

# Core Flight System (cFS) Training

## Simple Sat Overview

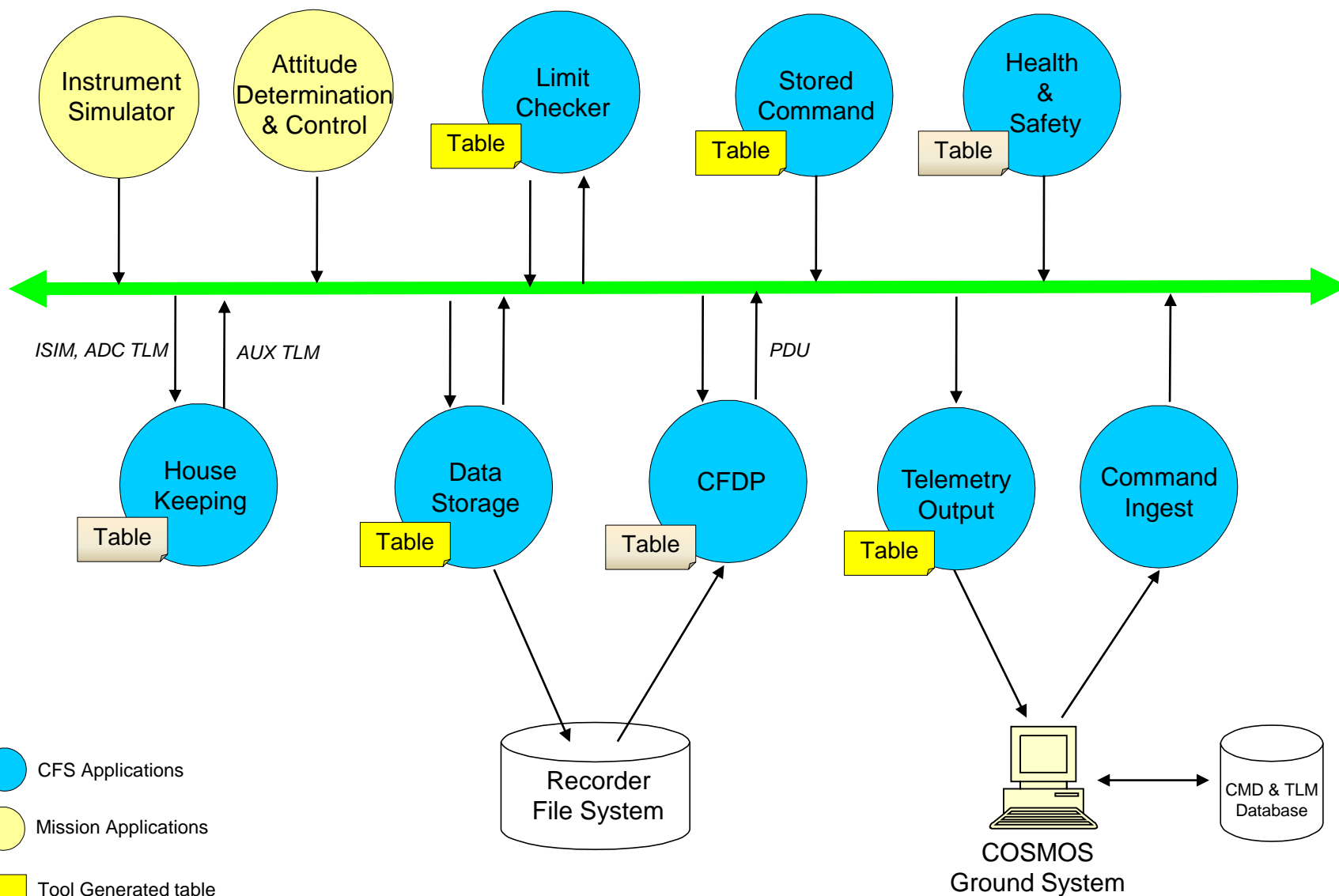
- **Provide hands on exercises for the systems engineering training modules**

## **1. Work through exercises using Simple Sat (SimSat)**

- Fictional spacecraft to provide a context for the data management design and exercises

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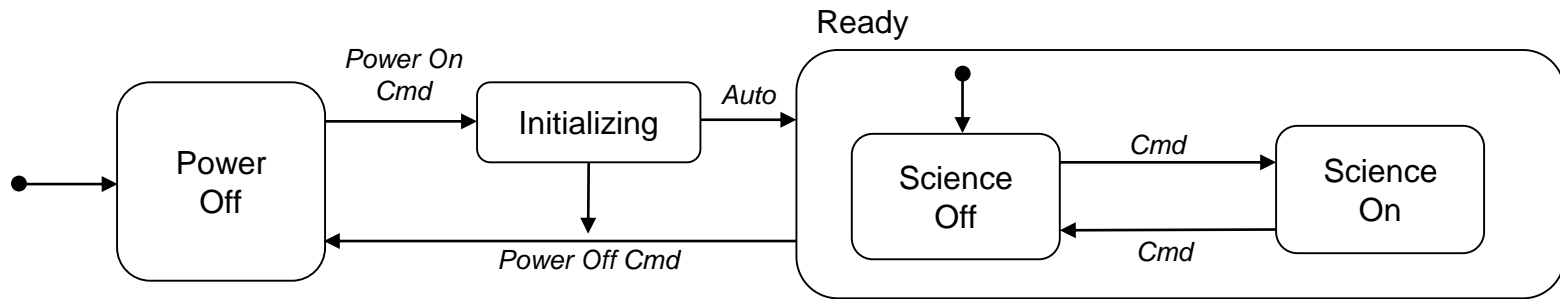
- **Low Earth Orbit (LEO)**
  - 90 minute orbit
  - One 15 minute ground contact per orbit with bi-directional comm
- **One science instrument, iSim**
  - Detector's 1Hz scan produces 10 bytes of data
  - Power on sequence
    - Apply power, wait for instrument warm up (~20s), then enable science
  - Power off sequence
    - Disable power

