



Space Data Systems Applications in the iPAS Pathfinder Laboratory

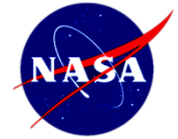
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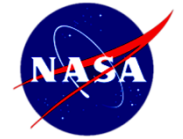
NASA Johnson Space Center

integrated Power, Avionics, and Software (iPAS) Pathfinder Lab Overview

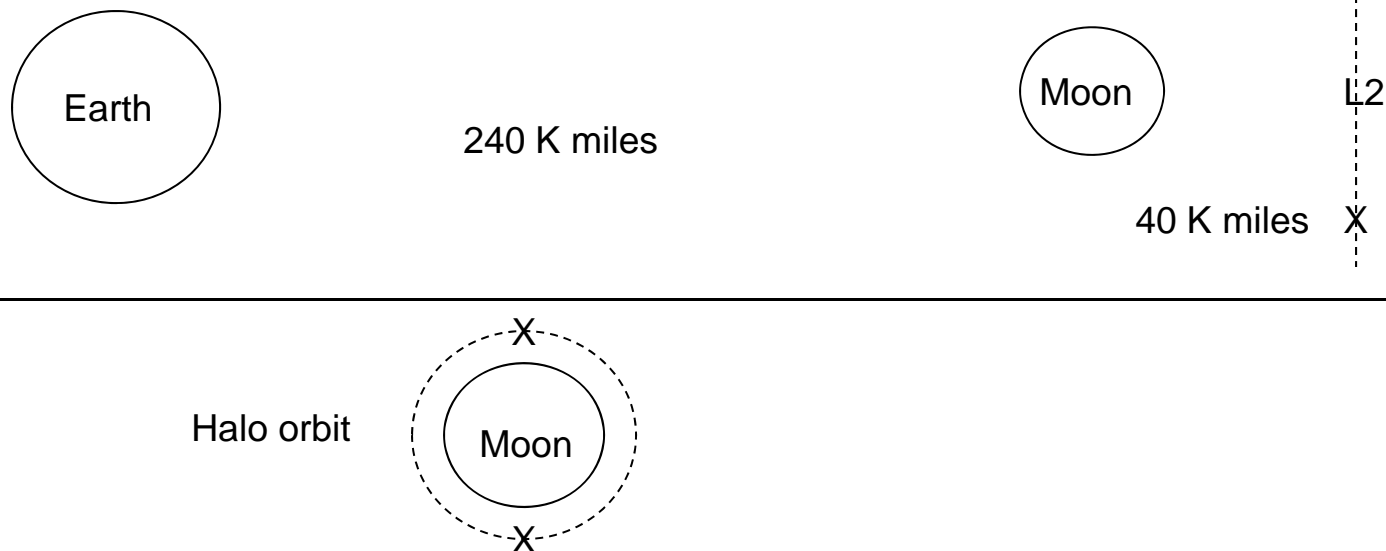


- The iPAS is an integrated hardware/software test and evaluation environment, in support of current and future spacecraft development
- The iPAS has two main elements
 - A common avionics, hardware, and software architecture that can be applied over various missions
 - A common testbed framework that supports integrated hardware/software testing for a variety of applications
- The iPAS includes the following (non-flight qualified) components:
 - Core Flight Software (from GSFC)
 - Commercially available Proton and S950 Flight Computer boards
 - Power and propulsion systems based on representative flight hardware
 - A realistic flight deck based on the Multi-Purpose Crew Vehicle (MPCV), including realistic flight controls and displays
 - A Space Data System based on CCSDS protocols

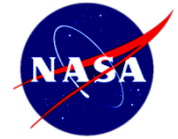
Current iPAS Mission Simulation



- The iPAS mission is to have the MPCV rendezvous with an ISS derived waypoint vehicle in a halo orbit about the earth-moon L2 Lagrangian point.
 - 1.3 seconds OWLT
 - Easy to stationkeep: 10 M/sec per year
 - Current max range of the MPCV
 - Halo orbit: constant line of sight



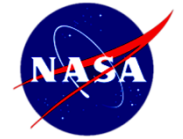
iPAS Space Data System Rationale



Mission Operations Goals for iPAS:

