ParkinsonSAT Remote Data Relay (Psat)

Cubesat Conference
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Psat

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UNCLASS
Psat Xponder can also serve as complete comms & C&DH in a cubesat

- New tiny 5W RF Xponder
- Simple Sun Pointing ADCS $50
- Can support other SERB Payloads
- COTS solar panels $360 / ($15,000)

Psat USNA-0601
Psat Transponder

Aux Payload

75% Payload Space Available! (only 50% shown here)

- 18 cu.in for Transponder
- External 19” whip antenna
- 68 cu.in for Aux Payload (SPMS?)
- Aux payload gets 4” external panel
- Aug payload gets .5 kg – self contained
- 1 to 3W average power for aux payload
Psat Structure (& Thermal)

Was 0 C to 40 C on body
Sun Pointing Attitude Control System

- Pointing requirements are relaxed +/- 32 deg for 85% power
- High precision attitude control not required

Power Available vs. Satellite Angle Required

Cubesat
3.5W

SAFE mode
1.5W
Matlab Simulation of Modified B*dot

Modified Bdot Control

$\omega_x$

$\omega_y$ (deg/sec)

$\omega_z$

time (hrs)
Ground Station Software
Cubesat #A

Now split between two cubesats

Cubesat #B

aux payloads

19" whips
Huge reduction from transponders on PCSAT’s 1, 2, ANDE and RAFT missions

Now reduced 18:1 in volume/mass for 4” cubesat 2009

Earlier reductions to 5” cubesat on RAFT (2006) 4:1
Ground Terminal Applications Focus  (force tracking and text-messaging)

Supports Student Experimenters
School missions/movements
Theater area communications
and Emergency Response Comms

Education
Force
Multiplier!
Ground Terminal Applications Focus

Supports Student Experimenters world wide
Mission Background
Psat Xponder Mission (Remote Data Relay)

FOCUS:
“Network Centric” & Remote Sensor Experiments

300 stations In 35 miles

Find any station - http://aprs.fi/WB4APR*
Ground Terminal Applications Focus

Tactical Situational Awareness and Text Messaging

Last 100 stations!

Direction & Distance

Frequency and Tone
Example Situational Awareness (in SLC Utah)

27 users in S.L.C

map.findu.com/N7RKB*
Psat transponder can draw from thousands of experimenters for large scale loading experiments and other SERB experiments.

- Multiple transponders on smaller picosats can form a constellation for greater coverage and reduced latency.

- Not only the sensors and users exist, but the global Internet collection and distribution system also exists from PCSAT1 & 2.
Small Platform Minimum Satcom (SPMS) Background

Ground Terminal is Walkie-Talkie, and Palm Pilot

“When you have no comms, 1200 baud text/data is great!”

CAPT Chas Richard
Psat Global Internet linked Comms Network

Global APRS Real-Time Connectivity

AND Every APRS user connected to the internet is AUTOMATICALLY an IGate to RF for his area (think cellular)

APRS Global Packet Radio Network
Internet Linked for live Communications

Automatic Packet Reporting System
Psat APRS Network Architecture

Global Volunteer Ground Station Network
Internet Linked for live Telemetry
APRS Experiment Data Access (via internet)

http://map.findu.com/wb4apr* to see data on ANY experiment in the world

Based on the USNA Automatic Packet Reporting System
“Purple Force” Tracking

Map.findu.com/wb4apr*

Tactical situational awareness
Where to See it ALL

Global Comm system

http://aprs.fi
Live Example:  www.aprs.org/wb4apr-15.html
Example Remote Sensors using **APRS Protocol**

Very Simple APRS transmitter

Based on the USNA **Automatic Packet Reporting System**
Universal Ham Radio Text Messaging Initiative

Send/RX anytime, anywhere, any device by callsign

26 separate systems!
Psat
USNA-0601

Sensor Buoy Baseline (prototype)

Naval Academy Student Project
* If free-floating, do not disturb.
* If aground, move to deep water and advise bruninga@usna.edu
* If later than 30 Nov 2006, recover and advise above.

2006  15:1 reduction  2008

See Buoy Location and Telemetry at http://www.ew.unsa.edu/~bruninga/buoy4.html

Piggrem
DOD Synergy with Educational Experimenters

Based on the USNA Automatic Packet Reporting System

APRS Data Experiment in F-16 Aircraft

• Typical Low Cost Experiment
“Purple Force” Tracking

Map.findu.com/w3ado*

Tactical situational awareness
APRS (Psat Transponders) in Space

- 2001 PCSAT-1 Prototype Comm (semi-operational)
- 2006 PCSAT2 on ISS (returned after 1 year)
- 2007 ANDE de-orbited in 1 year
- 2008 RAFT de-orbited in 5 months
- 2007 Present ISS semi-operational due crew settings

Experimenter need a continuous Transponder in Space

APRS space frequency is published as 145.825

Huge reduction from Previous APRS transponders on PCSAT’s 1,2, ANDE and RAFT missions

Now reduced 18:1 in volume/mass
Mission: Remote Data Relay, Data Exfiltration, Remote Sensor Relay

Benefit: Support Space Education on the ground through space applications and student experimental access

Hardware: VHF simplex data Xsponder 145.825 MHz

Size/Mass: < 10 cu.in (1 PCB 3.4” square), <0.1kg

Power: < 1W orbit average, 5 volts.

Integration Requirement: Simply, on/off (or *)

Structure Impact: Needs 19” thin wire whip antenna (1 cu.in)

Benefit to Spacecraft: High visibility to worldwide educational institutions, fosters collaboration, orders of magnitude greater student experimental access to space systems (ground segment). * Independent back-up telemetry command/ control channel, RS232 serial data, 16 on/off discretes, backdoor reset capability. Worldwide Telemetry Beacon access via global station network.

2010 Navy SERB
Constellation Operation of USNA Satellites

All on 145.825 MHz

- Common VHF/HF, VHF/UHF, UHF/VHF
- Global connectivity
- Over the Horizon links
- 2, 3 or 4 hops extended range
- Joint operations (4 x 6 or 24 passes per day)
- Continuity of service

During the March 2006 joint PC1<=>PC2 operations period, numerous dual hop telemetry and user packets were observed. This telemetry packet from PCSAT2 is just about as far as we can get with satellite-to-satellite-to USNA. Notice how few European or USA users were in the footprint making it more probable that PCSAT-1 could hear PCSAT2's signal.
Dual Satellite 2-hop links
Global Volunteer
Groundstations
feed live downlink into Internet
Sensor Buoy Baseline  PCSAT validates our links

PCSAT2 User Plot 18 Apr 06

2010 Navy SERB
Prototype Buoy Data

Google for
“USNA Buoy”
Select USNA-1
(or Buoy4)
Questions?

2001-2007

USNA Comms Compatible Spacecraft

2006

2007

2009

Psat USNA-0601

1G-1 Axis Test/Demo

2006

2007

2010 Navy SERB