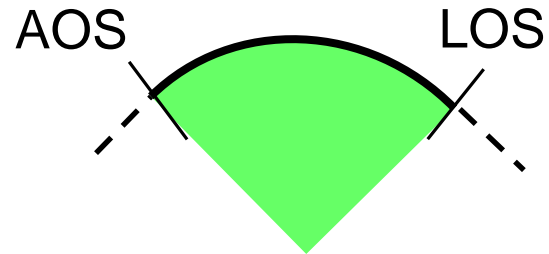


- **Science team requires**
  - A 1Hz auxiliary spacecraft data containing time, attitude, orbit data, and instrument status
  - Start science during a ground contact. Can be automated but ops prefers to monitor instrument health.
- **Ground contact resources/schedule are preplanned**
  - Implies autonomous operations can be loaded on board using stored commands
- **Each pass can either be a low or high downlink rate**
- **FSW must autonomously monitor instrument health and power off the instrument in the event of a fault**

- **iSim App**
  - Simulate science instrument data
  - Creates science data files and moves them to downlink directory
  - Commands
    - Power instrument on/off
    - Start/stop science data
    - Set/clear fault
  - Telemetry
    - Instrument status: Off, Initializing, Ready
    - Science data: Enabled, disabled
    - Fault: True, False
  - Use informational events to trace behavior.







Assess health

Retrieve Data

Upload

- Create and load stored command sequences to run a demo
- Use OpenSatKit exercises to work through an example



- **Housekeeping (HK)**
  - HK Combo packet 1 (0x089C) comes predefined with HK and contains HK data from each cFE app
    - Scheduler Slot 6, Activity 6
  - Create a new auxiliary science data packet using HK combo packet 2 (0x089D) that combines instrument status telemetry and ADC data
    - Scheduler Slot 6, Activity
- **Data Storage (DS)**
  - Configure file & filter tables to create:
    - Event message file: DS filter 6, file 0
    - Auxiliary data file: DS filter 15, file 6

- **Telemetry Output (KIT\_TO)**
  - Doesn't support filter tables
  - Create low/high tables that define which packets will be output for each scenario
  - Load low/high rate tables using stored commands
  
- **Limit Checker**
  - Monitor instrument status for the ready state and start RTS to enable science
  - Monitor instrument for a fault and start RTS to power off instrument if a fault persists for 3 seconds
    - WP #12 – Monitor ISIM fault
    - AP #2 – Start RTS 6 to stop science and power off the instrument

- **Stored Command (SC)**
  - Create Relative Time Sequences (RTS) to perform specific operational functions
  - RTS Definitions
    - 6 - Power off science instrument
    - TODO
      - Load KIT\_TO low rate table
      - Load KIT\_TO high rate table
      - Power on science instrument
      - Start science
      - Stop science
      - Start pass
      - End pass
  - Absolute Time Sequence (ATS)
    - Create an ATS to manage 24 hours of operations
    - For periodic operations such as bSat the duration of an ATS should be much longer than the ATS upload frequency to account for contingencies

- **File Manager (FM) & Trivial File Transfer Protocol (TFTP)**
  - Use FM to perform directory listing of files to downlink and to
  - Transfer files from flight to ground using TFTP
  
- **Checksum**
  - Configure checksum to monitor the stored command table checksums
  
- **CCSDS File Delivery Protocol (CF)**
  - Currently not in the kit
  - CF could significantly change the operational scenarios. Most of the file transfer and onboard file deletion activities could be automated if CF's "hot directory" and Class 2 mode are used

- **For each ground contact**
  1. Assess health of spacecraft
    - a. Take action if needed
  2. Manage onboard data files
  3. Uplink new ATS if needed

- **Verify expected spacecraft state**
  - This is mission specific, includes items such as
    - Expected control mode, clear LC flags, etc.
- **Dump, transfer, and display event log**
  - Event log should not fill up with informational events if you're judicious on how you define events. See cFE training module for guidelines
  - Clear log after log transferred to the ground

- 1. Use FM to list directory to a file**
- 2. Transfer directory file to the ground**
- 3. Sort files in priority order**
- 4. Transfer files in priority order**
  - a. Delete each file after successful transfer



# Reference