- Apply internationally standardized protocols to spacecraft command, telemetry, video, and file transfer in a realistic scenario where light-time delay becomes significant
 - Consultative Committee for Space Data Systems (CCSDS) standards:
 - Spacecraft Monitoring and Control (SM&C parameter and action services)
 - Asynchronous Message Service (AMS)
 - Delay / Disruption Tolerant Networking (DTN)
 - Licklider Transmission Protocol (LTP)
 - Provides reliable space to ground comm
 - “TCP in space”
 - Bundle Streaming Service (BSS)
 - Provides “cleaned up” video, after missing video data packets have been automatically detected and retransmitted by DTN
 - CCSDS File Delivery Protocol (cfdp)
 - Provides reliable file transfer in the space environment
- Raise the SM&C / AMS / DTN / LTP technical readiness level
- Bottom line: Acceptance and application of these standardized protocols will increase center-to-center interoperability and lower mission costs

Multi-Control-Center iPAS Overview



MPCV Hardware / Software
iPAS Lab, JSC Bldg. 29
(Green)

Command



DSN Operations Center
JPL Protocol Test Lab
(Yellow)

Telemetry



JPL



OTF, JSC Bldg. 30

(Peach)

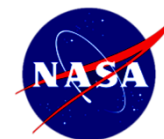


HOSC, MSFC

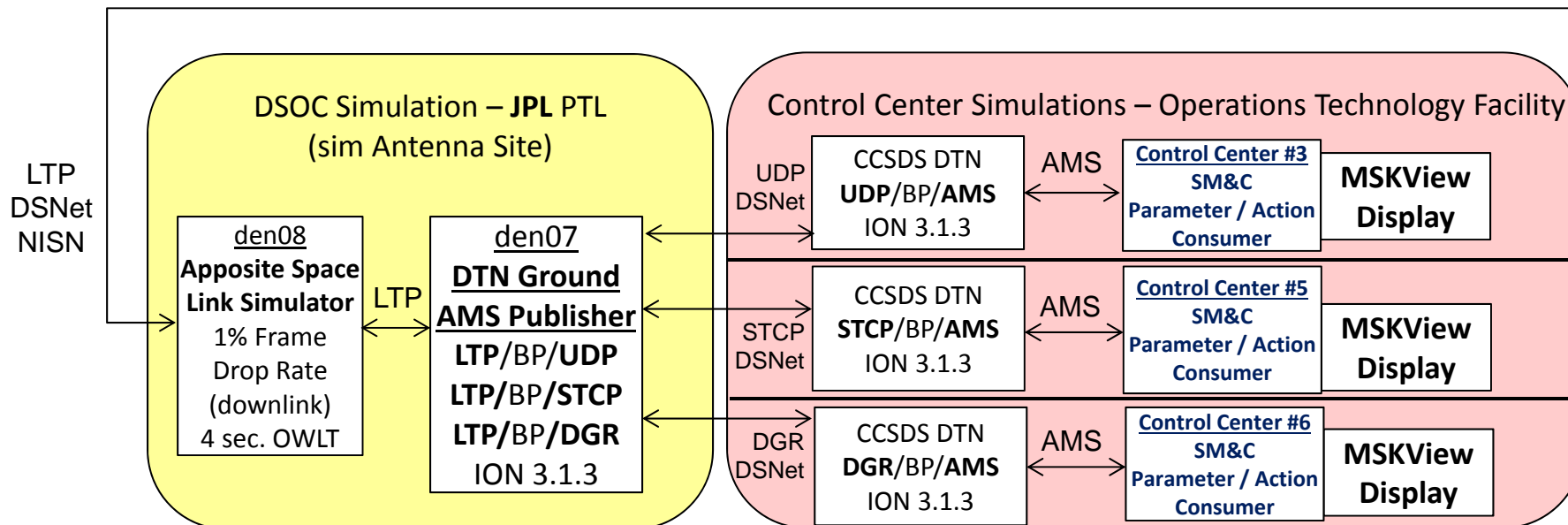
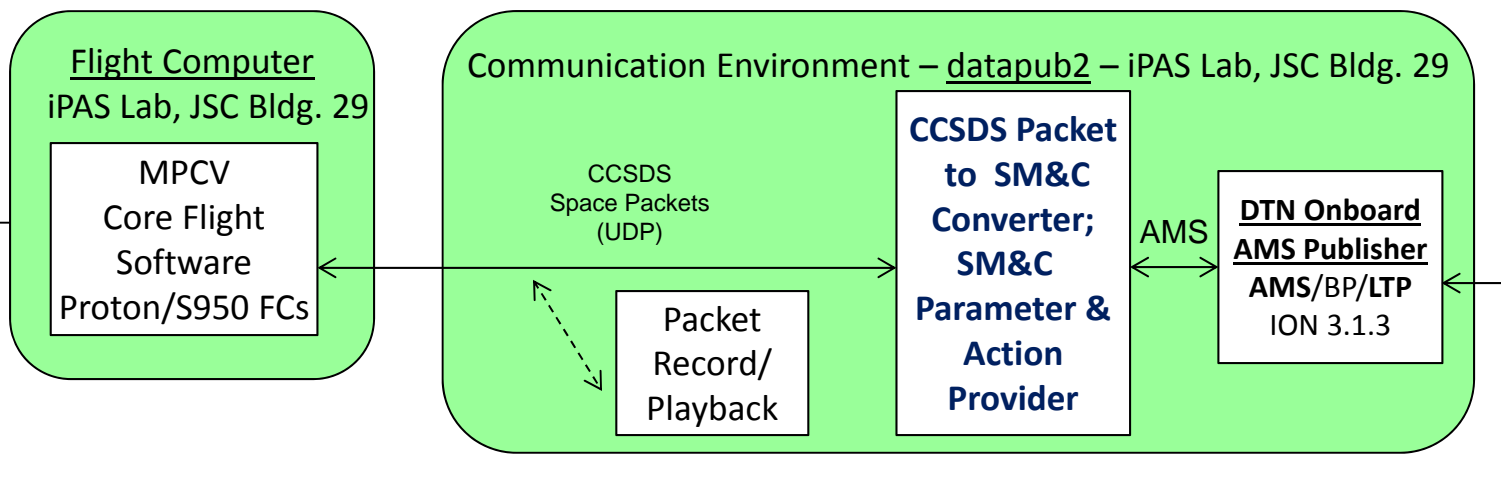


