

NATIONAL RECONNAISSANCE OFFICE

NROL-36/OUTSat Impacts/Lessons Learned

Office of Space Launch



FREEDOM'S SENTINEL IN SPACE



Agenda

- ✦ The Impact
- ✦ Manifest
- ✦ Integration
- ✦ Lessons Learned
- ✦ Aft Bulkhead Carrier Future
- ✦ Conclusion



The Photo



Credit: The Aerospace Corporation



The Impact

- ✦ Increased interest from senior leadership for use of smallsats – cubesats in particular
- ✦ Understanding by the primary SV customer that flying auxiliary payloads is doable
- ✦ Simple statements – but HUGE impact!



OUTSat CubeSat Manifest

Name	Size	Manifest Org	Mission	Sponsor	Organization
Re	3u	NRO/MSD	Space Object Tracking	LLNL	LLNL, NPS, Texas A&M
AENEAS	3u	NRO/MSD	Maritime Shipping Container TT&L	DHS	USC/ISI
SMDC ONE 2.1	3u	NRO/MSD	Tactical BLOS Comms	SMDC	MilTec Corp
SMDC ONE 2.2	3u	NRO/MSD	Tactical BLOS Comms	SMDC	MilTec Corp
AeroCube 4.5a	1u	NRO/MSD	Tech Validation	SMC	The Aerospace Corp
AeroCube 4.5b	1u	NRO/MSD	Tech Validation	SMC	The Aerospace Corp
AeroCube 4	1u	NRO/MSD	Data Logger; De-orbit device	NRO	The Aerospace Corp
CSSWE	3u	NASA/LSP	Monitor Accel of Radiation Belt Electrons	NSF	U of Colorado Boulder
CINEMA	3u	NASA/LSP	Monitor Ions/Neutrals/Electrons/Magnetic Fields	NSF	U of California Berkeley
CP-5	1u	NASA/LSP	Validate Large Surface Area De-Orbit Device	NASA	Cal Poly
CXBN	2u	NASA/LSP	Monitor Cosmic X-Ray/Gamma Ray Background	NASA	Morehead State U



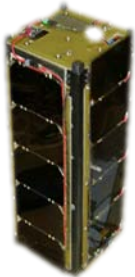
OUTSat Auxiliary Payload

CubeSats

P-POD (Poly-Pico Orbital Deployer)

NPSCuL & P-PODs

3U



Installed in P-POD
(Cal Poly, San Luis Obispo)

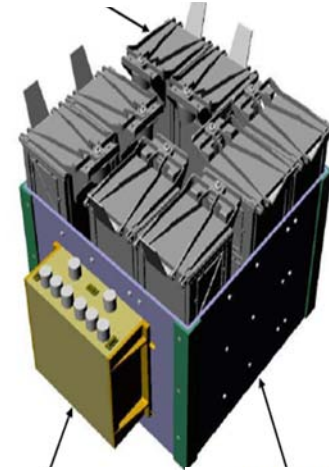


1U



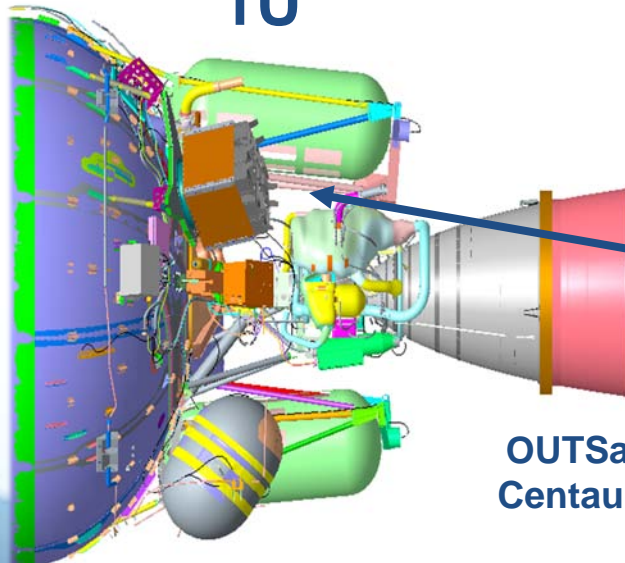
8 P-PODs installed in
NPSCuL
(NPS, Monterey, CA)

