiving and processing raw data and generating engineering data products (e.g., trend plots)
  - BUT, analysis of data (e.g., trend plots) tends to be manual in nature

Automation Challenges

- Automated planning and scheduling
  - Can be very dynamic with many variables
- Automated commanding
  - Trend continues to be that commanding requires an operator in the control center
  - Need closed loop commanding between planning process and process for evaluating commanding success/results
- Remote access to data (for engineering and science data analysis)
  - Bandwidth vs. data volume big challenge
  - Strong desire to move to Web-based access, via wireless interface when needed
- Commanding from remote locations
  - Security biggest concern/challenge

Automation Challenges

- Expert systems for monitoring real-time contacts and analyzing engineering (trending) data
  - Particularly need to be able to predict problems, not just react to them (much more efficient)
- Handling of multiple missions (constellations) with minimal increases in staff
  - Increased effort across the board needed without significant increase in capabilities
- Putting more autonomy on-board
  - Data recorder management and playback
  - Science planning, particular in reaction to measurements taken on-board (e.g., changing observing plan in response to detected cloud cover)
  - Science data processing
    - Particularly doing Level 0 and 1 data processing onboard