Simulated Mission: Dock with gateway vehicle in halo orbit about the Earth-Moon L2 point; final 2000 meters

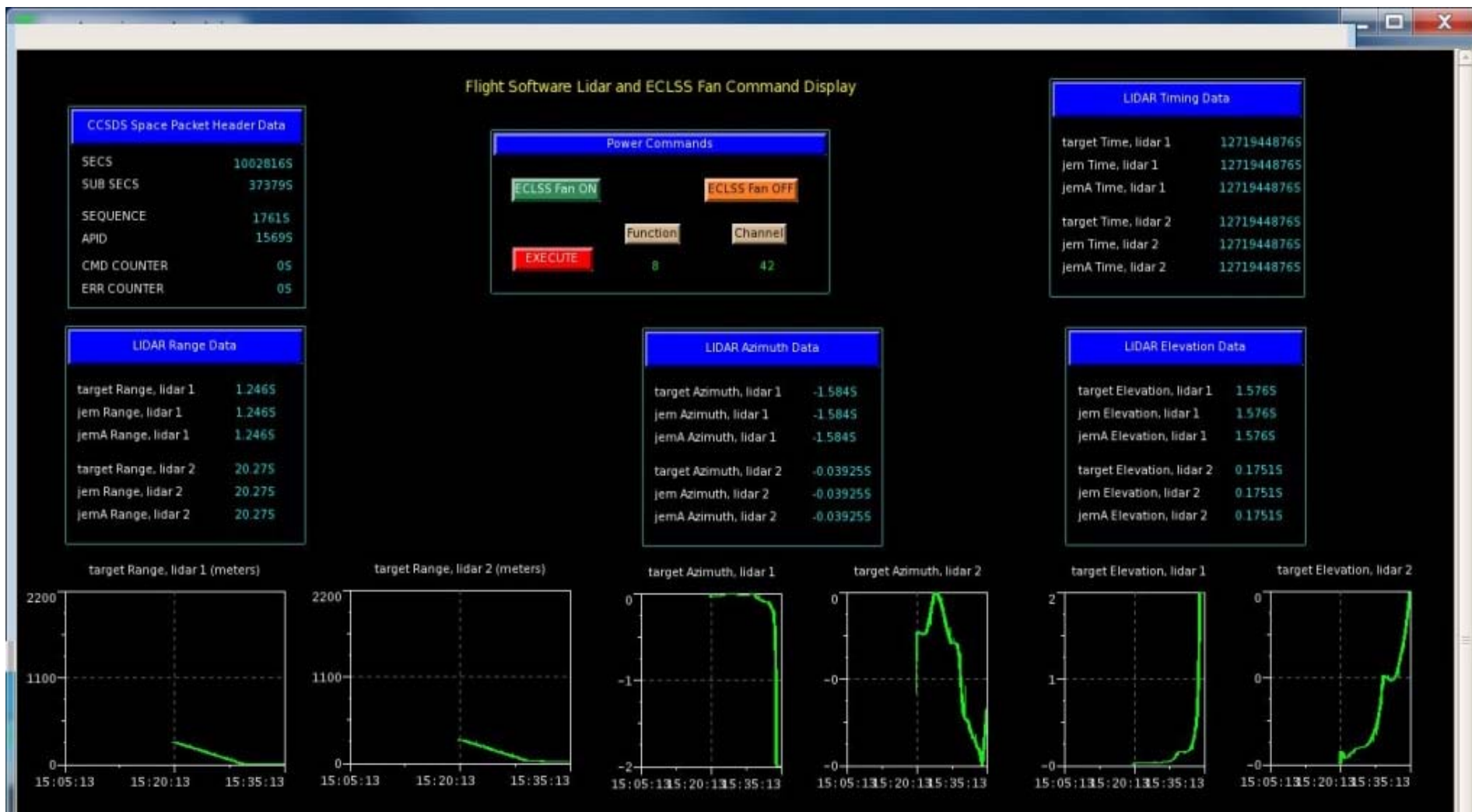
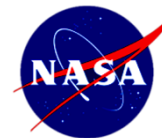
Multi-Control-Center iPAS Telemetry and Command System