PPOD's

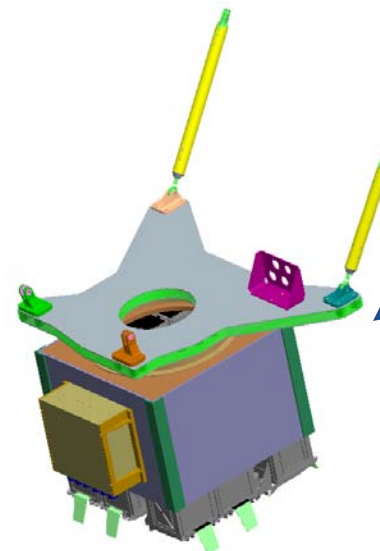


SAD

NPSCuL



OUTSat installed on
Centaur aft bulkhead



OUTSat

OUTSat Mated to
the ABC Plate
(Launch Site)



OSL's OUTSat Integration Team

- ✦ To ensure a single POC to ULA, Range Safety, and others – OSL contracted the role of the Auxiliary Payload Integration Contractor (APIC) to Cal Poly – using NASA/LSP existing contracting mechanism.
 - Cal Poly teamed with SRI Inc to provide the necessary expertise to perform all of the required APIC tasks
 - In this role, they have two main responsibilities.
 - ✦ Perform the integration function to deliver a fully tested OUTSat satellite to OSL for integration to the Atlas launch vehicle.
 - ✦ Single POC for the integration of OUTSat to the Atlas launch vehicle.
- ✦ OSL also has a direct relationship with Naval Postgraduate School to provide the NPSCuL "bus structure" and perform final acceptance testing of the integrated OUTSat.
 - NPS supports the APIC in their role of integrating contractor, and as such, in some circumstances interface directly with ULA and Range Safety to provide technical details on behalf of the APIC.



Lessons Learned - Inhibits

- ✦ Inhibits – Use them!
 - Safety considerations
 - ✦ Dual fault tolerant, 3 inhibits required for catastrophic events
 - ✦ If not DFT, must analyze to confirm not catastrophic
 - Lack of inhibits doesn't mean you *can't* fly, however time and money spent doing analyses may mean you *won't* fly – resources are limited!
 - Expertise at APIC, ULA, Range Safety to help
 - Consider: Power, deployables, beacons, transmitters, payloads
 - Our primary SV customers – and ULA - will insist all failure scenarios are analyzed



Lessons Learned - Licensing

- ✦ Licensing for the Auxiliary Payload(s)
 - Know what licenses/coordinations you need
 - ✦ Amateur, experimental, civilian, government, "remote sensing", etc
 - Know who's involved for your particular mission
 - ✦ IARU, FCC, NTIA, ITU, NOAA
 - Know the processes, paperwork, and timelines involved

 - As a result of issues during the L-36 processing, an rapport has been established between FCC and NRO/NASA/ORS.
 - Well defined process defined for license application established for a ABC (and other) "multi satellite" missions



Lessons Learned – Orbital Debris

- ✦ Orbital Debris – huge issue with all government agencies
 - Spacecraft as well as upper stages
 - On-orbit requirements – good stewards of space
 - End of Life:
 - ✦ Re-enter within 25 years and Casualty Expectation $< 10^{-5}$
 - ✦ Specified disposal orbits
 - ✦ Retrieval
 - National Space Policy defines “exception” process – high visibility
 - For FCC license, orbital debris assessment required
 - ✦ On orbit and Re-entry
 - ✦ Satellite components surviving re-entry and reaching earth’s surface likely (if > 15 J energy) to require insurance – it’s expensive!
 - ✦ Consider eliminating high-melting point materials from your design



Lessons Learned – Photos

- ✦ Take photos
- ✦ Take photos
- ✦ Take photos

- ✦ Document your configuration

- ✦ Helps with on-orbit anomaly resolution

- ✦ Instrumental in one of OUTSat cubesats being able to resolve post-vibration test anomaly, wouldn't have flown without photo documentation of flight configuration



ABC Future

✦ Near term:

- L-39 launch in December 2013
- L-55 launch late 2014
- NRO teamed with Air Force for AFSPC-5 launch late 2014

✦ Downstream: Work with Air Force to establish ABC as a standard service on applicable Atlas V missions



Conclusion

- ✦ ABC designed to offer low cost, recurring launch opportunity for smallsats (up to 85 kg) on one of the world's most reliable launch vehicles
- ✦ First use has had it's challenges, however:
 - OUTSat successfully placed 11 cubesats in orbit
 - L-36 primary mission team and ULA satisfied - all "do-no-harm" requirements met
- ✦ Challenges definitely exist for smallsats to co-exist with high-value national security payloads – but it is doable with the right planning
- ✦ Colloborate Colloborate Colloborate



Credit: The Aerospace Corporation

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