

Shuttle Fight Experiment Requirements

Flight Experiment Objectives: Demonstrate key functional capabilities of the PSA prototype. Prove system meets minimum safety operations requirements. Validate advanced crew support capabilities. Demonstrate advanced features such as remote, autonomous operations as well as environment fault isolation support.

Flight System Components & Functional Requirements

Ambient environment data (noise, temp, press, etc.)

Recording of voice and visual

Initially 2 for safety

Flight Demonstration Concept

A. System Components

1.0 PSA Free Flyer (battery packs)

2.0 PSA Laptop Server

2.1 500+ Mhz, 1 Gig RAM, 2 Audio ports (Nuance compatible), run PROLOG (Intel/Solaris), wireless ethernet interface (2+ Mbps throughput)

3.0 Crew Headset (headphones & microphone) head mounted high quality mike (need noise conditions)

4.0 Tele-operation joystick (6 degree of freedom) – Logitech Magellian

5.0 Laptop Server Video Camera

6.0 Targets (inventory, location, environmental source)

7.0 Ground System (same as above except for PSA free flyer)

B. Safety Requirements

1.0 Mobility

1.1 6 degrees of freedom

1.2 1-meter stopping distance

2.0 Shape & Volume Constraints: 9” diameter or less – sphere with no protruding appendages, or sharp edges

3.0 Obstacle Sensing Capabilities

3.1 Range: 4 meters in all 6 planes, error < 10%

3.2 Size: Objects greater than ??

4.0 Maximum Surface Temperature: less than ??

5.0 Noise limits: db/freq. Range

6.0 Global map registration <1 sec, error<10cm & < 5 deg.

7.0 Local movement detection < 0.1 sec, error < 1mm & < 1deg

C. Functional Requirements

1.0 Minimum Goals

1.1 System Checkout

1.1.1 PSA Free Flyer

1.1.1.1 System Power Checkout (battery)
(physical on-off switch)
(heartbeat LED)

1.1.1.2 Crew Interface Checkout

1.1.1.2.1 Audio (audio system test) RIACS

1.1.1.2.2 Video
(check laptop & free flyer video)
depth map calibration (set ranges for targets)
(have baseline disparity map)

1.1.1.3 LAN Connectivity Checkout – Lan manager (signal strength is good)

1.1.1.3.1 PSA

1.1.1.3.2 PSA Server

1.1.1.3.3 Ground (super ambitious maybe 2nd shuttle flight)

1.1.1.4 Sensor Functionality Checkout

1.1.1.4.1 Data Online (both available locally and on the server)

1.1.1.4.2 Calibration Check (compare this to Shuttle sensors – ancillary science data for the environment)

1.1.1.5 Propulsion System Checkout (pitch, yaw and roll articulation)

1.1.1.6 Software Applications Checkout
(run through calendar, sensor data, inventory display)

1.1.2 PSA Laptop Server Checkout

1.1.3 Crew Headset (part of the audio check)

1.1.4 Tele-operations Joystick (run self check)

1.1.5 PSA Laptop Videocamera (check displays on PSA & Laptop)

1.2 Core Functionality Demonstrations

Prep Work

Restraining Cage (straps and velcro to insure initial safety test)

Leash restraint

Check or apply fiducial targets (location and inventory)

1.2.1 Safety Navigation and Control Demonstrations
(crew validates PSA's orientation on laptop GUI)

1.2.1.1 Local Tele-operations control – translation & rotation tests
(in x,y,z) – canned sequence activated via laptop GUI

GUI disturbance rejection

GUI stability tests

Joystick control of set maneuvers

GUI execute set maneuvers

Test safing procedures

(degraded mode of operations)

1.2.1.2 Local Voice control – sensor values and PDA functions
then execute set maneuvers (real-time changes Stop, Backup, etc.)

1.2.1.3 Obstacle Avoidance

(crew member interference)

(small object interference)

(cables)

1.2.2 Local Sensor Monitoring – validate readings (both speech & text)

1.2.2.1 Oxygen

1.2.2.2 Nitrogen

1.2.2.3 Carbon Dioxide

1.2.2.4 Temperature

1.2.2.5 Humidity

1.2.2.6 Pressure

(parallel processing check)

1.2.3 PDA Application Demonstrations

1.2.3.1 Desktop Videoconferencing (between and Laptop Server)

1.2.3.2 Data Terminal (data access and display)

1.2.3.2.1 Display on the PSA Free Flyer

1.2.3.2.2 Display on the PSA Laptop Server

1.3 Local Autonomous Operations

1.3.1 Crew Flight Following – different types of following/orientations

- follow behind
- follow shoulder
- etc.
- speed tests

1.3.2 Environment Mapping

build an environmental map

1.3.3 Target Location Excursions

move commands target racks (marked by fiducial markers)

variable speed settings

variable pointing (orientation control)

station keeping

dynamic collision avoidance

2.0 Advanced Goals

2.1 Remote Onboard Autonomous Operations

2.1.1 Multi-deck/module Environment Mapping
(two crew operation)

2.1.2 Target Location Excursions

2.1.3 Cruise speed: 1m/s (0.25m/s fallback)

2.1.4 Operational Time: 10 minutes at cruise speed, 20 minutes stationary

2.2 Ground Remote Operations

(use ground terminal for voice commands)

2.2.1 Multi-deck/module Environment Mapping – validate operations via
3D visualizations on laptops

2.2.2 Target Location Excursions (between decks)

2.2.3 Crew Flight Following (between decks)

2.3 Advanced Applications

2.3.1 Inventory Tracking

2.4 Remote Applications

2.4.1 Ground to Crew Desktop Videoconferencing

2.4.2 Ground to Crew Data Terminal

2.4.2.1 Display on the PSA Free Flyer

2.4.2.2 Display on the PSA Laptop Server

2.4.2.3 Display on Ground terminal

2.5 Intelligent Operations

2.5.1 Multi-Task Planning/Sequencing – patrol scenario and then test if
recognizes an environmental disturbance

2.5.2 Environment Problem Location/Isolation

running a heater or CO₂ or safe gas test (Nitrogen) try out identification & isolation routines

C. Debugging and Contingency Plans