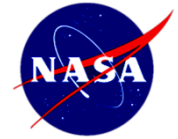
Onboard
ECLSS Fan



SM&C MSKView



Multi-Control-Center Demo



The screenshot displays a multi-control-center environment. The main window, titled "gnc_demo_ipas.msk mskview", shows a flight software interface with the following components:

- CCSDS Space Packet Header Data:**

SECS	1001440
SUB SECS	40421
- Power Commands:**
 - ECLSS Fan ON (green button)
 - ECLSS Fan OFF (orange button)
- Flight Software Lidar and ECLSS Fan Command** (title bar)

Below this, a second instance of the same interface is visible, showing additional data:

- CCSDS Space Packet Header Data:**

SECS	1001440
SUB SECS	40421
- Power Commands:**
 - ECLSS Fan ON (green button)
 - ECLSS Fan OFF (orange button)
- Flight Software Lidar and ECLSS Fan Command** (title bar)

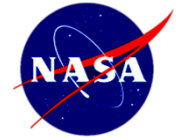
A third instance is partially visible at the bottom, showing:

- CCSDS Space Packet Header Data:**

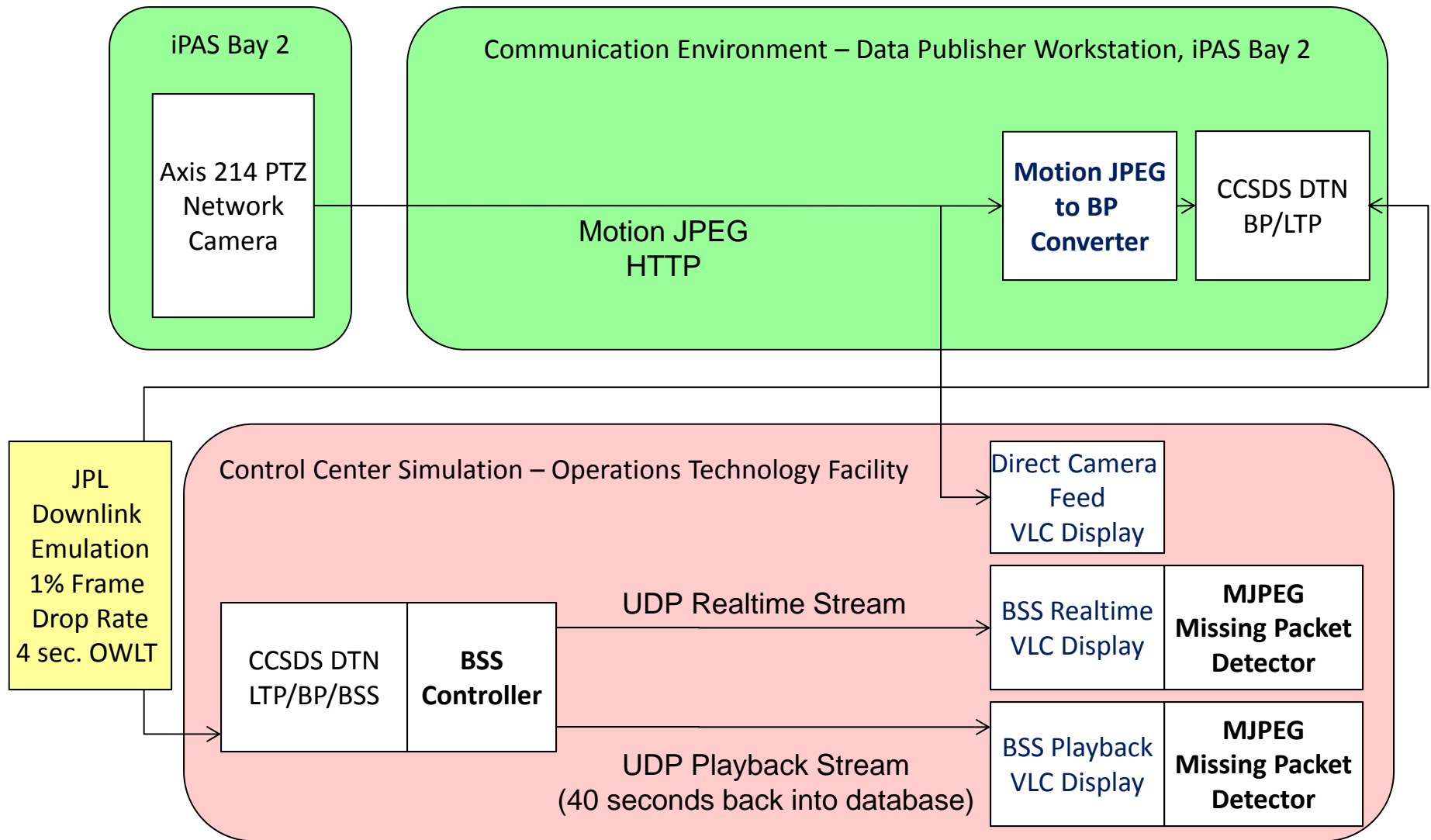
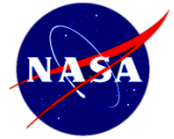
SECS	1001440
SUB SECS	40421
SEQUENCE	4336
APID	1569
CMD COUNTER	0
- Power Commands:**
 - ECLSS Fan ON (green button)
 - ECLSS Fan OFF (orange button)
 - EXECUTE (red button)
 - Function: 8
 - Channel: 42
- Flight Software Lidar and ECLSS Fan Command** (title bar)

The background shows a terminal window with various system messages and a taskbar with multiple instances of the application running.

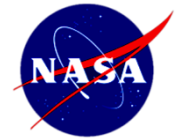
Bundle Streaming Service Video Demo



iPAS Video Stream Using BSS



Bundle Streaming Service Video Demo



The screenshot displays a Linux desktop environment with the following components:

- Top Panel:** Shows the system tray with icons for Applications, Places, System, and the time 10:50 AM.
- VLC (X11 output) Windows:** Three overlapping windows showing a video stream of a laboratory setup. The top window is timestamped 2013-10-18 10:50:27, the middle 2013-10-18 10:50:22, and the bottom 2013-10-18 10:49:42. The video shows a blue cabinet with a yellow frame and a sign that reads "nto Life stems".
- Terminal Windows:** Two terminal windows titled "trich@mccsil2:~/UDP" showing network traffic data. The top terminal displays data for sequence numbers 5087.5 to 5092.5, with missing mjpg packets 153, 154, 155, and 156. The bottom terminal displays data for sequence numbers 6170.5 to 6176.0.
- Taskbar:** Shows the active windows: [trich@mccsil2:~], VLC (X11 output), trich@mccsil2:~/UDP, and trich@mccsil2:~/JDP.